

**A Retrospective Audit of Emergency Department  
Management of Acute Dizziness and Vertigo in New Zealand:  
Evaluating Alignment to Evidence-Based Guidelines and the  
Impact of Physiotherapist Involvement**

Kane Nickles

A thesis submitted to  
Auckland University of Technology  
in fulfilment of the requirements for the degree of Master of  
Philosophy (MPhil)

2026

School of Allied Health

# Abstract

Acute dizziness and vertigo are common but diagnostically challenging presentations in emergency departments (EDs), with known risks of misdiagnosis and variability in care. Despite advances in diagnostic approaches, the extent to which evidence-based assessment and management are applied in routine clinical practice remains uncertain, particularly within the Aotearoa New Zealand context.

This study aimed to evaluate the quality and equity of care for patients presenting with acute dizziness and vertigo in two metropolitan EDs and to examine the contribution of ED physiotherapy to clinical practice. A mixed-methods design was employed, consisting of a rapid scoping review of evidence-based vestibular assessment and a retrospective clinical audit of emergency physician and physiotherapy documentation. A disproportionate stratified sampling approach was used to enhance representation of Māori patients and support equity analysis.

Overall adherence to evidence-based care was low across both diagnostic and management domains. Structured vestibular assessments were infrequently documented, and treatment approaches were often inconsistent with clinical guidelines. Physiotherapy involvement was associated with higher rates of evidence-based assessment and intervention. Māori patients received slightly lower rates of evidence-aligned care and had reduced access to physiotherapy services compared to non-Māori.

These findings highlight a gap between recommended and actual clinical practice and identify variation in access to specialised assessment. The study provides novel local evidence on emergency vestibular care, including Indigenous health data, and supports the need for system-level approaches to improve consistency, clinical quality, and equity in ED care pathways.

## Table of Contents

|                                                                                                           |      |
|-----------------------------------------------------------------------------------------------------------|------|
| Abstract                                                                                                  | i    |
| Table of Contents                                                                                         | ii   |
| List of Figures                                                                                           | vii  |
| List of Tables                                                                                            | viii |
| Attestation of Authorship                                                                                 | ix   |
| Acknowledgment of Artificial Intelligence Use                                                             | x    |
| Acknowledgments                                                                                           | xi   |
| Chapter 1                                                                                                 | 1    |
| 1.1    Introduction                                                                                       | 1    |
| 1.2    Structure of the Thesis                                                                            | 4    |
| 2    Chapter 2: Narrative Literature Review of Acute Dizziness and Vertigo in the<br>Emergency Department | 6    |
| 2.1    Search Strategy                                                                                    | 6    |
| 2.2    Burden of Acute Dizziness and Vertigo                                                              | 6    |
| 2.2.1    Conceptualisation and Definition of Acute Dizziness and Vertigo                                  | 7    |
| 2.2.2    Prevalence                                                                                       | 9    |
| 2.2.3    The Vestibular System                                                                            | 10   |
| 2.2.4    Common Vestibular Pathologies                                                                    | 13   |
| 2.3    ED Setting                                                                                         | 17   |
| 2.3.1    Setting challenges                                                                               | 17   |
| 2.3.2    Organisational pressures                                                                         | 19   |
| 2.3.3    ED Physiotherapy                                                                                 | 19   |
| 2.4    Indigenous Healthcare                                                                              | 20   |
| 2.4.1    Māori Health and Wellbeing                                                                       | 21   |
| 2.4.2    Māori Health and the Emergency Department Interface                                              | 23   |
| 2.5    Challenges of Acute Dizziness and Vertigo in the Emergency Department                              | 23   |
| 2.5.1    Condition Complexity                                                                             | 25   |
| 2.5.2    Behavioural Barriers to Evidence-Based Acute Dizziness and Vertigo<br>Management                 | 25   |
| 2.5.3    Imaging                                                                                          | 26   |
| 2.5.4    Inappropriate Pharmacological Response                                                           | 27   |

|       |                                                                            |    |
|-------|----------------------------------------------------------------------------|----|
| 2.5.5 | Non-use of Bedside Interventions                                           | 28 |
| 2.6   | Impact of these challenges                                                 | 29 |
| 2.6.1 | Patient Consequence                                                        | 29 |
| 2.6.2 | Healthcare Institution Consequence                                         | 30 |
| 2.6.3 | Societal Consequence                                                       | 31 |
| 2.7   | Response to Challenges                                                     | 32 |
| 2.8   | Summary of Narrative Review                                                | 34 |
| 3     | Chapter 3: Rapid Scoping Review                                            | 36 |
| 3.1   | Introduction                                                               | 36 |
| 3.1.1 | Objectives:                                                                | 37 |
| 3.1.2 | Rapid Scoping Review Questions                                             | 37 |
| 3.2   | Methodology                                                                | 38 |
| 3.2.1 | Study Design and Rationale                                                 | 38 |
| 3.2.2 | Methodological Framework                                                   | 39 |
| 3.2.3 | Eligibility                                                                | 39 |
| 3.2.4 | Information Sources / Databases                                            | 40 |
| 3.2.5 | Search Strategy and Analysis                                               | 40 |
| 3.2.6 | Search Terms                                                               | 40 |
| 3.2.7 | Study Selection                                                            | 42 |
| 3.2.8 | Data Extraction                                                            | 42 |
| 3.2.9 | Data Analysis                                                              | 43 |
| 3.3   | Results                                                                    | 44 |
| 3.3.1 | Quantitative Summary                                                       | 44 |
| 3.3.2 | Thematic Synthesis                                                         | 55 |
| 3.3.3 | Recommended Evidence Base and the Current State of International Adherence | 55 |
| 3.3.4 | Evidence Base and Guidelines                                               | 56 |
| 3.3.5 | Evidence-Based Assessment                                                  | 58 |
| 3.3.6 | Evidence-Based Intervention                                                | 61 |
| 3.3.7 | Adherence to Evidence Base Metrics                                         | 62 |

|        |                                                                                   |    |
|--------|-----------------------------------------------------------------------------------|----|
| 3.3.8  | Description of Physiotherapy                                                      | 64 |
| 3.3.9  | ED Physiotherapist Involvement                                                    | 64 |
| 3.3.10 | Indigenous Health Equity and Evidence of Disparities in Emergency Vestibular Care | 66 |
| 3.3.11 | Limitations of the Rapid Scoping Review                                           | 67 |
| 3.4    | Summary of Rapid Scoping Review                                                   | 68 |
| 3.4.1  | Transition from Rapid Scoping Review to Clinical Audit                            | 69 |
| 4      | Chapter 4: Retrospective Audit of Clinical Documentation                          | 70 |
| 4.1    | Purpose of the Study                                                              | 70 |
| 4.1.1  | Research Questions                                                                | 70 |
| 4.2    | Methodology                                                                       | 70 |
| 4.2.1  | Introduction                                                                      | 70 |
| 4.2.2  | Methodological Framework                                                          | 71 |
| 4.2.3  | Reflexivity                                                                       | 72 |
| 4.2.4  | Personal Relationship with Post-Positivism                                        | 72 |
| 4.3    | Study Design                                                                      | 73 |
| 4.3.1  | Ethical Approval and Data Privacy                                                 | 73 |
| 4.3.2  | Operationalising Te Tiriti o Waitangi                                             | 74 |
| 4.3.3  | Research Setting and Context                                                      | 77 |
| 4.3.4  | Sampling and Sampling Bias                                                        | 77 |
| 4.3.5  | Sample Size Power and Participant Selection                                       | 78 |
| 4.4    | Data Collection and Management                                                    | 79 |
| 4.4.1  | Phase One: Data Acquisition Process for Sample Selection                          | 79 |
| 4.4.2  | Randomisation and Sampling Procedures                                             | 80 |
| 4.4.3  | Phase Two: Data Extraction Process                                                | 81 |
| 4.4.4  | Data Extraction Tool                                                              | 82 |
| 4.4.5  | Data Management and Storage                                                       | 84 |
| 4.4.6  | Reviewer Characteristics and Training                                             | 85 |
| 4.5    | Data Analysis Plan                                                                | 85 |
| 4.5.1  | Statistical Interpretation of Strength of Agreement                               | 85 |

|        |                                                                                |     |
|--------|--------------------------------------------------------------------------------|-----|
| 4.5.2  | Descriptive Statistics                                                         | 87  |
| 4.5.3  | Inferential Statistics                                                         | 87  |
| 4.5.4  | Comparative Audit Analysis                                                     | 87  |
| 4.5.5  | Statistical Analysis of Interprofessional Concordance                          | 88  |
| 4.6    | Results                                                                        | 89  |
| 4.6.1  | Sample                                                                         | 89  |
| 4.6.2  | Characteristics of Sample                                                      | 90  |
| 4.6.3  | Emergency Department Service Delivery and System Performance                   | 91  |
| 4.6.4  | Clinical Practice Alignment with Evidence-Based Guidelines                     | 93  |
| 4.6.5  | Initial Triage and Secondary Screening                                         | 93  |
| 4.6.6  | Management of Acute Vestibular Syndrome                                        | 94  |
| 4.6.7  | Management of Benign Paroxysmal Positional Vertigo                             | 98  |
| 4.6.8  | Neuroimaging and Vestibular Referral                                           | 102 |
| 4.6.9  | Equity of Care                                                                 | 102 |
| 4.6.10 | Summary of Key Findings                                                        | 104 |
| 4.7    | Discussion                                                                     | 106 |
| 4.7.1  | Study Design                                                                   | 107 |
| 4.7.2  | Data Fidelity and Extraction Reliability                                       | 108 |
| 4.7.3  | Comparison to Similar Established Literature                                   | 108 |
| 4.7.4  | Departmental Findings                                                          | 109 |
| 4.7.5  | Diagnosis Patterns                                                             | 110 |
| 4.7.6  | Acute Vestibular Syndrome Assessment                                           | 112 |
| 4.7.7  | BPPV Assessment                                                                | 113 |
| 4.7.8  | Advanced Imaging Use                                                           | 114 |
| 4.7.9  | BPPV Treatment                                                                 | 115 |
| 4.7.10 | Clinical Practice Alignment with Evidence-Based Guidelines                     | 116 |
| 4.7.11 | A Critique of GRACE-3: Acute dizziness and vertigo in the emergency department | 117 |
| 4.7.12 | Clinical Quality Comparison between Professional Roles                         | 123 |

|        |                                         |     |
|--------|-----------------------------------------|-----|
| 4.7.13 | Equity                                  | 123 |
| 4.7.14 | Limitations of the Clinical Audit       | 125 |
| 4.7.15 | Future Directions Clinical Implications | 127 |
| 4.8    | Conclusion                              | 131 |
| 4.8.1  | Clinical Implications                   | 131 |
| 4.8.2  | Organisational Recommendations          | 132 |
| 4.8.3  | Future Research                         | 132 |
| 4.8.4  | Concluding Statement                    | 133 |
|        | References                              | 134 |
|        | Appendices                              | 151 |

## List of Figures

|                                                                                                                                                                                             |     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <a href="#">Figure 1</a> Diagram of the Peripheral Vestibular System                                                                                                                        | 11  |
| <a href="#">Figure 2</a> Three Neuron Arc of the Vestibulo-Ocular Reflex.                                                                                                                   | 12  |
| <a href="#">Figure 3</a> PRISMA Flow Diagram of Search result, study selection and inclusion process                                                                                        | 44  |
| <a href="#">Figure 4</a> Chronological Distribution of Included Rapid Scoping Review Studies                                                                                                | 53  |
| <a href="#">Figure 5</a> Geographical Distribution of Included Studies                                                                                                                      | 54  |
| <a href="#">Figure 6</a> Frequency of Clinical Algorithms and Decision Support Tools Identified Across Included Studies                                                                     | 58  |
| <a href="#">Figure 7</a> Frequency of Evidence-Based Assessment Metrics Identified Across Included Studies                                                                                  | 60  |
| <a href="#">Figure 8</a> Frequency of Neuroimaging Recommendations Identified Across Included Studies                                                                                       | 61  |
| <a href="#">Figure 9</a> Frequency of Evidence-Based Intervention and Management Metrics Identified Across Included Studies                                                                 | 62  |
| <a href="#">Figure 10</a> Patient Selection Flow Diagram                                                                                                                                    | 90  |
| <a href="#">Figure 11</a> Emergency Medicine Physicians Documentation Nystagmus Assessment and HINTS+ Utilisation in Acute Dizziness and Vertigo Presentations                              | 97  |
| <a href="#">Figure 12</a> Emergency Medicine Benign Paroxysmal Positional Vertigo Diagnostic Pathway and Management                                                                         | 101 |
| <a href="#">Figure 13</a> Concordance to evidence-based clinical metrics between; emergency medicine physicians and emergency department physiotherapists, and Māori and non-Māori cohorts. | 105 |

## List of Tables

|                                                                                                                                                            |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <a href="#">Table 1</a> International Consensus Definitions for Major Vestibular Symptoms                                                                  | 7   |
| <a href="#">Table 2</a> Search Strategy Framework: Concept Blocks, Keywords, and Boolean Logic                                                             | 41  |
| <a href="#">Table 3</a> Characteristics of Included Studies of the Rapid Scoping Review and Thematic Mapping Relationship to the Review Research Questions | 46  |
| <a href="#">Table 4</a> Methodological Characteristics of Included Studies                                                                                 | 53  |
| <a href="#">Table 5</a> Mapping Te Tiriti Principles to Research Methods and Actions                                                                       | 76  |
| <a href="#">Table 6</a> Interpretation of Cohen’s Kappa ( $\kappa$ ) Strength of Agreement Benchmarks                                                      | 85  |
| <a href="#">Table 7</a> Inter-rater Reliability for HINTS-plus and BPPV Clinical Metrics                                                                   | 86  |
| <a href="#">Table 8</a> Outline of Interprofessional Concordance Matrix for Paired Clinical Documentation                                                  | 88  |
| <a href="#">Table 9</a> Example of Interprofessional Concordance Matrix for Paired Clinical Documentation                                                  | 89  |
| <a href="#">Table 10</a> Demographic Characteristics of the Total Population                                                                               | 91  |
| <a href="#">Table 11</a> Clinician Involvement and Primary Outcomes for Patients with Acute Dizziness and Vertigo, Stratified by Ethnicity                 | 92  |
| <a href="#">Table 12</a> Comparative Distribution of Medical Diagnoses between Physiotherapy-Managed and Non-Physiotherapy Cohorts                         | 93  |
| <a href="#">Table 13</a> Alignment with Evidence-Based Clinical Guidelines for Initial Triage and Secondary Screening Metrics Across Professional Cohorts  | 94  |
| <a href="#">Table 14</a> Alignment with Evidence-Based Clinical Guidelines for Acute Vestibular Syndrome Assessment Across Professional Cohorts            | 95  |
| <a href="#">Table 15</a> Alignment with Evidence-Based Clinical Guidelines for Benign Paroxysmal Positional Vertigo Assessment Across Professional Cohorts | 96  |
| <a href="#">Table 16</a> Professional Alignment with BPPV Intervention Guidelines within Clinician-Specific Diagnosed Cohorts                              | 98  |
| <a href="#">Table 17</a> Alignment with Evidence-Based Clinical Guidelines for Diagnostics and Disposition Across Professional Cohorts                     | 99  |
| <a href="#">Table 18</a> Inter-professional Agreement and Discordance in HINTS+ Documentation: A Paired Analysis                                           | 102 |
| <a href="#">Table 19</a> Inter-professional Agreement and Discordance in BPPV Assessment and Management: A Paired Analysis                                 | 102 |
| <a href="#">Table 20</a> Equity Analysis of Diagnostic and Therapeutic Adherence: A Comparison of Practice Patterns for Māori and Non-Māori Patients.      | 103 |

## **Attestation of Authorship**

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor used artificial intelligence tools or generative artificial intelligence tools (unless it is clearly stated, and referenced, along with the purpose of use), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

*Signed:*

*Date:* 08/04/2026

## Acknowledgment of Artificial Intelligence Use

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |                                      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|--------------------------------------|
| <b><i>Specify the chapter number(s) in your research proposal/research component where AI was used.</i></b>                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |                                      |
| <b>Chapter number(s):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Chapters 1 (Introduction), Discussion sections (Chapter 4), Conclusion (Section 4.8), including Clinical Implications, Future Research, and Concluding Statement.                                                                                                                                                                                                                                                                              |                   |                                      |
| <b><i>Briefly explain why the AI tool was used (e.g., idea generation, summarization, data analysis, image creation, etc.).</i></b>                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |                                      |
| <b>Purpose of AI Use:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                      | AI tools were used to support language refinement, structural editing, and clarification of academic writing. This included improving sentence clarity, reducing repetition, enhancing readability, and ensuring appropriate academic tone. AI was not used to generate original data, perform analysis, or produce substantive research content.                                                                                              |                   |                                      |
| <b><i>Clearly state the AI tools used.</i></b>                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |                                      |
| <b>AI Tool(s) Used:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                        | M365 Copilot (GPT-5 chat model)                                                                                                                                                                                                                                                                                                                                                                                                                |                   |                                      |
| <b><i>Prompts or queries entered into the AI tool (only the instructive portion of the prompt is required). Include all relevant variations.</i></b>                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |                                      |
| <b>Prompts Used:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                           | - “Refine this paragraph for clarity and academic tone.” - “Reduce repetition and improve flow in this section.” - “Edit this text to make it concise and appropriate for a thesis discussion section.” - “Ensure this paragraph aligns with academic writing standards without changing meaning.” – “Only correct grammar and spelling errors, using NZ English conventions. Do not change sentence structure, add content or alter meaning.” |                   |                                      |
| <b><i>A summary or description of the AI-generated output. (Optional: attach output in an appendix.)</i></b>                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |                                      |
| <b>Output Received:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                        | AI-generated outputs included revised versions of text passages with improved clarity, structure, and tone. Outputs focused on rewording existing content, consolidating repetitive ideas, and enhancing readability while preserving the original meaning.                                                                                                                                                                                    |                   |                                      |
| <b><i>Describe how the AI output was used, edited, or transformed.</i></b>                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |                                      |
| <b>Post-AI Processing Methods:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                             | All AI-generated outputs were critically reviewed, edited, and integrated by the author. Content was revised to ensure accuracy, alignment with study findings, and consistency with the overall argument of the thesis. The author retained full responsibility for all final written material and ensured that all interpretations, analyses, and conclusions were independently developed.                                                  |                   |                                      |
| <b><i>You may use this free text box to explain the intent for the use of the AI generated content. For example, rather than stating what prompt(s) were used, you may articulate the purpose for which the prompt was used (supported by examples) here:</i></b>                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |                                      |
| AI tools were used as an editorial support resource to improve clarity, coherence, and structure of written sections. The intent was to refine existing author-generated content rather than create new ideas or analyses. AI-assisted edits were reviewed and modified to ensure they accurately reflected the study findings, methodological rigor, and the author’s original interpretations. No AI tools were used in data collection, analysis, or generation of results. |                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |                                      |
| <b>STUDENT DECLARATION</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |                                      |
| <b><i>By signing you are confirming that the AI use stated in the table(s) above are accurate and follow AUT’s recommended guidelines detailed in the AI Hub and Postgraduate Handbook.</i></b>                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |                                      |
| <b>Student Name:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Kane Nickles                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Signature:</b> | <b>Date:</b> <sup>1</sup> 20/05/2026 |

## Acknowledgments

I have been privileged to receive immense support, guidance, and encouragement throughout the journey of completing this thesis.

First and foremost, I express my deepest gratitude to my supervisory team, Professor Denise Taylor and Dr. Shikha Chaudhary. This project originated when Professor Taylor generously entertained my initial request for support to complete a modest 15-point postgraduate paper. Within an hour, however, she had expertly mapped out a Master of Philosophy research project. While I did not fully appreciate the magnitude of what I was embarking upon that day, I am incredibly grateful for the vision and opportunity she presented. Dr. Chaudhary was a delightful and invaluable addition to this team, generously offering her time, patience, and academic wisdom, contributions I will deeply appreciate long after this work is complete. Together, both of my supervisors patiently allowed me the autonomy to navigate the challenges of research, providing the guidance necessary to keep me on track while protecting my space to learn and discover through the process.

I have also been significantly supported by a wider network of exceptional colleagues. I extend my sincere thanks to Dr. Etienne De Beer, who graciously agreed to support this work from its inception; his backing provided me with the confidence to proceed, knowing his guidance was always available when needed. My research assistant, colleague, and friend, Mr. Steen Bastkjaer, was instrumental to the completion of this work; I am immensely grateful for his hours of dedication, wise counsel, and steady encouragement. Dr. Irene Zeng was fabulous in providing statistical advice and support, often at short notice. I am also appreciative of my clinical colleagues and Health New Zealand for supporting my academic leave to complete this research.

This work was made possible through the generous support of the New Zealand Dizziness and Balance Centre. Their contribution afforded me the vital protected time required to fulfil this project alongside competing priorities, acting as a significant factor in its successful completion.

Finally, my deepest gratitude is reserved for my whānau, who have sacrificed, supported, encouraged, and guided me through every step of this demanding process. To Luana, Māia, Emi, and Raukura: thank you for your unwavering patience and love. I look forward to reclaiming our weekends and spending quality time with you all once again.

# Chapter 1

## 1.1 Introduction

The clinical management of acute dizziness and vertigo within the emergency department (ED) represents one of the most formidable diagnostic and operational challenges in modern acute care. Newman-Toker (2016) described these presentations as among the most misunderstood and commonly misdiagnosed symptoms in all of medicine.

Acute dizziness and vertigo are also among the more common conditions encountered in emergency medicine, accounting for approximately 4% of all presentations. The symptoms can encompass a wide array of descriptive features that overlap across multiple physiological systems. Therefore, the clinician has to consider a breadth of differential diagnoses from the outset (Goeldlin et al., 2019). These symptoms often sit at a precarious intersection between benign under-lying conditions and life-threatening medical or central nervous system pathology (Royle et al., 2011; Tarnutzer et al., 2025).

The diagnostic challenge presented by a symptomatology shared by both benign inner ear dysfunction and critical aetiologies is further compounded by the ED setting itself, where most, if not all, presentations are characterised by an acute level of severity and urgency. Patients frequently present with severe symptoms, including inability to mobilise, nausea, disorientation, and pronounced sensory disturbances. Upon the exclusion of medical, psychological and obvious neurological disorders, often the ED clinician is left with the dilemma of differentiating between peripheral and central vestibular system disorders. These diagnostic challenges are reported to be immediately life threatening in between 15% to 23.8% of cases (Goeldlin et al., 2019; Newman-Toker et al., 2008). Traditional approaches and diagnostic tools are unhelpful for the ED clinician, with neuroimaging, especially computed tomography (CT) demonstrating poor sensitivity in the acute phase of a vestibular stroke, a recent systematic review reported pooled sensitivity of only 28.5% (Kattah et al., 2009; Pavlovic et al., 2018; Shah, Oliveira, Farah, Seisa, Kara Balla, et al., 2023).

An enduring feature of ED care is the requirement for clinicians to make quick decisions, often with limited resources available. The rapid and high-stakes decision-making occurs within a context of competing demands on clinicians and decision makers attention as EDs face increasing pressures (Savioli et al., 2022). Often referred to as the “front doors” of the hospital, EDs are also the centre of a constrained healthcare system. Population growth and an ageing demographic, combined with strained primary care resources intensify incoming demand. Simultaneously, a lack of departure flow, impaired by capacity crisis in residential care and community services, leads to the phenomenon of “bed-block,” where patients remain in ED without a clinical indication. Consequently, the environment is further regulated by political health targets, such as the current “shorter stays in ED”

metric, which mandates a six-hour target for assessment, intervention and disposition to be actioned (Ardagh, 2017).

In response to the environmental challenges, condition-specific complexities and concerning rates of misdiagnosis, a theoretical ideal has emerged in the literature: a suite of bedside physical examinations designed to interrogate the vestibular system with high fidelity (Edlow et al., 2023; Vanni et al., 2024). These tests are non-invasive, cost-effective, and capable of providing immediate diagnostic clarity. However, the transition from theoretical excellence to standard clinical practice remains incomplete. The degree to which these evidence-aligned assessments are consistently applied in modern, high-pressure environments remains an area of significant clinical uncertainty.

To mitigate the modern pressures faced in the ED the traditional medical workforce has diversified into a multi-disciplinary workforce. Among these roles, the ED physiotherapist has emerged as a potentially critical contributor to the management of acute dizziness and vertigo. As experts in mobility and functional performance, physiotherapists are naturally aligned with the assessment of the balance apparatus (vestibular system). The evolution of the physiotherapy profession has seen physiotherapists move into specialised neurological and vestibular spaces, utilising their skills in manual handling and physiological screening to perform diagnostic and curative repositioning manoeuvres and accelerate patient access to rehabilitative input (Andreev & Mindova, 2024).

A focal point of interest for this research is the emerging role of the ED physiotherapist (Lefmann & Crane, 2016; Maka et al., 2022; Naylor et al., 2025). The ED physiotherapy role is one of growing interest and also of ambiguity, as its defining features continue to be identified. While established in ED settings, the workstreams and influence this role has on the wider healthcare environment are still maturing. Models of care include both primary- and secondary-contact positions, while the scope can be wide and reflective of local ED needs.

This study seeks to examine the quality of care provided by evaluating alignment with documented, evidence-based recommendations for acute dizziness and vertigo. Limited prior research has included ED physiotherapy along with emergency medicine in reviewing quality-of-care indicators in acute dizziness and vertigo presentations to the ED. Mixed findings have been reported, with two studies demonstrating the feasibility and safety of practice with vestibular specialist physiotherapists operating in the ED (Lloyd, Luscombe, et al., 2020; Stewart et al., 2022). Another found physiotherapists focused on mobility and fall prevention with little contribution to diagnostic vestibular testing or directed intervention (Lloyd, Mackintosh, et al., 2020).

Key to this work's inquiry is the mandate for health equity within Aotearoa New Zealand (Hudson et al., 2010; Ministry of Health, 2023). Guided by the principles of Te Tiriti o Waitangi, specifically *Whakamarumarū* (Active Protection) and *Mana Taurite* (Equity), this research will investigate the quality of clinical practice for all New Zealanders, but will maintain a dedicated focus on disparities in vestibular care for Māori patients. In a deliberate effort to prioritise

the Māori voice in data, a disproportionate stratified sampling framework was employed to honour the principle of equal explanatory power, ensure robust Indigenous representation, and mitigate statistical bias (Robson, 2002). As Indigenous populations are frequently sidelined in the datasets that dictate service architecture, they paradoxically sustain higher rates of clinical attrition and inequitable access to specialised diagnostics (Edlow et al., 2023; Prisk et al., 2016). By including the Māori patient experience within acute vestibular care, this research identifies pathways for systemic redesign that move beyond deficit-based paradigms to operationalise the principles of Te Tiriti o Waitangi (Australasian College for Emergency Medicine, 2022).

Presently, in the New Zealand clinical context, there is an absence of information to guide decision-makers on the needs of this population with acute dizziness and vertigo, the quality of care delivered, the equity of its delivery, or the structural capacity of the health workforce to deliver culturally responsive, high-fidelity diagnostic responses. Evidence from the international literature depicts generalist clinicians operating within high-volume, cognitively demanding environments, frequently defaulting to neuroimaging or pharmacological palliation, often at the expense of definitive bedside assessment (Comolli et al., 2023; Kerber & Newman-Toker, 2015). Despite the proliferation of diagnostic frameworks, validation of sensitive bedside assessments and the publication of comprehensive ED-focused clinical guidelines (Edlow et al., 2023; Kattah et al., 2009; Vanni et al., 2024), the global literature does not adequately bridge the implementation fidelity deficit. It remains largely silent on the granular clinical reality of service delivery, the specific impact of interdisciplinary professional roles, and the degree to which these evidence-based responses are actually achieved.

Without a local empirical baseline, the “standard care” provided in Aotearoa New Zealand will continue to operate within an environment where systemic disparities prevent equal access to accurate, timely diagnoses. Within this space, clinical accuracy and equitable actions fail because they are unmeasured, unmanaged, and treated as unrelated variables. The interlinked objectives of this research are to benchmark local clinical performance within selected New Zealand EDs against established evidence-based recommendations, to illuminate the ED physiotherapist's position within acute dizziness and vertigo pathways, and to make visible the often-invisible Indigenous health data. While each strand of this research is important alone, it is the synthesis of these three components in reflection of clinical reality that gives this work its strength.

To achieve these objectives, this thesis employed a two-phase methodological architecture: a rapid scoping review coupled with a retrospective clinical audit. The rapid scoping review mapped the global evidence-based guidelines for acute vestibular management and identified the reported impact of physiotherapy involvement, while broadly scoping literature regarding Indigenous ED experiences of acute dizziness or vertigo.

The retrospective clinical audit utilised quality-improvement-based SQUIRE 2.0 and RECORD frameworks to evaluate the clinical practice reality across two metropolitan Auckland EDs,

with a purposive census of Māori records to ensure statistical clarity regarding equity. This research aims to provide the empirical foundation for an interwoven care model that integrates clinical excellence, fiscal responsibility, and cultural safety into a resilient, evidence-aligned pathway for acute vestibular care.

## 1.2 Structure of the Thesis

To assist in navigating this document, the following roadmap outlines its structural progression. This research employs a multi-phase approach grounded in a *whiria* (weaving) framework, where each chapter identifies and evaluates a distinct component of the acute vestibular care pathway.

**Chapter 2: Narrative Literature Review:** This chapter provides the foundational “threads” of the study. It explores the burden of vestibular pathology, the physiological mechanics of the vestibular system, and the unique organisational challenges of the ED setting. Crucially, it establishes the ethical and cultural framework of the research by examining Māori health and wellbeing at the ED interface, identifying the systemic consequences of diagnostic attrition for both the patient and the institution.

**Chapter 3: Rapid Scoping Review:** Representing the first phase of the methodological architecture, this chapter maps the global evidence-based “strands” of care. By synthesising international guidelines and reported outcomes for physiotherapy involvement, this review contributes to establishing the “ideal” benchmark for evidence-informed management. It also investigates the global literature regarding Indigenous experiences in emergency care, identifying a profound epistemic gap and the systematic omission of Indigenous voices within this setting.

**Chapter 4: Retrospective Clinical Audit:** This core empirical chapter interrogates the clinical reality of two metropolitan Auckland EDs. Utilising SQUIRE 2.0 and RECORD frameworks, the audit evaluates the degree of concordance between local practice and international recommendations. The methodology details the purposive census of all eligible Māori records, a strategy designed to optimise statistical representation and enhance the visibility of Indigenous health data within the constraints of the available clinical cohort. The results section examines the measured variations in interdisciplinary care and identifies the points of diagnostic attrition where evidence-aligned care failed to reach the patient. The discussion evaluates these audit findings within the wider literature landscape, critiques the GRACE-3 guidelines against pragmatic ED constraints, examines the professional asynchrony between medical and physiotherapy cohorts, and explores potential underlying mechanisms driving Māori outcomes. Finally, the conclusion and clinical implications synthesise the findings to propose a systemic realignment. This moves beyond identifying deficits to

advocate for a resilient, interdigitated care model. By weaving together clinical excellence, fiscal responsibility, and Te Tiriti-led equity, this chapter provides a blueprint for an integrated care pathway designed to address the systemic diagnostic disparities currently observed in Aotearoa New Zealand.

## 2 Chapter 2: Narrative Literature Review of Acute Dizziness and Vertigo in the Emergency Department

This chapter presents the foundational concepts driving this thesis. The key constructs of acute dizziness and vertigo are expanded to provide an awareness of their underlying neuroanatomical foundations, historical context, and clinically relevant features within the ED setting. The ED setting itself is further described, with setting-specific challenges outlined. As this work is located in Aotearoa New Zealand, it is crucial to consider its relevance to Māori, and more broadly, to review Indigenous healthcare within the context of acute vestibular presentations. Additionally, the burgeoning role of the ED physiotherapist is examined, and its association with acute care is explored. These concepts are subsequently integrated to examine the overall challenges associated with managing acute dizziness and vertigo, before the relevant literature addressing these impacts is summarised.

### 2.1 Search Strategy

The search strategy for this narrative review sought to provide conceptual breadth to inform definitions, explore pathophysiological mechanisms, and establish clinical context. Electronic databases were searched via the EBSCO platform. To capture the core subject areas, search terms reflected four key themes:

- **Setting:** *Emergency Department, ED, Emergency Medic\*, Acute Care, Emergency Service\*, Emergency Room;*
- **Condition of interest:** *Dizziness, Vertigo, Disequilibrium, Imbalance, Lightheadedness, Giddiness, Unsteadiness, "Acute Vestibular Syndrome";*
- **Indigenous healthcare:** *Māori, "First Nations", Native, Indigenous, "Tangata Whenua", Aboriginal; and*
- **Location:** *New Zealand, NZ, Aotearoa.*

No restrictions were placed on publication dates, though results were limited to English-language publications. Reference lists of key review articles and clinical guidelines were hand-searched using a citation snowballing approach to capture pertinent literature. Unlike the formal, systematic eligibility criteria applied in Chapter 3 (Rapid Scoping Review), this narrative search was iterative and intended to provide a broad conceptual platform rather than an exhaustive evidence synthesis.

### 2.2 Burden of Acute Dizziness and Vertigo

Over the past 10 to 15 years, acute dizziness and vertigo has emerged as a significant area of challenge and concern for EDs globally (Comolli et al., 2023; Newman-Toker, 2016). While emergency clinicians are routinely tasked with navigating clinical complexity, this specific

presentation represents a complex clinical challenge. This difficulty is substantially underpinned by a vast aetiological spectrum, where symptoms may signal either benign peripheral dysfunction or life-threatening systemic and cerebrovascular events (Newman-Toker et al., 2008; Voetsch & Sehgal, 2021). The resulting burden of acute dizziness and vertigo on healthcare systems is considerable, with these symptoms frequently prompting ED visits worldwide. The literature increasingly highlights the difficulty EDs face in accurately diagnosing and managing these conditions, often leading to misdiagnosis, inappropriate testing, and delayed or inadequate treatment. These failures can result in increased morbidity, mortality, and healthcare costs (Newman-Toker et al., 2014; Tarnutzer et al., 2011). As such, this symptom complex is best conceptualised not as a discrete condition, but as a multifaceted clinical presentation encompassing a wide spectrum of potential diagnoses. While the terms “acute,” “dizziness,” and “vertigo” are semantically distinct, their combined usage provides a comprehensive framework for categorising a group of symptoms with varied underlying drivers. Within the environment of emergency medicine, the pathophysiology of acute dizziness and vertigo involves a vast array of potential aetiologies, with this thesis focusing specifically on those arising from vestibular dysfunction.

A clear definition and a comprehensive understanding of the epidemiological burden of acute dizziness and vertigo are essential to underscore the clinical imperative for sound management, particularly when acute symptom severity prompts emergency intervention.

### ***2.2.1 Conceptualisation and Definition of Acute Dizziness and Vertigo***

Central to this research is the definition of acute dizziness and vertigo. Establishing a clear conceptual framework for these terms is fundamental to the study’s methodology. This section defines the constituent elements of acute dizziness and vertigo and justifies the adoption of this composite terminology as the most appropriate nomenclature for evaluating vestibular presentations in the emergency setting.

Dizziness serves as an umbrella term for the array of symptoms used by patients to describe a variety of abnormal sensory experiences (Voetsch & Sehgal, 2021). The clinical presentation of dizziness encompasses a broad spectrum of underlying pathologies and subjective qualities. These range from traditional vestibular sensations such as vertigo, disequilibrium, and imbalance to more nebulous reports of faintness, light-headedness, or cognitive “fog.” In some cases, dizziness may also encompass transient visual disturbances, disorientation, and even paroxysmal events like brief seizures (Newman-Toker et al., 2007). The heterogeneity of these symptom descriptions makes categorisation and definition inherently challenging. This conceptual fluidity of dizziness can obscure its clinical significance and introduces taxonomic ambiguity within a research context (Voetsch & Sehgal, 2021).

Historical attempts to resolve this ambiguity, pioneered by Drachman and Hart (1972), focused on the qualitative characterisation of symptoms, leading to the development of subtypes

intended to signal specific aetiologies. Under this traditional paradigm, vertigo was primarily categorised as a clinical subset of dizziness, representing a distinct phenomenological type within a broader diagnostic hierarchy (Hanley & O' Dowd, 2002). Further historical categorisation of vertigo specified separate groups of “true” vertigo and non-vertiginous symptoms (Evans, 1990; Hanley & O' Dowd, 2002). This traditional approach culminated in advocating for a delineating typology between presyncope, disequilibrium, psychogenic dizziness, and vertigo (Hanley & O' Dowd, 2002; Wipperman, 2014). However, this approach of relying on qualitative characterisation has more recently been critiqued as problematic. Contemporary opinion advocates for definitions moving away from a focus on symptom quality alone (Kerber & Newman-Toker, 2015; Voetsch & Sehgal, 2021). Contemporary frameworks define dizziness (and vertigo) with respect to symptom timing and triggers (Newman-Toker & Edlow, 2015). Timing refers to the onset, duration, and evolution of the dizziness, whereas triggers refer to movements, actions, or situations that provoke the onset of dizziness (Newman-Toker & Edlow, 2015; Voetsch & Sehgal, 2021).

The term “acute,” both conceptually and within the bounds of a clinical context, encompasses defining qualities of a temporal nature as well as qualitative characteristics relating to intensity or severity of a symptom (Gabrielsen et al., 2009). For this work, acute dizziness and vertigo are defined by their temporal nature, particularly the duration and recent onset of symptoms. This approach facilitates alignment with current recommendations and classifications of dizziness and vertigo symptoms (Edlow, 2019; Edlow et al., 2018; Newman-Toker & Edlow, 2015).

With such a variable prevalence of underlying disorders Bisdorff et al. (2015) noted dizziness and vertigo symptoms cross medical specialist boundaries. For a specialty such as neurology or otolaryngology to be competent across a spectrum of diagnoses, comprehensive knowledge of the inner ear is required. Consequently, a unifying definition has been established by an international, interdisciplinary scientific society. The Bárány Society definitions of dizziness and vertigo encompassing modern ideas are widely recognised ([Table 1](#)). The Bárány Society describes dizziness as the sensation of disturbed or impaired spatial orientation, and vertigo as a sensation of self-motion when no self-motion is occurring (Bisdorff et al., 2015). This work accepts the description by the Bárány Society for dizziness and for vertigo. To widely capture the general and heterogeneous terms used by patients, clinicians and researchers, both dizziness and vertigo are utilised in combination, reflecting the consensus in recent literature (Bery et al., 2025; Dmitriew et al., 2021; Edlow et al., 2023; Gerlier et al., 2021; Herdman, 2024; Puissant et al., 2024)

**Table 1***International Consensus Definitions for Major Vestibular Symptoms*

| <b>Symptom</b>      | <b>Definition</b>                                                                                                                                                                                                                                                                              |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Dizziness</b>    | The sensation of disturbed or impaired spatial orientation without a false or distorted sense of motion. This includes sensations sometimes referred to as giddiness, light-headedness, or non-specific dizziness, but does not include vertigo.                                               |
| <b>Presyncope</b>   | Presyncope (also near-syncope or faintness) is the sensation of impending loss of consciousness. This sensation may or may not be followed by syncope. When patients report “light-headedness” (which is a very non-specific term), it should be classified as presyncope, dizziness, or both. |
| <b>Syncope</b>      | Syncope (also faint) is a transient loss of consciousness due to transient global cerebral hypoperfusion characterized by rapid onset, short duration, and spontaneous complete recovery. Syncope usually leads to a loss of postural control and falling.                                     |
| <b>Vertigo</b>      | The sensation of self-motion (of the head/body) when no self-motion is occurring, or the sensation of distorted self-motion during an otherwise normal head movement.                                                                                                                          |
| <b>Unsteadiness</b> | Unsteadiness is the feeling of being unstable while seated, standing, or walking without a particular directional preference. This sensation has previously been called disequilibrium or imbalance.                                                                                           |

*Note.* Adapted from (Bery et al., 2025).

### 2.2.2 Prevalence

Kerber et al. (2008) reported a 37% increase in dizziness-related visits in the United States between 1993 and 2004. At the time this accounted for approximately 2.5% of all ED encounters. More recent epidemiological data suggests a further escalation, with a contemporary consensus placing the prevalence at approximately 4% to 4.4% of all ED visits (Newman-Toker et al., 2008; Saber Tehrani et al., 2013). This trend appears to be a global phenomenon rather than a localised occurrence, with comparable prevalence rates of 4.1% recently reported in South Korea (Kim et al., 2024) and similar burdens noted in Italy (Vanni et al., 2024). A recent estimate of the number of people presenting to EDs annually with acute dizziness and vertigo has been reported to be between 50 to 100 million worldwide (Tarnutzer et al., 2025). This number may be expected to grow, with a globally ageing population combined with a higher reported prevalence of dizziness and vertigo in these aged populations (Agrawal et al., 2012; Kim et al., 2024; Newman-Toker & Edlow, 2015). Consequently, the established burden of acute dizziness is poised to intensify, necessitating its recognition as an increasingly pivotal priority for emergency healthcare systems.

The prevalence of the underlying cause of acute dizziness and vertigo is more difficult to appreciate. The diagnostic landscape is complicated by the inherent heterogeneity of a broad undifferentiated population (S. U. Lee et al., 2025). Some authors report no single underlying pathology accounting for more than 5% to 10% of all ED acute dizziness and vertigo presentations (Tarnutzer et al., 2025). While certainly the majority of presentations may stem from benign

peripheral inner ear or medical causes, the prevalence of critically important pathologies is also significant (Goeldlin et al., 2019; Morrow et al., 2023). Perhaps more relevant to an ED setting is the distinction between emergent and endangering conditions than specific diagnoses. It has been estimated that up to 30% of patients presenting with dizziness in the ED harbour a serious underlying disorder (Newman-Toker et al., 2008; Voetsch & Sehgal, 2021). Within this high-risk cohort, life-threatening conditions including ischemic stroke, transient ischemic attack (TIA), cardiac arrhythmias, and acute systemic infections account for approximately 15% of cases (Voetsch & Sehgal, 2021). The remaining majority of presentations from the broad undifferentiated pool of acute dizziness and vertigo patients are believed to be made up of benign, peripheral disorders of the vestibular system.

The epidemiological data underscores a critical tension in acute care: while most acute dizziness and vertigo presentations are benign, a significant and rising proportion involve high-acuity pathologies with profound implications for patient morbidity and mortality (Newman-Toker et al., 2014). To discern the clinical significance of these varied presentations, it is important to first outline the complex neuroanatomical and physiological mechanisms that maintain postural and gaze stability. Minor disruptions to these pathways and delicate structures can result in the profound symptoms observed in ED presentations of acute dizziness and vertigo.

### **2.2.3    *The Vestibular System***

The vestibular system comprises a peripheral apparatus and a central vestibular apparatus consisting of a network of central brainstem and cerebellar pathways dedicated to the maintenance of gaze stability, postural control and spatial cognition (Khan & Chang, 2013; Kingma & van de Berg, 2016; Lopez & Blanke, 2011). This system provides essential sensory data regarding head orientation and motion, which underpins human balance. The following section details these anatomical structures and their functional roles.

**The Peripheral Vestibular System:** The peripheral sensors are encased within the petrous portion of the temporal bone (Khan & Chang, 2013), with afferent pathways traversing the internal auditory canal via the vestibulocochlear nerve (CN VIII), which enters the brainstem at the level of the vestibular nuclei.

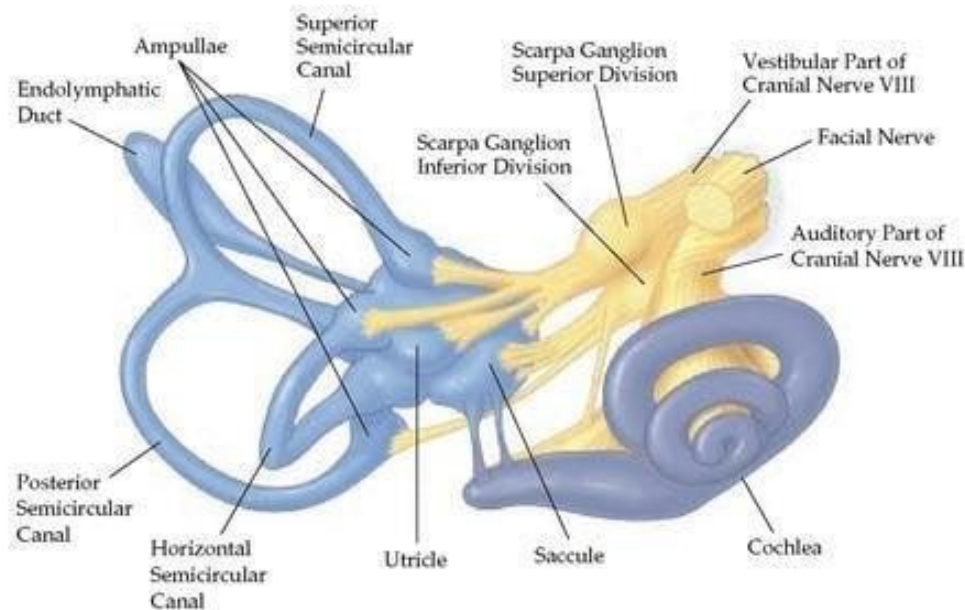
Head motion is captured by a specialised set of peripheral receptors that resolve movement into translational and rotational components, namely the utricle, saccule and semicircular canals. Translational motion is processed by the utricle and saccule. The utricular macula is a patch of sensory cells oriented to detect horizontal-plane acceleration and gravity, while the saccular macula is sensitive to vertical acceleration and gravity. Angular motion stimulates the six semicircular canals, which are arranged in nearly orthogonal planes with each inner ear hosting a horizontal, anterior, and posterior canal (Della Santina et al., 2005; Khan & Chang, 2013; Voetsch & Sehgal, 2021) ([Figure 1](#)).

These canals work in synergistic pairs to produce afferent signals through the depolarisation of hair cells, providing the central nervous system with a precise representation of angular velocity.

The detection of angular motion relies on the hydrodynamics of endolymph fluid within the semicircular canals (Khan & Chang, 2013). Each canal consists of a bony labyrinth housing a membranous counterpart; this membranous structure contains the potassium-rich endolymph. As the head rotates, the inertia of the endolymph acts upon specialised hair cells embedded within the gelatinous cupula located in the canal's ampulla. The ampulla is a dilation of the semicircular canal near the terminal opening to the utricle (Khan & Chang, 2013). This system is remarkably delicate, with a canal diameter of approximately 1.0 mm (Daocai et al., 2014; Kavitha et al., 2023; Lee et al., 2013).

**Figure 1**

*Diagram of the Peripheral Vestibular System*

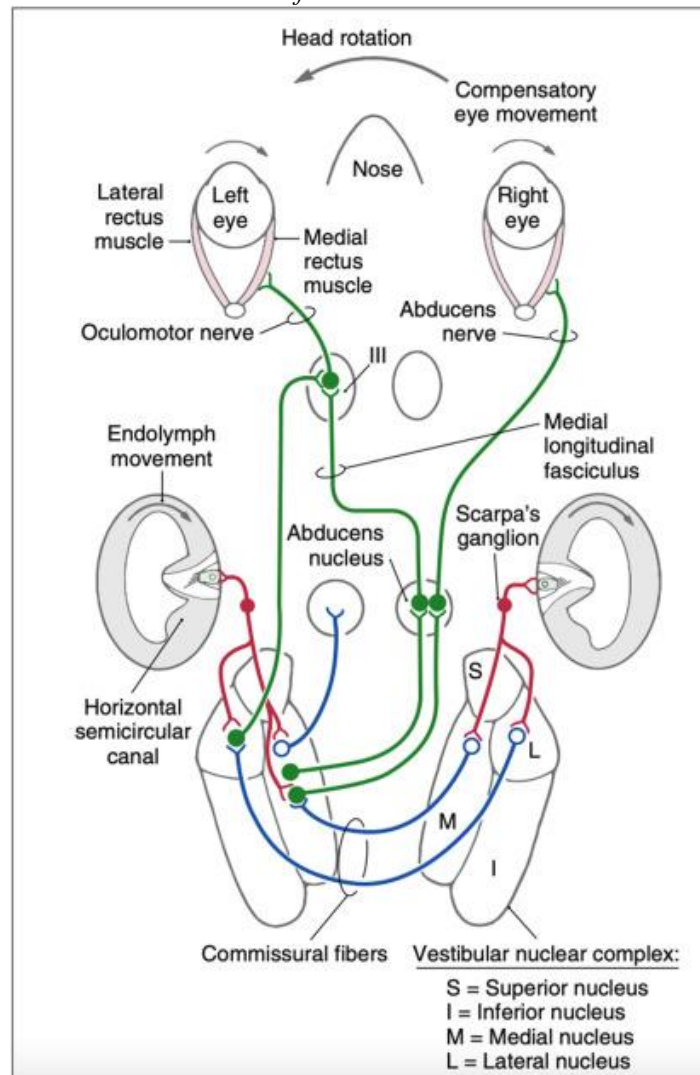


*Note.* Adapted from Ezzelregal (2016).

A cornerstone of vestibular function is the vestibulo-ocular reflex (VOR). This three-neuron arc, composed of the primary vestibular afferent, the vestibular nuclei, and the extraocular motor nuclei (cranial nerves III, IV, and VI), facilitates gaze stability by generating eye movements equal and opposite to head rotation (Collewijn & Smeets, 2000) ([Figure 2](#)). A high-gain VOR is essential for maintaining a clear visual image on the fovea during rapid movement. This anatomical simplicity bypasses complex cortical processing, allowing near-instantaneous gaze stability.

**Figure 2**

*Three Neuron Arc of the Vestibulo-Ocular Reflex.*



*Note.* Adapted from Rafael et al. (2025).

In the normative physiological state, the integrity of the VOR is predicated on a constant resting tonic discharge from the bilateral peripheral vestibular apparatus. When the head is stationary, these afferent signals maintain a precise equilibrium. Upon rotation, the system engages a “push-pull” dynamic, where the semicircular canals ipsilateral to the rotation undergo depolarisation, while the contralateral counterparts simultaneously undergo hyperpolarisation (Voetsch & Sehgal, 2021). The brainstem integrates this differential input to derive the precise angular velocity of head movement. Any structural or functional disruption along this primary pathway results in vestibular hypofunction.

**The Central Vestibular System:** The central vestibular system comprises intracranial

pathways and structures responsible for integrating peripheral inputs with multisensory data from the visual and somatosensory systems. While the peripheral apparatus detects motion, the central architecture interprets and modulates these signals to maintain a global equilibrium (Renga, 2019).

The anatomical and clinical transition to the central system from the peripheral apparatus occurs at the vestibular nuclear complex, located within the pontomedullary junction of the brainstem. These nuclei serve as the primary processing centre where afferent signals from the eighth cranial nerve are received (Khan & Chang, 2013). It functions as a specialised integrator that represents the bilateral vestibular afferents into multiple cerebellar and cortical areas, facilitating the system's primary functions: the reflexive control of gaze, head, and body position; the perception of self-motion; the control of voluntary movement; and higher-order vestibular cognitive processing (Dieterich & Brandt, 2015; Lopez & Blanke, 2011).

Distinct ascending and descending projections extend from the brainstem across several pathways. Ascending projections travel through the medial longitudinal fasciculus to the oculomotor nuclei in the midbrain and the thalamus, eventually reaching the vestibular cortex (Khan & Chang, 2013; Lopez & Blanke, 2011). These pathways facilitate conscious spatial orientation and the perception of verticality. The cerebellar feedback loop (specifically the vestibulo-cerebellum or flocculonodular lobe) acts as a supranuclear adaptive modulator. It processes constant feedback from the vestibular nuclei and provides inhibitory modulation to the vestibulo-ocular reflex. This loop maintains the required plasticity for vestibular compensation, allowing recalibration of central gains following peripheral dysfunction (Takeda et al., 2024).

Descending projections along the vestibulospinal tracts (lateral and medial) descend into the spinal cord to influence motor neurons. These tracts are responsible for the vestibulospinal reflex, which triggers the postural adjustments in the trunk and limbs necessary to prevent falls during movement (Strupp et al., 1998).

#### **2.2.4 Common Vestibular Pathologies**

**Benign Paroxysmal Positional Vertigo:** Benign paroxysmal positional vertigo (BPPV) is the most common peripheral disorder encountered in EDs and is reported in 10% to 50% of acute dizziness and vertigo presentations (Bhattacharyya et al., 2017; Comolli et al., 2023; Kim & Zee, 2014; Ronchetti et al., 2025). Symptoms are typically provoked by changes in head position relative to gravity (Kim & Zee, 2014). While the hallmark of BPPV is transient vertigo lasting seconds, many patients additionally report a secondary, persistent sense of imbalance or residual dizziness between vertiginous episodes. Meticulous history-taking usually identifies that the peak intensity of symptoms is strictly coupled with head movement (Kim & Zee, 2014). Autonomic arousal is common, with patients frequently experiencing significant nausea and occasionally emesis.

Despite its benign nomenclature, the condition imposes a substantial burden on the individual. It is associated with a marked reduction in quality of life, restricted participation in activities of daily

living, and a significantly heightened risk of falls, particularly in older populations (Celik et al., 2024; Martens et al., 2019).

**Pathophysiology:** The underlying pathology involves the mechanical displacement of calcium carbonate crystals (otoconia) from the utricular macula into the semicircular canals (Celik et al., 2024; Fife & von Brevern, 2018; Lopez-Escamez et al., 2005). Displaced otoconia that enter the semicircular canals are termed canaliths. Because these canaliths possess a higher relative density than the surrounding endolymph, they become susceptible to gravity and inertia, disrupting normal fluid dynamics

Two primary mechanisms of BPPV are described:

- **Canalolithiasis:** The most common variant, where mobile debris floats freely within the canal lumen. When the head moves, the gravitational shift of these canaliths induces hydrodynamic drag on the endolymph, leading to aberrant activation of the ampullary nerve (Lee & Kim, 2010).
- **Cupulolithiasis:** A less frequent variant where otoconia adhere directly to the cupula itself. This renders the cupula sensitive to gravity in any position that deviates from the Earth-vertical, resulting in a more persistent nystagmus and vertigo during positional testing.

While often idiopathic, BPPV may be secondary to head trauma, prolonged recumbency (e.g., extended surgical or dental procedures), or concurrent inner ear disorders. The clinical course is frequently marked by spontaneous remissions and recurrences, with an estimated annual recurrence rate of approximately 15% (Kim & Zee, 2014).

**Diagnostic and Therapeutic Standards:** The diagnosis of BPPV relies on provocative positional testing to elicit characteristic nystagmus. The Dix-Hallpike manoeuvre remains the gold standard for identifying posterior canal involvement, the most frequent variant of the condition, while the Pagnini-McClure (supine roll) test is the primary diagnostic tool for the horizontal canal variant (Bhattacharyya et al., 2017; Perez-Vazquez et al., 2018).

Therapeutic interventions are similarly mechanical, utilising canalith-repositioning or liberatory manoeuvres that leverage either inertia or gravity to return the debris to the utricle. The Epley manoeuvre is the most robustly evidenced treatment for posterior canal BPPV, whereas clinicians typically employ the Gufoni manoeuvre or Lempert roll for horizontal canal variants (Bhattacharyya et al., 2017; Perez-Vazquez et al., 2018).

**Acute Vestibular Syndrome:** Acute vestibular syndrome is defined as a clinical syndrome of acute-onset, continuous dizziness or vertigo lasting days to weeks, typically accompanied by nausea, vomiting, spontaneous or gaze-evoked nystagmus, and postural instability (Edlow et al., 2023; Herdman, 2024). Unlike the paroxysmal nature of BPPV, the persistence of symptoms in acute

vestibular syndrome signals an ongoing disruption of vestibular signalling, necessitating a rapid and accurate differentiation between benign peripheral causes and life-threatening central pathologies.

The clinical significance of acute vestibular syndrome is underscored by both its prevalence and the potential for diagnostic error. This condition has been reported to account for approximately 20% to 25% of all ED presentations for dizziness (Herdman, 2024; Tarnutzer et al., 2025). In a cross-sectional study of 1,535 ED patients, Comolli et al. (2023) found that the three most frequent diagnoses were stroke (10.1%), BPPV (9.8%), and vestibular neuritis (9.6%), whereas some historical population studies report cerebrovascular events as infrequent and peripheral aetiologies very common (Herr et al., 1989; Kerber et al., 2006). More recently published literature underscores ongoing concern that the historical reassurance of most presentations being non-dangerous may not hold as tightly as once thought. Significantly, in the 2023 Comolli et al. study, the incidence of stroke rose to over 25% among the subset of patients presenting with an acute vestibular syndrome. Goeldlin et al. (2019) reported similar findings, where the underlying condition was life-threatening in 23.8% of ED visits with acute vestibular syndrome as the main complaint. Therefore, missed stroke remains a significant concern in this cohort.

**Unilateral Vestibular Hypofunction:** The most common peripheral cause of acute vestibular syndrome is unilateral vestibular hypofunction, which is described as the partial or complete loss of afferent input from one peripheral vestibular organ or the vestibular nerve (Hall et al., 2022; McDonnell & Hillier, 2015). This deficit is typically secondary to an inflammatory or viral insult to the vestibulocochlear nerve; in such instances, the presentation is clinically designated as vestibular neuritis (Strupp & Brandt, 2009). Although unilateral hypofunction can also be attributed to ototoxic exposure or Ménière's disease (Hall et al., 2022), the defining pathophysiological hallmark remains the same; a sudden tonic imbalance between the healthy and affected vestibular systems that drives the characteristic spontaneous nystagmus and vertigo.

**Central Origin Pathology:** A fundamental concept in the management of acute dizziness and vertigo is that the central pathways, particularly within the cerebellum and brainstem, share overlapping neural pathways with the peripheral vestibular entry points. Because the cerebellum provides constant inhibitory modulation to the vestibular nuclei, an acute central lesion, such as a posterior circulation stroke, can disrupt this inhibition (De Benedictis et al., 2022; Jaeger, 2022). This disruption creates a neural asymmetry that can clinically mimic a peripheral nerve failure, such as the unilateral vestibular hypofunction observed in vestibular neuritis.

The anatomical basis of central mimicry of benign peripheral conditions can arise from numerous critical pathologies. In addition to posterior circulation ischaemia, these include vertebrobasilar artery dissections, intracranial haemorrhages, space-occupying lesions, or

demyelinating disorders (Voetsch & Sehgal, 2021). Unilateral vestibular hypofunction may similarly result from structural trauma or surgical transection.

**Diagnostic and Therapeutic Standards, The HINTS-plus Diagnostic Battery:** To address the diagnostic tension between peripheral and central acute vestibular syndrome, the HINTS (Head Impulse, Nystagmus, Test of Skew) battery was developed. Originally validated by Kattah et al. (2009), this bedside assessment cluster has demonstrated superior sensitivity to early magnetic resonance imaging (MRI) for detecting stroke in acute vestibular syndrome presentations. The test battery was later expanded to HINTS-plus to include a bedside hearing assessment, which improves diagnostic sensitivity to anterior inferior cerebellar artery (AICA) infarction.

The HINTS-plus bedside battery comprises three oculomotor examinations and a screen for acute hearing loss:

- **Nystagmus:** Observation of the nystagmus pattern is critical. Peripheral nystagmus is typically unidirectional and obeys Alexander's law, meaning it increases in intensity when the patient looks in the direction of the fast phase (Shikino & Ikusaka, 2021).
- **Head Impulse Test:** Considered the neuro-otological standard for assessing vestibulo-ocular reflex function, a positive (abnormal) head impulse test is indicated by a corrective catch-up saccade and suggests a peripheral lesion (Grill et al., 2018).
- **Test of Skew:** This assesses for vertical ocular misalignment or "skew deviation," a highly specific sign of a central brainstem or cerebellar lesion (Kattah et al., 2009).
- **Hearing Screen (plus):** The addition of a bedside finger-rub hearing assessment addresses potential anterior inferior cerebellar artery (AICA) territory infarct. These infarcts can cause sudden hearing loss alongside vestibular symptoms because the vascular supply to the labyrinth becomes compromised, closely mimicking a peripheral labyrinthitis or neuritis.

The HINTS-plus battery offers high clinical utility due to its speed (typically completed within minutes), lack of expensive equipment, and high sensitivity (Gottlieb et al., 2023; Kattah, 2018; Shah, Oliveira, Farah, Seisa, Balla, et al., 2023). However, its effectiveness is heavily dependent on the clinician's expertise. While validation studies involving neuro-otologists showed exceptional results, issues in the clinical performance of the HINTS test have been described by others (Dmitriew et al., 2021), indicating significantly lower sensitivity and specificity when the battery is performed by emergency physicians (Ohle et al., 2020).

The primary barrier to HINTS-plus implementation appears to be the physical performance and interpretation of the head impulse test (McDowell & Moore, 2016), which requires the hands-on manual delivery of a precise head thrust and a concurring ability to detect subtle, rapid eye movements. Furthermore, there can be limitations in nystagmus assessment; while traditional Frenzel lenses or modern infrared goggles can improve nystagmus analysis by removing visual fixation, these

tools are not always available in a standard ED setting, thereby narrowing the pool of potential HINTS-plus candidates (Dmitriew et al., 2021).

Once a central pathology has been excluded, the mainstay of recovery for peripheral acute vestibular syndrome is vestibular rehabilitation. This exercise-based approach employs neural plasticity to facilitate central compensation for the peripheral deficit. A Cochrane review by McDonnell and Hillier (2015) confirmed the utility of vestibular rehabilitation, finding it to be superior to sham or control interventions in reducing dizziness and improving functional balance.

## **2.3 ED Setting**

The definitions and prevalence for the most common presentations of acute dizziness and vertigo to EDs have been described above, alongside established evidence-based assessments and treatments. However, the theoretical clarity of these definitions and gold-standard assessments often dissipates when applied within the complex clinical environment of an acute care setting. To understand why diagnostic ambiguity persists despite these established frameworks, it is necessary to examine the specific operational and environmental constraints of the emergency department. The following section explores the ED as a unique clinical environment where the undifferentiated nature of vestibular symptoms meets the pressures of rapid triaging, resource limitation, and high-volume throughput.

In the context of this study, the ED is defined as a high-acuity, front-line clinical environment characterised by its role as the primary interface between the community and the hospital system. The fundamental goal of the ED is not necessarily the provision of definitive long-term care, but rather the rapid risk-stratification, identification, stabilisation, and disposition of patients presenting with undifferentiated symptoms, often under strict resource constraints (Goeldlin et al., 2019; Lateef et al., 2025). For patients experiencing acute dizziness and vertigo, the ED serves as a critical junction where benign aetiologies must be swiftly and accurately differentiated from life-threatening medical or central neurological events.

The ED is also a highly collaborative environment, comprising a diverse workforce of emergency medicine physicians, nursing staff, and increasingly allied health professionals, such as physiotherapists. This multidisciplinary composition addresses the escalating complexity of patient presentations and the necessity for resource efficiency by synthesising medical, diagnostic, and functional expertise.

### **2.3.1 Setting challenges**

Managing acute dizziness and vertigo in the ED is complicated by a convergence of systemic pressures that challenge diagnostic accuracy. These include an increasingly frail and aged population, systemic constraints of wider hospital capacity, performance indicators geared toward patient flow

through the department, acute understaffing, and impaired access to primary care within the community (Savioli et al., 2022; Tenbensen et al., 2017).

The intersection of a burgeoning geriatric population and increasing clinical frailty has resulted in a marked escalation of complexity in ED presentations. Older adults frequently present with a high burden of multimorbidity and polypharmacy, which introduces significant confounding variables. This is particularly relevant as patients presenting to the ED with acute dizziness and vertigo are typically older, with 25% to 30% aged over 65 years (Voetsch & Sehgal, 2021). This cohort is more likely to present with confounding conditions such as orthostatic hypotension, polypharmacy, presbystasis, or other pre-existing compromises to the multifaceted balance system. Emerging evidence suggests a higher prevalence of undiagnosed vestibular dysfunction within this cohort, potentially contributing to increased fall risks and cognitive decline (Arshad & Seemungal, 2016; Montero-Odasso et al., 2022). Diagnostic clarity is further obscured by the atypical subjective reports common in older demographics and the physical challenges inherent in performing bedside assessments (Newman-Toker et al., 2007). When coupled with the age-related escalation of risk factors for central neurological events, such as hypertension, this demographic presents a profound diagnostic challenge within the time-constrained environment of the ED.

Declining access to primary healthcare in the community can result in the ED becoming the default provider for non-emergent issues. When combined with chronic understaffing, the time-per-patient is further compressed (Arrich et al., 2017; Varner, 2023). Modern EDs frequently operate at or beyond capacity, experiencing the phenomenon of “bed block,” where a lack of available inpatient beds leads to patient boarding in the ED (Curley & Gozman, 2026; Tenbensen et al., 2017). This congestion disrupts the clinical workflow, increases cognitive load for clinicians, and limits the physical space available for comprehensive vestibular bedside examinations. Ohle et al. (2026), described environmental challenges in crowded EDs, reporting that the restriction of assessing patients in seated positions rather than on appropriate examination stretchers presented significant barriers to the performance of gold-standard BPPV assessments.

Driven by governmental health goals and political performance indicators, EDs are often evaluated using metrics focused on time-to-treatment and length of stay (Tenbensen et al., 2020). While these indicators aim to improve efficiency, they can create a systemic bias toward rapid disposition over thorough, time-intensive physical assessments. These issues may be reinforced by clinician misperceptions regarding the temporal efficiency of undertaking various assessments and interventions (Bashir et al., 2015). These factors may combine to increase the risk of diagnostic error or influence clinical decisions, such as the utilisation of imaging modalities like CT, which require minimal clinician time to order but ultimately contribute to an increased overall length of ED stay.

Acute dizziness and vertigo assessment and management can be complex, requiring skilled clinicians who may not always be available in the 24 hours a day, seven days a week service model of an ED. Despite the growing multidisciplinary presence in EDs, there is commonly a lack of specialist

resources in emergency settings, which may further contribute to adverse outcomes, misdiagnosis, and sub-standard care practices (Newman-Toker et al., 2009; Saber Tehrani et al., 2018).

### **2.3.2 Organisational pressures**

Time pressures in the ED stem not only from the clinical imperative to respond rapidly to a patient's immediate medical emergency, but also from organisational administrators and politicians. Governmental health targets in New Zealand have historically placed a sharp focus on ED length of stay. Current governmental health targets have reintroduced a "shorter stays in ED" target, mandating that patients attending the department be admitted, discharged, or transferred within 6 hours (Tenbensen et al., 2017). These targets were originally introduced between 2009 and 2017 and subsequently returned in 2024. In the intervening years, even when public reporting was not mandated, this six-hour threshold remained a benchmark metric. Under these time-pressured conditions, evidence suggests that clinical decision-making becomes more vulnerable to prejudice, stereotyping, and bias (Curtis et al., 2020).

Proponents of the policy highlight benefits such as reduced mortality and increased operational efficiency (Ardagh, 2017; Ardagh & Drew, 2015; Tenbensen et al., 2017), while critics point to the systemic risk of "gaming," where reported timeframes are artificially manipulated alongside costly resource expenditures (Jones et al., 2017; Tenbensen et al., 2020). The long-term benefits to patient outcomes and public health remain ambiguous, as EDs must adapt to performance metrics that ultimately reflect variables outside of the ED's locus of control, including residential care capacity, community health resources, general practitioner access, and wider hospital bed block.

### **2.3.3 ED Physiotherapy**

A prominent shift toward interdisciplinary care has introduced new professional roles into acute settings, offering cost-effective and specialised solutions for complex patient populations (Drennan et al., 2023). This shift is reflected in the rising global presence of physiotherapists within the ED, a development that has prompted growing academic interest in their clinical utility (Barrett & Terry, 2018; Miner et al., 2022). Despite this expansion, ED physiotherapy remains in a formative stage compared to more traditional physiotherapy domains, leading to wide variation in how these services are integrated and delivered internationally (Barrett & Terry, 2018; Lefmann & Crane, 2016; Maka et al., 2022).

While many ED programmes have successfully leveraged physiotherapy expertise in musculoskeletal medicine, establishing roles characterised by primary contact autonomy (de Gruchy et al., 2015; Ferreira et al., 2019; Gagnon et al., 2026; Gagnon et al., 2021; Gagnon et al., 2024); others have focused on secondary contact models managing mobility, falls, and frailty (Goldberg et al., 2020). Complementing these established pathways is an emerging recognition of the physiotherapist's utility in vestibular assessment and management, with physiotherapists demonstrating expertise in vestibular

assessment, balance evaluation, rehabilitation, and patient education (Hillier & Hollohan, 2007; Stewart et al., 2019). Despite this clinical shift, there remains a notable paucity of literature specifically evaluating the integration of physiotherapy within the acute dizziness and vertigo cohort (Lloyd, Mackintosh, et al., 2020). A possible contributor to this gap may be the lack of consensus in the literature concerning the requisite experience and skillset for an ED physiotherapist. Current evidence suggests that the efficacy of the role is predicated on a “specialised generalist” model. Under this framework, clinicians are expected to navigate a broad spectrum of acute presentations while demonstrating expert-level diagnostic and therapeutic skills in targeted domains, most notably musculoskeletal assessment, the management of frailty or mobility, and the evaluation of acute vestibular dysfunction.

Physiotherapy is a safe, feasible, and evidence-based option for the acute management of peripheral vertigo (Evans et al., 2024; Hall et al., 2022; Hillier & Hollohan, 2007; Kerber & Newman-Toker, 2015). Preliminary studies demonstrate the value of the ED physiotherapist role (G. T. Lee et al., 2025); however, this support is currently concentrated within specific clinical domains, most notably the diagnosis and mechanical intervention of BPPV. ED physiotherapy input has been associated with an improved quality of care and closer approximation to evidence-based practice (Lloyd, Luscombe, et al., 2020; Stewart et al., 2022), yielding favourable reductions in advanced imaging alongside an increased rate of specific peripheral diagnoses (Kim et al., 2025; Lloyd, Luscombe, et al., 2020; Stewart et al., 2022). Reductions in wait times and lower hospital readmission rates are viewed positively, whereas an association with increased admissions from the ED and longer hospital lengths of stay represent less favourable outcomes within an ED operational context (Stewart et al., 2022). Physiotherapy is, on balance, viewed favourably for improving the care of acute dizziness and vertigo, yet remains underutilised in the ED (Lloyd, Mackintosh, et al., 2020).

Integrating physiotherapy into the vestibular care pathway may optimise workforce capacity by reallocating clinical load, while simultaneously employing the profession’s specialised *hands-on* expertise in bedside assessment and manoeuvre-based treatment. Furthermore, the inclusion of physiotherapists within the ED multidisciplinary team fosters a more holistic diagnostic lens. This diversity in clinical perspective ensures that patient management extends beyond a narrow biomedical focus to address the broader biopsychosocial domains of wellbeing, including social, psychological, and health equity considerations.

## **2.4 Indigenous Healthcare**

The fundamental drivers of illness do not differ between Indigenous and non-Indigenous populations; however, the resulting burden of disease, disability, and mortality is consistently and disproportionately higher among Indigenous peoples (Gracey & King, 2009; Wilson et al., 2021). This health gap is not a biological inevitability but a consequence of systemic marginalisation within nation-states. Internationally, Indigenous peoples are frequently underrepresented in health discourse

and, in many regions, remain statistically indiscernible due to a lack of recognised or accurate data (Stephens et al., 2005).

A primary barrier to addressing these discrepancies is the inadequacy of localised statistical data regarding Indigenous demographics, health outcomes, and socioeconomic circumstances (Gracey & King, 2009; Selak et al., 2013). Without robust, regularly collected data, governments often fail to acknowledge the specific rights and requirements of Indigenous groups, leading to a profound misallocation of resources. As Stephens et al. (2005) observed, when data does exist, it invariably reveals that Indigenous peoples experience significantly worse health and social indicators than non-Indigenous populations in the same society. To close these gaps, research must be gathered locally to account for the vast diversity of Indigenous experiences while simultaneously addressing the universal socioeconomic inequities that drive these discrepancies (Gracey & King, 2009; Stephens et al., 2005).

Beyond quantitative data, a fundamental issue remains the lack of Indigenous representation in health policy and research. Indigenous peoples are not merely a sub-group with poor health outcomes; rather, they are distinct populations whose perspectives and understandings of health are often sidelined by dominant western medical frameworks (Stephens et al., 2005). Addressing these inequities requires a paradigm shift toward research that respects Indigenous self-determination, thereby granting these communities the right to shape their own research priorities and policy solutions (Robson, 2002).

Despite the geographic and cultural diversity of Indigenous peoples, the determinants of their health status share striking similarities (Gracey & King, 2009). Improving these outcomes necessitates an international commitment to urgent action and the mobilisation of adequate resources to address historical disparities in mortality and morbidity (Wilson et al., 2021). As explored within the New Zealand context in the following section, these global principles of representation, data integrity, and socioeconomic equity are essential for understanding the specific health inequities faced by Māori within the acute healthcare system.

#### **2.4.1 Māori Health and Wellbeing**

The disparity in health outcomes between Māori and non-Māori is well-documented, with Māori consistently experiencing higher rates of morbidity and mortality across nearly all health indicators (Abraham et al., 2018; Palmer et al., 2019). These inequities are not merely a reflection of current socioeconomic status but are rooted in a fundamental misalignment between holistic Māori worldviews and the dominant Western medical paradigms that structure the New Zealand healthcare system (Graham & Masters-Awatere, 2020).

The Māori view of health is inherently holistic, often conceptualised through models such as Te Whare Tapa Whā (Durie, 1985) or the Meihana Model (Pitama et al., 2007), which integrate multiple dimensions of what makes a person and whānau well. The core pillars of these models

comprise taha tinana (physical), taha hinengaro (mental/emotional), taha whānau (familial), and taha wairua (spiritual) wellbeing (Rochford, 2004) . Unlike Western models, which tend toward an individualistic and reductionist focus on isolated symptoms, Indigenous notions of health are collective and encompass the wellbeing of the whānau, the wider community, and the ecosystem (taiao) in which they live (Pitama et al., 2014; Stephens et al., 2005).

In contrast, the New Zealand public health system is largely designed to privilege individualistic clinical discourses and acute physical needs (Graham & Masters-Awatere, 2020). This biomedical and reductionist approach, which dominates both research and hospital service delivery, often fails to recognise or value the multifaceted nature of Māori health and wellbeing. Consequently, Māori patients may find western clinical environments lacking, as their experiences are frequently subsumed into colonial narratives that prioritise the physical presenting symptom over person's wider spiritual and familial context.

Long before European contact, Māori had established sophisticated health structures tailored to their environment and collective social systems (Treaty of Waitangi Tribunal, 2019). Colonisation fundamentally disrupted these frameworks, imposing a health system, including the construction of the early hospital network, configured primarily to serve the needs of Pākehā (Graham & Masters-Awatere, 2020).

The modern inequities in Māori healthcare outcomes are therefore consistent with broader Indigenous experiences of colonisation, including land loss, language degradation, and systemic discriminatory policies (Rochford, 2004). Within the contemporary hospital setting, this history manifests as institutional racism, where Māori patients typically receive inequitable access to specialised interventions and a lower quality of care compared to their non-Māori counterparts.

Māori have described that the New Zealand healthcare system feels “hostile and alienating,” leading to consistently negative hospital experiences (Graham & Masters-Awatere, 2020, p. 199). Health equity literature identifies three primary systemic barriers that perpetuate these poor outcomes:

- **Organisational Structures:** Rigid clinical networks and operational systems that do not accommodate collective (whānau) involvement or Māori protocols (tikanga) (Espiner et al., 2021; Hudson et al., 2010).
- **Staff Interactions:** The presence of implicit bias and a lack of clinical cultural safety, which can lead to the misinterpretation of symptoms or a profound breakdown in clinical trust (Komene et al., 2024).
- **Practical Considerations:** Socioeconomic hurdles, including transportation, cost, and the flexibility of hospital scheduling, which disproportionately impact Māori access to acute and follow-up care (Harris et al., 2006; Patu et al., 2023).

#### **2.4.2 Māori Health and the Emergency Department Interface**

EDs are an integral component of healthcare delivery worldwide. However, there is increasing evidence that EDs may not operate equitably for all patients, with Indigenous and minoritised ethnicity patients experiencing differential pain management alongside less robust evaluation and treatment of acute conditions (Edlow et al., 2023; Prisk et al., 2016; Stephens et al., 2005). Māori are and have historically been underserved by the healthcare system; recent studies note Māori experience the worst health outcomes by any metric in Aotearoa New Zealand (Health Quality & Safety Commission, 2019), and Māori were found to be more than twice as likely to die within 10 days of ED discharge than non-Māori (Curtis et al., 2020). As such, the physical ED environment aligns with broader reports of negative Māori healthcare experiences, where restrictive room layouts and a lack of clinical privacy can negatively influence how Māori navigate acute care. In addition, healthcare workers may not adequately integrate holistic Māori views of health into their clinical practice (Abraham et al., 2018). It has been postulated that the demanding ED environment lends itself to clinician bias due to the time-pressured nature of rapid clinical decision-making and time-limited patient consultations (Tomas, 2018).

A recently published study, described by its authors as the most comprehensive investigation of acute outcomes by ethnicity to date in New Zealand, examined ED admissions across 18 of the 20 former District Health Boards (DHBs) in Aotearoa New Zealand. The study reported profound inequities in ED mortality that were highly unlikely to be explained by conventional ED process measures or patient comorbidities (Curtis et al., 2022). These findings reinforce the urgent need to investigate health professional bias and institutional racism within an acute care context. Other local authors have similarly called for ED research that includes both the analysis of Māori health outcomes and actionable, strategic responses where structural inequities exist. Attempts to address this gap, such as the aspirations of the Australasian College for Emergency Medicine's *Te Rautaki Manaaki Mana* strategy (2022–2025) for excellence in emergency care for Māori, specifically advocate for including the analysis of Māori health outcomes in ED research and clinical audits (Australasian College for Emergency Medicine, 2022). This approach is supported by equity researchers who call for regular auditing for ethnic inequities within ED care, the robust collection of high-quality ethnicity data, the deliberate consideration of Māori sample sizes to ensure equal explanatory power, and a clear Kaupapa Māori positioning of clinical research (Curtis, 2016; Curtis et al., 2019; Robson, 2002; Tomas, 2018; Yates, 2020).

#### **2.5 Challenges of Acute Dizziness and Vertigo in the Emergency Department**

A critical function of an ED is to differentiate between non-emergent and emergent causes of presenting symptoms. This has proven uniquely challenging within the cohort of patients presenting with acute dizziness and vertigo, where ED clinicians misdiagnose stroke at clinically significant rates; indeed, cerebrovascular accidents presenting with vestibular symptoms represent the most

commonly missed strokes in emergency medicine (Gurley & Edlow, 2019; Savitz et al., 2007). A recent systematic review examining diagnostic errors in the ED identified stroke as the leading cause of serious harm resulting from misdiagnosis (Newman-Toker et al., 2022). These cerebrovascular events are reported to be missed 9% to 17% of the time at initial ED presentation (Newman-Toker et al., 2022; Tarnutzer et al., 2025; Tarnutzer et al., 2017). Further analyses of missed strokes in the ED report that cases presenting with isolated dizziness and vertigo are initially missed approximately 40% of the time. In comparison, strokes presenting with classic motor symptoms are missed in only around 4% of cases, a rate that sits slightly lower than the estimated 5.7% baseline of all ED visits associated with at least one diagnostic error. This alarming rate of misdiagnosis in ED patients presenting with vestibular symptoms is not new, with historical reports indicating missed strokes in 35% of cases where the primary ED complaint was dizziness (Kerber et al., 2006; Moulin et al., 2003).

While more concern is duly given to the high misdiagnosis rate of life-threatening conditions, it appears that all causes of acute dizziness and vertigo face diagnostic challenges in the ED. A German study by Rojl et al. (2011) reported that 44% of this cohort were initially misdiagnosed; notably, this included revising initial benign diagnoses to critical or central pathologies. Others have reported peripheral vestibular disorders being misdiagnosed in the ED at rates estimated between 74% and 81% (Kerber et al., 2011; Kerber & Newman-Toker, 2015; Rojl et al., 2011). Because posterior circulation transient ischaemic attacks most commonly present with transient, isolated vertigo, they may be misdiagnosed on initial clinical contact as high as 90% of the time (Tarnutzer et al., 2017). It may not be unreasonable, based on these findings, to presume that presentation to an ED with acute dizziness and vertigo would, more likely than not, result in an initial misdiagnosis. Therefore, questions abound regarding reliability of ED epidemiological data, the efficiency of resource allocation, and the appropriateness of clinical treatment decisions made within an acute care context.

This diagnostic difficulty is not the result of a single factor, but rather a convergence of clinical, environmental, and systemic variables that complicate the trajectory from initial presentation to definitive diagnosis. To understand why acute dizziness and vertigo remain a frequent site of diagnostic error and resource inefficiency, it is necessary to examine the multifaceted hurdles faced by the front-line clinician.

The following subsections detail these interconnected challenges, beginning with the inherent complexity of the condition itself, where the necessity of differentiating central neurological events from benign peripheral mimics requires a level of oculomotor precision that often eludes standard medical screening. This section also explores the behavioural barriers to evidence-based practice, specifically regarding the nuances of oculomotor examinations, bedside manual assessments, and canalith repositioning manoeuvres. It addresses how a pedagogical gap perpetuates an unwarranted clinical reassurance characterised by the overutilisation of CT imaging. This reliance on radiology as a heuristic shortcut is coupled with a pharmacological approach that frequently prioritises symptomatic suppression over definitive bedside interventions. By framing these systemic and

clinical barriers, this chapter establishes the rationale for mapping current responses in the literature to this significant clinical problem, and underscores the importance of evaluating local clinical practices within an Aotearoa New Zealand ED context.

### **2.5.1 Condition Complexity**

The anatomical proximity and functional interdependence of the peripheral and central vestibular pathways create a complex diagnostic overlap that defines the clinical challenge of acute dizziness and vertigo. In a healthy state, the peripheral apparatus provides the raw sensory data, while the central system; primarily the brainstem and cerebellum, processes and modulates this input to ensure postural and ocular stability. However, because these systems share the same brainstem integration hubs and inhibitory feedback loops, an acute lesion within either domain can produce an identical symptomatic profile of vertigo, nystagmus, and imbalance (Comolli et al., 2023; Gurley & Edlow, 2019). Vertigo is much more frequently caused by a peripheral aetiology; however, it is also the most common symptom of a posterior circulation ischaemic stroke and is often unaccompanied by more obvious or classic neurological deficits (Newman-Toker, 2016).

The symptomatic presentation of acute dizziness and vertigo arises from a heterogeneous array of pathomechanisms spanning otologic, vestibular, cardiovascular, respiratory, psychiatric, and neurological systems (Herdman, 2024). While critical aetiologies represent a statistical minority of the total acute dizziness and vertigo cohort, the incidence of life-threatening events such as ischaemic stroke is sufficiently prevalent in the acute setting to remain a dominant diagnostic priority (Goeldlin et al., 2019). Consequently, the critical clinical outcome and clinician apprehension surrounding a missed stroke diagnosis stand in direct tension with the high volume of benign presentations (Voetsch & Sehgal, 2021).

This phenomenological mimicry, where benign peripheral insults such as vestibular neuritis present nearly identically to malignant central events like posterior circulation strokes, is a primary driver of diagnostic uncertainty. This uncertainty potentially precipitates defensive medical practices where reactive strategies, such as the overutilisation of diagnostic imaging or prolonged symptomatic suppression, are frequently misaligned with modern, evidence-based understandings of vestibular physiology and clinical best-practice.

### **2.5.2 Behavioural Barriers to Evidence-Based Acute Dizziness and Vertigo Management**

Emergency physicians are faced with considerable clinical challenges, including the imperative to execute life-saving measures with limited information in unpredictable clinical situations. To achieve this, they must remain adaptable, flexible, innovative, and resourceful (Lateef et al., 2025). A foundational tenet of emergency medicine is the rapid assessment and differentiation of low-risk, well patients from the critically ill (Rosen, 1979). Understandably, the training required for an ED physician must be comprehensive and broad (Lateef et al., 2025).

Traditional diagnostic approaches utilised by emergency physicians in the assessment of acute dizziness and vertigo have relied heavily on symptom quality, specifically distinguishing "dizziness" from "vertigo" (Newman-Toker, 2007; Stanton et al., 2007). While modern neuro-otological literature has moved firmly toward the diagnostic weighting of symptom timing and triggers alongside targeted bedside examinations, the extent to which this contemporary paradigm is operationalised by emergency physicians remains incomplete, with several investigations highlighting substantial clinical concerns (Edlow et al., 2023; Herdman, 2024; Newman-Toker et al., 2009; Saber Tehrani et al., 2018; Vanni et al., 2024). Among the many challenges described throughout this section, a distinct lack of post-graduate training for the "generalist" ED physician in acute neuro-otology is frequently highlighted. While remaining apprised of rapidly advancing clinical literature is both essential and challenging for frontline clinicians, it is apparent that acute dizziness and vertigo presentations represent an area of particularly high cognitive and diagnostic demand (Lateef et al., 2025).

Dutch et al. (2008) described dizziness as a *disliked* presentation by ED physicians. It was reported ED physicians selectively avoided disliked complaints, such as dizziness, which were consequently associated with longer waiting times post-triage than control-matched cases, whereas favoured conditions were selectively prioritised. In an international survey of emergency physicians, the development of clinical decision rules for acute vertigo was identified as one of the highest priorities for the profession (Eagles et al., 2008). This suggests a long-standing recognition among clinicians that current diagnostic frameworks for acute dizziness and vertigo are insufficient.

The gap between evidence-based best practice and routine clinical execution is therefore not a new concern. A recent example is highlighted in the assessment of acute dizziness and vertigo, where the use of the HINTS exam is a strong recommendation in recent clinical guidelines (Edlow et al., 2023); however, in those guidelines, the authors note HINTS is yet to reach the status of a clinical standard of care as most ED clinicians are not trained in its use (Edlow et al., 2023). The suboptimal uptake of validated vestibular assessments is multifaceted, involving both educational and environmental barriers. Central to this issue is emergency physicians' infrequent practice of specialised physical manoeuvres. Unlike more common ED procedures, the head impulse test and canalith repositioning manoeuvres require high-precision motor skills and nuanced interpretation of ocular movement. Without regular exposure and formalised training programmes, emergency physicians often lack the confidence to rely on these findings for high-stakes decision-making, such as the exclusion of posterior circulation ischaemia.

### **2.5.3 Imaging**

A noteworthy challenge in the contemporary management of acute dizziness and vertigo is the pervasive overreliance on neuroimaging, often at the expense of a comprehensive clinical examination (Morrow et al., 2023; Newman-Toker, 2016; Savitz et al., 2007). This trend is driven largely by the high accessibility and perceived time efficiency of CT within the ED environment.

However, the diagnostic yield of CT for posterior circulation stroke is notoriously poor, with sensitivity reported as low as 7% to 16% in the hyperacute phase (Morrow et al., 2023; Newman-Toker, 2016).

Despite its suboptimal sensitivity, CT usage has increased over time, as clinicians seek rapid reassurance of the absence of intracranial pathology (Kerber et al., 2008; Pavlovic et al., 2018; Smith-Bindman et al., 2008). This reliance creates a precarious false assurance where a negative CT result is inappropriately weighted as evidence of a benign peripheral cause. Such misinterpretation carries profound clinical risks, as it may lead to the inappropriate discharge of patients with evolving cerebellar or brainstem infarcts (Savitz et al., 2007). Grewal et al. (2015) examined a retrospective cohort of patients discharged from the ED with a diagnosis of peripheral vertigo; they found that those who underwent CT imaging were 2.3 times more likely to be hospitalised with a stroke in the following 30 days than those who did not receive CT imaging. These authors concluded high-risk strokes were being missed in patients who received CT imaging. Newman-Toker (2016) cites this as an example of clinicians being falsely reassured by a normal head CT, despite demonstrating accurate risk-stratification in their initial selection for neuroimaging.

Even MRI, while superior to CT, may yield false-negative results in up to 20% of cases within the first 24 to 48 hours of symptom onset (Newman-Toker, 2016). The routine application of neuroimaging in the absence of focal neurological deficits imposes a substantial burden on healthcare resources without a commensurate value to patient outcomes. The financial costs of inappropriate scanning are compounded by systemic inefficiencies, including the time required to transport, scan, and interpret neuroimaging, paradoxically restricting ED patient flow and increasing the length of stay for patients who could more accurately, and rapidly, be triaged via bedside neuro-otological assessments.

Beyond the economic impact, unnecessary exposure to ionising radiation and the potential for incidental findings of no clinical relevance, which can trigger further unnecessary or invasive investigations, represent tangible harms to the patient. The literature demonstrates that routine neuroimaging is not superior to validated bedside clinical assessment clusters, such as the HINTS-plus battery or the STANDING algorithm, and should be viewed as a secondary diagnostic adjunct rather than a primary screening tool within the acute vestibular context (Edlow et al., 2023; Vanni et al., 2024).

#### **2.5.4 *Inappropriate Pharmacological Response***

A pervasive challenge in the emergency management of acute dizziness and vertigo is the disproportionate reliance on pharmacological symptom suppression over definitive, cause-directed intervention. This is most acutely observed in the management of BPPV. Despite being a mechanical disorder requiring curative physical repositioning manoeuvres, recent literature indicates a significant overuse of vestibular suppressants in the ED for these patients (Bhattacharyya et al., 2017; McGillis et

al., 2023). The frontline use of non-curative medical therapies, most notably prochlorperazine, remains a common, yet often inappropriate, response to the acutely dizzy patient (Sharif et al., 2023). While antiemetics and vestibular suppressants may provide temporary relief from the autonomic distress of an acute episode, they do not address the underlying pathophysiology. In the case of BPPV, prescribing medication rather than performing a Dix-Hallpike assessment and subsequent Epley manoeuvre represents a missed opportunity for immediate resolution (Fife & von Brevern, 2018; Khoujah et al., 2023; Sharif et al., 2023).

The default prescription of these drugs can be counterproductive, particularly with prolonged use in acute vestibular syndrome. Vestibular suppressants, including benzodiazepines and certain antihistamines, function by reducing the firing rate of the vestibular nuclei (Dyhrfeld-Johnsen & Attali, 2019; Soto & Vega, 2010; Sousa et al., 2024). While this suppresses the acute symptoms, it simultaneously masks the very neurophysiological signals the central nervous system requires to initiate vestibular compensation. As previously discussed, the brain's neuroplastic capacity following a peripheral insult relies on the central processing of asymmetrical vestibular input. In suppressing this input pharmacologically, clinicians may inadvertently delay the long-term functional recovery of the patient (Hall et al., 2022; Sousa et al., 2024).

### ***2.5.5 Non-use of Bedside Interventions***

Despite the existence of highly effective, low-cost bedside interventions for acute dizziness and vertigo, a significant intervention gap persists within the ED (Bhattacharyya et al., 2017; Perez-Vazquez et al., 2018). This gap is characterised by a failure to transition from a successful diagnosis to the immediate implementation of recommended treatment modalities, such as canalith repositioning manoeuvres or targeted referrals for vestibular rehabilitation (Edlow et al., 2023; Kerber et al., 2013; Lammers et al., 2020).

In the case of BPPV, the disparity between diagnostic evidence and therapeutic action is particularly stark (Bashir et al., 2014; Kerber et al., 2013). While the Epley manoeuvre and other canal repositioning manoeuvres are recognised as the benchmark for providing immediate symptomatic relief and resolving the underlying mechanical dysfunction, they are infrequently performed by emergency physicians (Edlow & Kerber, 2023; Lloyd, Mackintosh, et al., 2020; Neely et al., 2021). Kerber et al. (2013) highlighted that even when benign paroxysmal positional vertigo is correctly identified, only a small fraction of patients receive a repositioning manoeuvre during their ED stay. This diagnostic-therapeutic mismatch represents a significant missed opportunity, as patients are at risk of being discharged with a prescription for vestibular suppressants rather than the mechanical cure that could have definitively resolved their symptoms prior to leaving the hospital.

Beyond the immediate resolution of BPPV, there is a missed opportunity to leverage the ED as a critical entry point for vestibular rehabilitation. For patients presenting with acute vestibular syndrome, early education and the initiation of compensatory exercises are important for long-term

functional recovery (Hall et al., 2022). However, Lammers et al. (2020) observed that many patients with peripheral vestibular disorders are discharged from the ED without a clear rehabilitation pathway or an appropriate referral to specialist physiotherapy services.

This lack of follow-up has compounding effects on the healthcare system. Patients who do not receive timely bedside intervention or a structured rehabilitation plan are at a higher risk of developing persistent postural-perceptual dizziness, chronic imbalance, falls or further injury from falls and an increased fear of falling, as well as protracted functional limitations and reduced occupational productivity (Hall et al., 2022; Madrigal et al., 2024; Montero-Odasso et al., 2022).

The underutilisation of these bedside interventions underscores a need for a shift in the ED model of care, moving away from a purely diagnostic mindset toward a more comprehensive approach that prioritises timely functional recovery and utilisation of appropriate follow-up.

## **2.6 Impact of these challenges**

While many dizziness and vertigo presentations are benign, as detailed previously, the historical difficulty in differentiating peripheral vestibulopathy from central pathology has led to a high rate of misdiagnosis within acute care settings (Royle et al., 2011; Voetsch & Sehgal, 2021). This diagnostic failure is most critical regarding posterior circulation cerebrovascular events, which are frequently overlooked or misattributed to less severe conditions (Gurley & Edlow, 2019; Kerber et al., 2006).

Acute ischaemic strokes that are initially missed or mismanaged are associated with significantly higher disability and mortality rates at the 12-month mark compared to those identified and treated promptly (Richoz et al., 2015). Atzema et al. (2016) concluded that a significant number of strokes, or sentinel events preceding a major stroke, are erroneously diagnosed as peripheral disorders during the initial ED encounter. The potential impact inherent in mismanaging acute dizziness and vertigo extends beyond the immediate clinical risk of a missed stroke, creating a compounding burden that is felt across three distinct levels: the individual patient, healthcare institutions, and the wider society. The following sections provide a detailed examination of these impacts, describing how the previously described challenges in acute dizziness and vertigo management create a cycle of clinical and economic inefficiency.

### **2.6.1 Patient Consequence**

The individual burden of acute dizziness and vertigo mismanagement is varied, ranging from an acute clinical catastrophe to a chronic erosion of functional autonomy. Diagnostic error in this cohort has been identified as a major public health crisis. Missed or delayed stroke diagnosis carries the potential for permanent neurological deficit or death, with thousands of patients suffering avoidable death or permanent disability (Edlow & Newman-Toker, 2016). The implications of such errors are particularly stark regarding the narrow window for acute intervention. Research indicates

that approximately one-third of missed strokes would have been eligible for time-sensitive recombinant tissue plasminogen activator (tPA) treatment had they been correctly identified upon presentation (Tarnutzer et al., 2017). The failure to initiate these protocols is associated with a 4-fold increase in mortality, underscoring that even mild initial presentations of cerebrovascular disease carry the potential for significant, preventable harm if the underlying pathology is ignored (Richoz et al., 2015).

While the risks of missed stroke are potentially catastrophic, even an ostensibly benign peripheral pathology incurs substantial human costs. Mismanaged or unresolved vestibular symptoms lead to a marked reduction in health-related quality of life, characterised by limitations in activities of daily living and a restricted capacity for social and occupational participation (Mohwald et al., 2020; Smith et al., 2024). Further, a lack of diagnostic clarity can foster anxiety and persistent psychological distress, contributing to the development of chronic maladaptation and kinesiophobia (Gopinath et al., 2024; Mira, 2008; Tarnutzer et al., 2017).

In a New Zealand context, these impacts extend beyond the individual to the whānau. The persistent instability and fall risk associated with unaddressed disorders can alter family dynamics, forcing shifts in intergenerational roles and placing an unexpected caregiver burden on relatives (Mao et al., 2024). For many patients, the loss of the ability to contribute to the home or community results in a diminished sense of mana and purpose, illustrating that patient impact extends far beyond a clinical metric to represent a profound disruption to the holistic wellbeing of the family unit (Bourke et al., 2023).

### **2.6.2 *Healthcare Institution Consequence***

The challenges of managing acute dizziness and vertigo in the ED setting extend beyond individual clinical outcomes, imposing a significant burden on healthcare institutions through systemic inefficiencies and the suboptimal allocation of resources. Central to this issue is a mismatch between resource needs and utilisation, characterised by a paradoxical combination of overutilisation and underutilisation (Newman-Toker et al., 2009). While expensive, low-yield neuroimaging modalities are frequently overused for benign presentations, critical cost-efficient interventions are simultaneously underutilised. The clinical default to computed tomography to exclude central pathology, for example, leads to an increased financial burden on the healthcare system without a commensurate improvement in diagnostic certainty.

In addition to the overreliance on neuroimaging, another driver of organisational strain is the inappropriate activation of specialised pathways. An avoidable resource burden occurs secondary to inappropriate triage to acute stroke pathways, as the majority of patients presenting to the ED with dizziness do not have an underlying stroke. When clinicians lack the specialised bedside skills to confidently exclude central mimics, they often default to defensive medicine, simultaneously ordering advanced neuroimaging and occupying acute neurology beds that should otherwise be reserved for

patients with confirmed cerebrovascular events (Morrow et al., 2023). This trend not only increases direct hospital costs but also impairs patient flow, prolongs ED length of stay, and hinders institutional performance targets, such as the six-hour disposition goal.

Organisational impact is further compounded by the long-term sequelae of misdiagnosis. When a stroke is missed or misidentified as a peripheral disorder, the healthcare system incurs additional downstream costs. Misdiagnosed patients are at a significantly higher risk for acute complications and recurrent events due to the lack of secondary stroke prevention and a failure to treat the underlying vascular pathology during the initial encounter (Gurley & Edlow, 2019). These preventable recurrences frequently lead to intensive care admissions and prolonged rehabilitative stays, which are exponentially more expensive than an accurate initial diagnosis and management plan. A more parsimonious diagnostic approach, prioritising targeted clinical examination over reflexive imaging, offers a clear pathway to mitigate these systemic pressures while simultaneously improving the accuracy of triage and the efficiency of hospital flow.

### **2.6.3 Societal Consequence**

At a macro level, the mismanagement of acute dizziness and vertigo translates into substantial economic losses, driven by a combination of direct healthcare expenditure and indirect productivity deficits. As global and domestic populations age, the prevalence of vestibular disorders is projected to rise significantly, placing an escalating financial burden on social welfare and public health systems (Kim et al., 2024). The intersection of an ageing population and suboptimal acute dizziness and vertigo management creates a potential compounding accumulation of disability. Vestibular impairment is a leading modifiable risk factor for falls, representing a significant cause of injury-related hospitalisation and threatened independence among older New Zealanders (Mao et al., 2024; Montero-Odasso et al., 2022). When the acute care system fails to resolve these impairments, an avoidable decline in physical function can necessitate a premature transition to residential care, shifting the financial burden from the acute health sector to long-term socialised care and family resources.

The economic impact is further exacerbated by the loss of workplace productivity (Nagdee et al., 2024). Vestibular symptoms are a principal determinant of both absenteeism and presenteeism, or reduced performance while at work. Because dizziness is often unpredictable and debilitating, it can lead to prolonged periods of sick leave or, in severe cases, premature withdrawal from the workforce (Benecke et al., 2013; Neuhauser et al., 2008). This burden is not limited to the patient but also extends to the caregiver and whānau, who may be forced to reduce their own employment hours to support an unstable or housebound relative. The aggregate loss of labour and tax revenue, coupled with the increased demand for social support payments, represents a further compounding cost to the national economy.

## 2.7 Response to Challenges

The cumulative discourse presented in the preceding sections delineates a multifaceted crisis in the emergent management of acute dizziness and vertigo. The current clinical landscape is characterised by a precarious diagnostic-therapeutic discordance, where the grave risks of missed posterior circulation strokes coexist with the systemic surplus of over-imaging and the pharmacological masking of mechanical disorders. It is evident that the status quo, which relies on non-specific neuroimaging and the qualitative assessment of symptoms, is unsustainable and compromises patient safety and institutional efficiency.

The individual, institutional, and societal impacts collectively signal an urgent need for a paradigm shift in emergency vestibular care. To mitigate the identified risks and optimise the allocation of healthcare resources, a series of strategic responses has emerged in the literature. There are published algorithms to guide ED decisions and resource allocation, the development of novel risk-stratifying and diagnostic test batteries, and an acknowledgement of the need for condition-specific skillsets and training (Edlow et al., 2023; Ronchetti et al., 2025; Vanni et al., 2024; Wang et al., 2021). In addition to this, a series of published expert opinions demonstrate a clear appetite for a wider dissemination of knowledge (Edlow & Newman-Toker, 2016; Herdman, 2024; Spiegel et al., 2017; Tarnutzer & Edlow, 2023; Tsang et al., 2017).

The following section examines these evolving strategies and evaluates the diagnostic and therapeutic trajectory of the acutely dizzy patient. As previously discussed, a noteworthy paradigm shift has occurred in the recommended clinical approach to dizziness, with the traditional classification system superseded by the *timing and triggers*, approach (Drachman & Hart, 1972; Edlow et al., 2018). This modern framework prioritises the temporal profile and provocative factors of a presentation, facilitating a more objective, pathophysiological categorisation of acute dizziness and vertigo.

The success of this transition is underpinned by the integration of comprehensive history-taking and targeted bedside examinations that demonstrate superior diagnostic utility in the acute care setting. Beyond routine neurological screening which typically assesses limb power, sensation, and coordination contemporary practice emphasises functional metrics such as gait analysis and postural stability (Vanni et al., 2017). Diagnostic accuracy is further enhanced through the systematic application of reference-standard provocative positional tests for BPPV, alongside specialised analysis of oculomotor performance (Bhattacharyya et al., 2017; Kerber et al., 2011; Newman-Toker et al., 2015; Perez-Vazquez et al., 2018).

Fundamental to this clinical evolution is the precise analysis of spontaneous and induced nystagmus. These individual clinical signs have been synthesised into validated diagnostic clusters, most notably the HINTS battery and the STANDING bedside algorithm (Kattah et al., 2009; Vanni et al., 2014). By combining structured observations of nystagmus morphology, the head impulse test, and the test of skew, the HINTS exam offers a significantly more reliable differentiation between

peripheral and central vestibular disorders than the qualitative, symptom-based methods of the past (Gerlier et al., 2021; Kattah et al., 2009).

Recognising the critical need to support frontline clinicians in high-pressure environments, these complex neuro-otological assessments have been increasingly distilled into accessible clinical decision rules. This has resulted in a global proliferation of mnemonic-based algorithms and visual diagnostic pathways designed to enhance the speed, safety, and accuracy of ED triage (Cristiano et al., 2020; Filippopoulos et al., 2022; Mandge et al., 2020; Nakatsuka & Molloy, 2022; Neely et al., 2023; Pellegrino et al., 2022; Sandlund et al., 2019; Stewart et al., 2022).

While Kattah's HINTS remains a foundational paradigm shift toward targeted neuro-otological examinations, numerous international research groups have also developed similar physiology-based protocols, such as TiTrATE (Timing, Triggers, and Targeted Examination) (Newman-Toker & Edlow, 2015) and the aforementioned STANDING (SponTaneous Nystagmus, Direction, head Impulse test, standiNG) algorithm, which combines elements of the HINTS exam, TiTrATE, and BPPV positional tests. This multiplicity of diagnostic models reflects a global trajectory showing that the management of acute dizziness and vertigo must transition from a historical reliance on subjective symptom descriptions toward a systematic, evidence-based application of clinical physiology.

The ABCD<sup>2</sup> is a stroke risk stratification tool originally validated in cohorts presenting with transient ischaemic attacks; this tool predicts the seven day risk of stroke by combining independent predictors, including age, diabetes mellitus, blood pressure, symptom duration, and specific clinical features (Johnston et al., 2007). Early attempts to manage acute dizziness repurposed the ABCD<sup>2</sup> score to identify stroke risk in the acutely dizzy patient (Navi et al., 2012). This approach was subsequently found to be insufficient and lacked the requisite sensitivity for the acute dizziness and vertigo cohort (Gerlier et al., 2021; Newman-Toker, Kerber, et al., 2013). The literature increasingly advocates for the use of subtle ocular findings to differentiate central from peripheral pathologies, presenting an efficient and cost-effective method for reducing misdiagnosis-related harms (Newman-Toker, Saber Tehrani, et al., 2013).

Growing literature regarding modern approaches to acute dizziness and vertigo presentations also places an additional cognitive burden on emergency clinicians. To address this, diagnostic safeguards have been advocated, ranging from bedside checklists to the development of sophisticated clinical decision support algorithms and pathways (Tarnutzer et al., 2017). The more sophisticated responses include multidisciplinary input; alongside this, there is a growing yet inconclusive discourse regarding the optimal team composition for managing acute dizziness and vertigo. While some scholars suggest that a team-based approach is essential for high-stakes decision-making, a clear consensus on the specific roles within that team remains elusive (Tarnutzer et al., 2017). Traditional care models advocated for routine access to neurology; however, the practicality of this model is questioned due to insufficient specialist availability and the operational realities of rural hospitals

(Caplan, 2007; Tarnutzer et al., 2017). Consequently, the literature increasingly signals that a broader culture change may be required, one that embraces a multidisciplinary framework where specialised assessment skills are distributed across a wider clinical team, including allied health professionals such as an ED physiotherapist (Drennan et al., 2023). Another operational response includes the exploration of telemedicine to mitigate the scarcity of specialists. Although tele-stroke networks have proven a feasible option for emergent care (Bladin & Cadilhac, 2014), the application of tele-neurotology is an emerging post-COVID response (Chari et al., 2020). While Noda et al. (2023) have proposed that the integration of smartphone-based ocular recordings with remote specialist consultation represents a feasible option.

Despite numerous proffered solutions to these established problems, there has been little definitive consensus on the optimal approach. Recent guidelines (GRACE-3: Guidelines for Reasonable and Appropriate Care in the Emergency Department 3) by Edlow et al. (2023) represent the first modern, comprehensive, and high-quality published work specifically relevant to an ED setting. There is a strong case to promote this work as foundational for establishing modern care pathways for acute dizziness and vertigo within EDs. However, there has been some critique (Srinivasan & Tirschwell, 2023). As these recommendations are pivotal to informing the metrics included in the bespoke data extraction tool developed for this work, the GRACE-3 guidelines themselves are critically examined in Chapter 4 ([4.7.11](#))

## **2.8 Summary of Narrative Review**

The narrative review has described the complex clinical, organisational, and societal landscape of acute dizziness and vertigo within the ED. Despite a high prevalence, this condition remains one of the most significant diagnostic and operational challenges in acute care.

The ED setting is frequently ill-equipped to manage the inherent complexity of an acute presentation of dizziness and vertigo. A historical reliance on outdated diagnostic paradigms currently competes with a rapid proliferation of recently published algorithms, risk-stratification metrics, and diagnostic test clusters, requiring clinicians to retain complex assessment patterns while simultaneously acquiring new physical skills to perform specialised neuro-otological bedside assessments within an environment characterised by severe clinical, organisational, and operational time pressures.

The resulting diagnostic and therapeutic ambiguity frequently lead clinicians to fall back on low-yield neuroimaging and the inappropriate use of vestibular medications. Crucially, these systemic failures are not distributed equally; for Māori and other indigenous populations, the ED can function as a site of reinforced health inequity, where structural access barriers and a lack of culturally safe, holistic assessment models contribute to higher rates of misdiagnosis and poorer longitudinal outcomes. Systemic disparities in healthcare access and outcomes for Māori are well-documented; however, whether these specific inequities extend to the acute assessment and management of

dizziness and vertigo in EDs remains unknown, which is an issue within itself. Addressing this deficit is vital for aligning ED care with the statutory and ethical obligations of Te Tiriti o Waitangi, thereby ensuring equitable healthcare delivery for all.

Another modern ED response to these issues is the expansion of a multidisciplinary approach. An explicit focus of this work is the utilisation of ED physiotherapy within acute vestibular care pathways; however, the extent to which these clinical implementations are widespread, deeply embedded, or successful remains unclear. Nor is the trajectory clearly signposted for other EDs to replicate this particular model, or to adopt any of the other proffered theoretical solutions to the challenges of acute dizziness and vertigo care.

The cumulative impact of these challenges is substantial, manifesting as avoidable morbidity from missed posterior circulation strokes, increased fall risks from unmanaged BPPV, and significant economic losses driven by hospital re-presentations and diminished workplace productivity. Consequently, this profound opportunity for clinical and operational optimisation warrants targeted empirical investigation.

### **3 Chapter 3: Rapid Scoping Review**

#### **Acute Dizziness and Vertigo Management in Emergency Departments: A Rapid Scoping Review Exploring Guideline Adherence, Physiotherapist Involvement, and Health Disparities**

##### **3.1 Introduction**

The clinical burden of acute dizziness and vertigo is well-documented; however, the literature remains limited regarding the clinical application of theoretical solutions, systemic efficiency, and the efficacy of multidisciplinary allied health interventions, and it is entirely silent on the New Zealand socio-demographic context (Stewart et al., 2018).

A pivotal shift in the research agenda has been proposed by Newman-Toker (2016), who argues that the field must move beyond merely defining the problem of diagnostic error. Instead, the focus should shift toward actionable implementation science and the actualisation of previously proposed solutions to determine if historical issues in ED care remain persistent or have been effectively mitigated by modern protocols.

Currently, there is a distinct absence of literature examining how these evolving and varied standards of care are actioned in real-world clinical settings. Consequently, whether ED diagnostic performance has genuinely improved remains an open question. It remains unclear if this academic response to the defined challenges has been successfully translated into frontline care, or if the opportunity to implement evidence-based recommendations has been fully realised.

While the shift toward evidence-based pathways is a necessary evolution, the current lack of a unified synthesis risks perpetuating a reliance on costly, low sensitivity diagnostics and outdated clinical practices. Furthermore, because multiple competing algorithmic approaches are described in the literature, a scoping review is an appropriate methodology to map and collate the available evidence to understand this heterogeneous landscape.

There remains a notable paucity of literature specifically evaluating the integration of physiotherapy within the acute dizziness and vertigo cohort. The rising global presence of physiotherapists within the ED has been described in the preceding narrative review. This development has prompted an emerging focus in the literature regarding ED physiotherapists' clinical utility. Despite this growth, ED physiotherapy remains in a formative stage compared to the profession's traditional domains, resulting in heterogeneous service integration and delivery models. To mitigate conceptual and clinical ambiguity, this review maps the landscape of physiotherapy care for acute dizziness and vertigo in the ED, specifically evaluating physiotherapy's contribution to evidence-based management.

In Aotearoa New Zealand, recent evidence indicates that Māori experience significant disadvantages and discrepancies in ED care, largely attributed to entrenched systemic and institutional factors (Edlow et al., 2023). Recognising the critical importance of Indigenous data in shaping

equitable care delivery (Yates, 2020), the narrative review identified a profound gap in the literature regarding Māori experiences of acute dizziness and vertigo. This rapid scoping review explicitly includes a global search strategy to identify how Indigenous populations experience emergency care for acute vestibular presentations.

The fragmented academic response across multiple care pathways and competing diagnostic algorithms, coupled with the lack of New Zealand-specific data particularly concerning Māori health and the emerging role of allied health professionals, necessitate a transition from conceptual critique to empirical mapping of the evidence base. This chapter, therefore, presents the methodology and findings of a rapid scoping review.

### **3.1.1 Objectives:**

The objectives of this rapid scoping review were:

1. To systematically identify and map the existing literature regarding clinical practice guidelines and empirically supported standards of care for acute dizziness and vertigo within the ED setting. This objective seeks to delineate a global benchmark of validated diagnostic and therapeutic metrics against which local clinical practice could be objectively evaluated.
2. To characterise the nature and extent of reported clinician adherence to established vestibular benchmarks. This involves identifying studies that quantify the utilisation of recommended assessment protocols and interventions, thereby highlighting common discrepancies between theoretical paradigms and real-world clinical execution.
3. To evaluate the operationalisation and clinical impact of physiotherapy involvement within acute vestibular presentations. This objective focuses on quantifying how the involvement of ED physiotherapists influences adherence rates to evidence-based standards and identifies the roles these clinicians assume in the ED.
4. To critically appraise the representation of Indigenous populations, specifically Māori, within the global vestibular literature. This objective aims to determine the extent of current knowledge regarding health equity in acute dizziness management and to identify reported disparities in care delivery, clinical outcomes, or the systemic barriers that influence the experiences of Indigenous patients in acute settings.

### **3.1.2 Rapid Scoping Review Questions**

**Question 1.** What evidence base or established guidelines are recommended for managing acute dizziness and vertigo in the ED, and what is the current state of international adherence to these guidelines?

**Question 2.** What is the evidence for ED physiotherapist involvement in managing acute dizziness and vertigo, and how does this align with established guidelines and evidence-based practices?

**Question 3.** What evidence exists on health disparities in managing acute dizziness and vertigo in indigenous populations?

## **3.2 Methodology**

### **3.2.1 Study Design and Rationale**

As preliminary searching revealed a paucity of local data, this rapid scoping review aimed to examine the international evidence base and information sources describing ED management of acute dizziness and vertigo presentations. The rapid scoping review methodology was selected as the most appropriate framework to systematically map the heterogeneous body of literature surrounding acute vestibular management. Unlike a traditional systematic review, which focuses on a narrow clinical question, a scoping review is designed to identify research gaps, scope a body of literature and summarise the findings (Armstrong et al., 2011; Munn et al., 2018). Scoping reviews provide a reliable mechanism to collect and organise important background information, facilitating the construction of a comprehensive overview of the existing evidence base (Armstrong et al., 2011). This utility is beneficial to achieving the first rapid scoping review objective: to delineate a global landscape of validated diagnostic and therapeutic approaches for acute dizziness and vertigo within the ED and identify global literature reporting clinician adherence to these approaches.

As noted by Munn et al. (2018), scoping reviews are particularly useful for examining emerging evidence. Given that the integration of ED physiotherapists into vestibular pathways represents an emerging model of care, a scoping review is an appropriate approach to answer the second question, by identifying the specific roles these clinicians assume and quantifying their influence on evidence-based adherence.

Finally, the third research question is also well accounted for by a scoping methodology, where the objective is to identify gaps in knowledge or research (Armstrong et al., 2011; Munn et al., 2018). This approach is particularly salient for critically appraising the representation of Indigenous populations, specifically Māori, within the global vestibular landscape. By mapping the nature and extent of the literature, as proposed in the third rapid scoping review question, this scoping review will allow determination of the current extent of health equity knowledge in this area.

The search strategy for a scoping review should ideally aim to be as comprehensive as possible within the constraints of time and resources (Peters et al., 2020). Given the temporal and financial constraints of this project, a rapid scoping review methodology was chosen to best answer the above questions while still maintaining an appropriate level of rigour and transparency. A rapid review methodology identifies several legitimate techniques that may be used to shorten the timescale (Grant & Booth, 2009; Tricco et al., 2017). Restrictions in the degree of quality appraisal, limitations to information sources, such as excluding grey literature, and a more judicious selection of extraction variables has been suggested as legitimate methods to allow a timely and still rigorous process (Grant & Booth, 2009). However, these modifications are expected to increase the risk of bias, which

highlights the critical importance of explicitly documenting the methodology and its limitations, including which stages have been abbreviated, and reporting the likely effect of these reviewer choices (Aromataris & Munn, 2020).

### 3.2.2 *Methodological Framework*

The PRISMA Extension for Scoping Reviews (PRISMA-ScR) was followed to ensure transparency and reproducibility (Tricco et al., 2018).

### 3.2.3 *Eligibility*

Study eligibility was determined using the Population, Concept, and Context framework recommended by the Joanna Briggs Institute for scoping reviews (Aromataris & Munn, 2020). Peer-reviewed studies published in English were considered for inclusion if they addressed the primary research objective regarding acute vestibular presentations in the ED.

#### **Inclusion Criteria:**

- **Population:** Adults (20 years or older) presenting with acute dizziness or vertigo.
- **Concept:** Clinical practice guidelines, consensus statements, evidence-based frameworks, or empirical evaluations of clinician adherence to these standards. The literature must address at least one of the following: clinical assessment or diagnostic criteria; management and treatment protocols; or health equity, specifically regarding Indigenous or minority populations.
- **Context:** The ED setting, or clinical settings where findings are directly applicable to the undifferentiated, time-pressured nature of acute emergency care.

#### **Exclusion Criteria:**

- **Secondary/Medical Dizziness:** Presentations caused primarily by systemic medical issues (such as cardiac, metabolic, or infectious aetiologies) or specific non-vestibular mimics (including dysautonomia, persistent postural-perceptual dizziness [PPPD], and acute intoxication).
- **Trauma & Obvious Neurology:** Dizziness resulting directly from head trauma or concussion, or neurological pathologies clearly outside the primary acute vestibular scope (such as acute presentations of multiple sclerosis).
- **Narrow Technical Focus:** Studies focusing solely on biochemical efficacy (isolated pharmacology) or imaging technicalities (isolated radiology) without clear integration into a bedside clinical diagnostic framework.
- **Non-Acute Care:** Studies focusing primarily on long-term outpatient rehabilitation, surgical interventions, or chronic compensatory mechanisms.

- **Evidence Quality:** Expert opinions, narrative reviews, or superseded versions of updated clinical guidelines.

### 3.2.4 *Information Sources / Databases*

Databases searched included MEDLINE and CINAHL (accessed via the EBSCOhost platform), and the Cochrane Database of Systematic Reviews. These were selected to provide a comprehensive range of biomedical and allied health literature. CINAHL was specifically included to capture multidisciplinary approaches to vestibular care, while the Cochrane Library was utilised to identify high-quality systematic reviews and established clinical practice guidelines. Grey literature was excluded due to limitations in time and financial resources, as well as a strategic decision to optimise operational efforts by focusing exclusively on more rigorous, peer-reviewed datasets.

### 3.2.5 *Search Strategy and Analysis*

To address the three research questions, a unified, multi-faceted search strategy was developed. This strategy centred on the intersection of the ED setting and adult populations presenting with acute dizziness or vertigo. By using a single comprehensive search execution, the review captured the breadth of literature required to facilitate the analysis of three distinct thematic streams:

- **Stream 1: Clinical Standards and Adherence.** This stream maps the evidence-based protocols relevant to ED care and synthesises reported data regarding clinician adherence and implementation fidelity.
- **Stream 2: Physiotherapy Involvement.** This stream isolates literature that specifically identifies the clinical role, utilisation, and operational impact of physiotherapists within the ED vestibular pathway.
- **Stream 3: Health Equity.** This stream examines literature regarding Māori and other Indigenous populations, specifically focusing on documented disparities in acute clinical management, institutional diagnostic accuracy, or longitudinal health outcomes.

**Search Execution:** The search was structured using a three-block Boolean logic model: Concept 1 (Condition) AND Concept 2 (Setting) AND Concept 3 (Thematic Focus). The third block utilised “OR” logic to simultaneously capture literature across the three primary streams of inquiry: clinical standards and adherence, the role of physiotherapy, and health equity for Indigenous populations.

### 3.2.6 *Search Terms*

The search strategy employed a comprehensive combination of keywords, natural language phrases, and Boolean operators. While the search terms included several concepts identical to Medical Subject Headings (MeSH), all terms were systematically searched as keywords across the various database platforms (EBSCOhost and Cochrane), as outlined in [Table 2](#).

**Table 2***Search Strategy Framework: Concept Blocks, Keywords, and Boolean Logic*

| Concept Block | Focal Area               | Search Terms (Keywords, Truncation & MeSH)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Boolean Logic     |
|---------------|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| Concept 1     | Condition (Population)   | Dizziness OR Vertigo OR Disequilibrium OR Imbalance OR Lightheadedness OR Giddiness OR Unsteadiness OR "Acute Vestibular Syndrome"                                                                                                                                                                                                                                                                                                                                                                                          | OR (within block) |
| Concept 2     | Setting (Context)        | Emergency Department OR ED OR Emergency Medic* OR Acute Care OR Emergency Service* OR Emergency Room OR Emergency Unit OR Emergency Ward                                                                                                                                                                                                                                                                                                                                                                                    | OR (within block) |
| Concept 3     | Thematic Focus (Concept) | A: Clinical Standards: Guideline Adherence OR "Evidence-Based" OR "Best Practice" OR "Clinical Practice Guidelines" OR "Quality of Care" OR "Protocol Compliance" OR "Standard of Care" OR "Clinical Pathway*" OR Consensus OR Algorithm OR Guideline*<br>B: Physiotherapy: Physiotherap*, "Physical Therap*", "Vestibular Rehabilitation"<br>C: Health Equity: "Disparit*", "Inequit*", "Inequality", "Bias", "Equity", "Access to Care", "First Nations", "Native", "Māori", "Indigenous", "Tangata Whenua", "Aboriginal" | OR (within block) |

### **3.2.7 Study Selection**

A search using the above criteria and search terms was executed on September 19, 2025. The study selection process was managed via Covidence systematic review software to ensure a transparent, auditable trail for all inclusion and exclusion decisions. Covidence is a web-based collaboration software platform that streamlines the production of systematic and other literature reviews (Veritas Health Innovation, 2025). In accordance with rapid review methodologies, a single-reviewer protocol was employed for both title/abstract and full-text screening. While this approach was necessitated by the expedited timeline, consistency was maintained through the application of a rigorous, predetermined eligibility framework within the software, ensuring each decision remained objective and reproducible.

To optimise screening efficiency and precision, keyword highlighting was utilised within the Covidence platform. This provided a visual aid that cross-referenced search terms related to the core clinical, professional, and equity-based domains, ensuring the primary reviewer maintained a consistent focus on the specific research objectives throughout the screening process.

Study selection was conducted in two distinct stages. Initially, the title and abstract of each record were evaluated to remove clearly irrelevant citations. Following PRISMA-ScR guidelines, specific reasons for exclusion were not recorded at this initial stage. A liberal acceleration approach was adopted; any record where eligibility was ambiguous was automatically promoted to the full-text review phase to ensure no relevant literature was prematurely excluded. It must be noted that a single-reviewer protocol introduces an inherent risk of selection bias through the potential omission of relevant studies (Tricco et al., 2017). In the second stage, the remaining articles underwent full-text evaluation against the eligibility criteria. At this stage, specific reasons for exclusion were documented for each record to ensure a high level of methodological transparency.

Studies where only an abstract was available, and for which the full text could not be retrieved, were excluded to ensure the integrity of the subsequent qualitative synthesis and data extraction.

### **3.2.8 Data Extraction**

A standardised data charting form was developed and managed within the Covidence platform to ensure a systematic and consistent extraction process. In alignment with the JBI methodology for scoping reviews (Peters et al., 2020), this form was designed to capture specific evidence related to clinical standards, physiotherapy involvement, and Indigenous health equity.

Consistent with the rapid review protocol, data extraction was performed by a single reviewer. To ensure the accuracy and integrity of the extracted data, the charting form was initially piloted on a subset of three included studies. This pilot phase ensured that the extraction fields were sufficiently sensitive to capture the variance across the three thematic streams of clinical guidelines, physiotherapy involvement, and health equity outcomes.

The following categories of data were extracted from each included study:

- **Study Characteristics:** Author(s), year of publication, country of origin, and study design.
- **Clinical Standards and Adherence:** Type of guideline or evidence-based framework identified, specific assessment or diagnostic metrics (e.g., HINTS-plus, STANDING), and any quantified data regarding clinician adherence.
- **Physiotherapy Involvement:** Description of the physiotherapist's specific clinical role within the ED care pathway and any diagnostic or operational outcomes correlated with their involvement.
- **Health Equity:** Explicit identification of Māori or other Indigenous and minority populations, documented disparities in care delivery, and specific clinical outcomes related to guideline adherence within these patient groups.

### 3.2.9 Data Analysis

The results of the rapid scoping review were synthesised using a narrative and descriptive approach to provide a comprehensive map of the available evidence. In accordance with the JBI methodology for scoping reviews (Peters et al., 2020), data synthesis was conducted in two sections: a quantitative summary and a thematic synthesis.

**Quantitative Summary:** Descriptive statistics were employed to summarise the basic characteristics of the included studies. This included frequency counts and percentages related to the year of publication, geographic distribution and study design.

**Thematic Synthesis:** A narrative synthesis was utilised to address the three primary research questions. This involved a thematic mapping process where data were categorised into the following core streams:

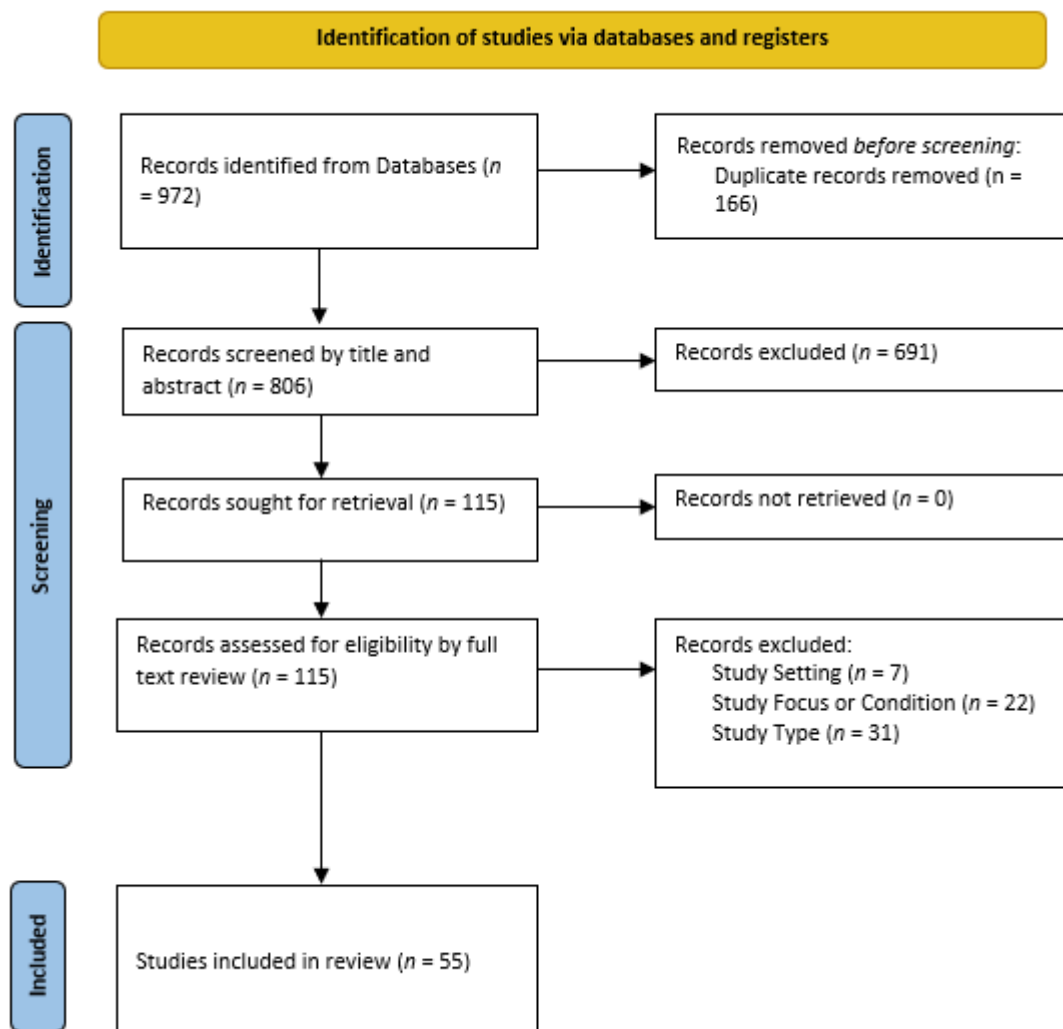
- **Clinical Standard Adherence:** Identifying the frequency and variety of evidence-based assessment tools (e.g., HINTS-plus, STANDING) and interventional metrics reported in the literature.
- **Physiotherapy Involvement:** Analysing the nature and extent of physiotherapist involvement and its reported correlation with clinical guideline adherence.
- **Health Equity:** Mapping the literature regarding Māori and other Indigenous or minority health outcomes to identify specific disparities in the acute clinical management pathway. The resulting synthesis consolidates the extant literature in acute vestibular management, highlighting prevalent evidence-based metrics and exposing critical gaps in the international evidence base.

### 3.3 Results

The results of the search execution and the subsequent multi-stage screening process are summarised in the PRISMA-ScR flow diagram (Figure 3) documenting the distillation of the global evidence base into the final study cohort.

**Figure 3**

*PRISMA Flow Diagram of Search result, study selection and inclusion process*



#### 3.3.1 Quantitative Summary

A total of 972 records were identified through the systematic database search. Following the removal of 166 duplicates, 806 records remained for title and abstract screening. Of these, 691 were excluded for failing to meet primary eligibility criteria, including an inappropriate clinical setting,

non-acute populations, or misalignment with the review's scope (e.g., narrow technical focuses on pharmacology or radiographic imaging).

The remaining 115 records were retrieved for full-text assessment. Upon detailed review, 60 records were excluded. Specific reasons for exclusion included: incorrect setting or condition ( $n = 7$ ); non-acute presentations or misaligned clinical focus ( $n = 22$ ); and ineligible study designs, such as expert opinions or narrative reviews lacking a systematic methodology ( $n = 31$ ). This selection process resulted in a final cohort of 55 studies for inclusion in the scoping review.

**Characteristics of Evidence:** A total of 55 studies met the inclusion criteria; their demographic characteristics, including geographical location, study design, primary research aims, and participant sample sizes, are summarised in [Table 3](#). Additionally, this table indicates how each study informed the thematic mapping process.

**Table 3**

*Characteristics of Included Studies of the Rapid Scoping Review (N = 55) and Thematic Mapping Relationship to the Review Research Questions.*

| Author (Year)              | Country                           | Study Design                      | Sample Size (N)              | Primary Research Aim                                                                                                                  | Thematic Mapping |    |    |
|----------------------------|-----------------------------------|-----------------------------------|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|------------------|----|----|
|                            |                                   |                                   |                              |                                                                                                                                       | Q1               | Q2 | Q3 |
| Ahsan et al., 2013         | United States of America          | Other: Retrospective chart review | 1681                         | Evaluate the diagnostic utility and cost-effectiveness of CT/MRI for dizziness in the ED.                                             | ✓                |    |    |
| Ammar et al., 2017         | United States of America          | Other: Retrospective chart review | 521                          | Investigate the prevalence of central causes, clinical predictors, and the cost and diagnostic yield of neuroimaging in ED dizziness. | ✓                |    |    |
| Aroor et al., 2017         | United States of America          | Other: Retrospective chart review | 736 (from 858 screened)      | Evaluate the sensitivity of the FAST algorithm and the efficacy of a revised mnemonic for acute ischemic stroke detection.            | ✓                |    |    |
| Ashiq et al., 2024         | Qatar, Pakistan, and Saudi Arabia | Systematic review                 | 3,993                        | Systematic review of the diagnostic accuracy of CT scans compared to MRI as the reference standard.                                   | ✓                |    |    |
| Bhattacharyya et al., 2017 | United States of America          | Consensus/ Guideline              | N/A                          | Update evidence-based recommendations for BPPV to improve diagnostic accuracy and the utilisation of effective therapeutic manoeuvres | ✓                |    |    |
| Bierrum et al., 2023       | UK                                | Case series                       | 4                            | Assess the clinical and economic benefits of an embedded acute vertigo service for ED dizziness using a case series model.            | ✓                | ✓  |    |
| Bradshaw et al., 2023      | Australia                         | Qualitative research              | 26 (13 medical / 13 physios) | Identify barriers and facilitators to guideline-concordant BPPV management in the ED using the Theoretical Domains Framework          | ✓                | ✓  |    |
| Brown, 2011                | United States of America          | Systematic review                 | 2 studies                    | Assess the effectiveness of canalith repositioning manoeuvres for acute BPPV.                                                         | ✓                |    |    |
| Cristiano et al., 2020     | Italy                             | Cohort study                      | 363                          | Assess the clinical and economic outcomes of a diagnostic manoeuvres training intervention for ED medical personnel.                  | ✓                |    |    |

|                            |                                                  |                                             |                                      |                                                                                                                                                              |   |   |
|----------------------------|--------------------------------------------------|---------------------------------------------|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|
| Dubey et al., 2022         | United States of America                         | Retrospective analysis of a national survey | 2007 (N = 35,490); 2017 (N = 16,709) | To analyse a national database to assess the rate and patterns of head CT imaging in the ED.                                                                 | ✓ | ✓ |
| Dumitrascu et al., 2017    | United States of America                         | Quality Improvement initiative              | 43 (pre: 27; post: 16)               | To study the feasibility of implementing HINTS-plus testing in the ED to reduce unnecessary neuroimaging in patients with isolated Acute Vestibular Syndrome | ✓ |   |
| Edlow et al., 2023         | United States of America; Europe; Canada, Brazil | Consensus/ Guideline                        | N/A                                  | Establish evidence-based guidelines for acute ED dizziness via a systematic GRADE assessment                                                                 | ✓ | ✓ |
| Filippopoulos et al., 2022 | Germany                                          | Diagnostic test accuracy study              | 407                                  | Develop and validate a diagnostic algorithm for the identification of cerebrovascular events and the classification of common vestibular disorders           | ✓ |   |
| Gerlier et al., 2021       | France                                           | Diagnostic test accuracy study              | 300                                  | Evaluate the accuracy of the STANDING algorithm among naïve examiners and its agreement with senior experts in diagnosing central vertigo.                   | ✓ |   |
| Gerlier et al., 2023       | France                                           | Diagnostic test accuracy study              | 312                                  | Compare the diagnostic accuracy of the HINTS exam, STANDING algorithm, and ABCD <sup>2</sup> score for central causes of acute dizziness.                    | ✓ |   |
| Giardino et al., 2021      | Argentina                                        | Randomised controlled trial                 | 101                                  | Compare two treatment interventions for acute BPPV in the ED                                                                                                 | ✓ |   |
| Gottlieb et al., 2023      | United States of America                         | Systematic review                           | 2024                                 | Systematically assess the diagnostic performance of the HINTS bedside exam for central causes of AVS                                                         | ✓ |   |
| Grewal et al., 2015        | Canada                                           | Cohort study                                | 41,794 (8,596 CT-exposed)            | Determine CT imaging rates and the incidence of missed strokes among ED patients with peripheral vertigo.                                                    | ✓ |   |
| Hall et al., 2021          | United States of America                         | Consensus/ Guideline                        | 67 articles, (N = 3,989)             | Provide updated evidence-based guidelines through a systematic review and critical appraisal of recent clinical literature.                                  | ✓ | ✓ |
| Herdman et al., 2023       | UK                                               | Qualitative research                        | 51 ECs (Survey) / 6 (Interview)      | Design an implementation strategy for acute vertigo care based on an analysis of ED-specific barriers and facilitators.                                      | ✓ | ✓ |

|                        |                          |                                   |                              |                                                                                                                                                       |   |   |   |
|------------------------|--------------------------|-----------------------------------|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|
| Hunter et al., 2022    | United States of America | Systematic review                 | 27 Trials                    | Assess the therapeutic efficacy of benzodiazepines versus antihistamines in acute vertigo via systematic review and meta-analysis.                    | ✓ |   |   |
| Imam et al., 2024      | Qatar                    | Retrospective descriptive review  | 1,571                        | To describe the demographics, risk factors, clinical features, and outcomes of Posterior Circulation Ischemic Stroke in a large multiethnic database. |   |   | ✓ |
| Ip et al., 2022        | Australia                | Qualitative research              | N/A                          | Assess clinician perspectives on the implementation of specialised vestibular physiotherapy within the ED.                                            | ✓ | ✓ |   |
| Kerber et al., 2011    | United States of America | Cross sectional study             | 1091                         | Assess a strategy to increase diagnostic (DHT) and therapeutic (CRM) manoeuvre utilisation for BPPV in the ED.                                        | ✓ |   |   |
| Kerber et al., 2020    | United States of America | Randomised controlled trial       | 7635                         | Assess the frequency and quality of ED nystagmus documentation to determine the need for clinical decision support tools.                             | ✓ |   |   |
| Khoujah et al., 2023   | United States of America | Systematic review                 | 758                          | Conduct an evidence synthesis of the Epley manoeuvre for BPPV to inform emergency care guidelines and clinical standards.                             | ✓ | ✓ |   |
| Kim et al., 2012       | United States of America | Cohort study                      | 378,992 (20,795 dizzy cases) | Assess the variation in ED neuroimaging rates for dizzy patients and its correlation with actual stroke detection across multiple sites.              | ✓ |   |   |
| Ljunggren et al., 2018 | Sweden                   | Cohort study                      | 2,126                        | Evaluate the epidemiological profile and management strategies for AVS and non-AVS presentations in the ED.                                           | ✓ |   |   |
| Lloyd et al., 2018     | Australia                | Retrospective observational study | 96                           | Evaluate the safety, feasibility, and clinical impact of vestibular physiotherapy implementation on evidence-based care in the ED.                    | ✓ | ✓ |   |
| Lloyd et al., 2020     | Australia                | Non-randomised experimental study | 52                           | Assess guideline-concordant BPPV care and the frequency of physiotherapy involvement in the emergency setting.                                        | ✓ | ✓ |   |
| Machner et al., 2020   | Germany                  | Cohort study                      | 610                          | Evaluate the diagnostic utility of clinical signs in predicting acute brain lesions to create a neuroimaging decision support algorithm.              | ✓ |   |   |

|                                  |                          |                                                      |                                            |                                                                                                                                                     |   |   |
|----------------------------------|--------------------------|------------------------------------------------------|--------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|---|---|
| Mandge et al., 2020              | United States of America | Cross sectional study                                | 177                                        | Assess the diagnostic performance and statistical correlation of clinical predictors for central versus peripheral vertigo in the ED.               | ✓ |   |
| Masood et al., 2024              | Bahrain                  | Cross sectional study                                | 481                                        | Assess the diagnostic value of head CT scans for identifying central aetiologies in acute dizziness presentations.                                  | ✓ |   |
| Nakatsuka and Molloy, 2022       | Australia                | Systematic review                                    | 450                                        | Assess the diagnostic accuracy of the HINTS and STANDING tools in acute vestibular syndrome via systematic review and meta-analysis.                | ✓ |   |
| Neely et al., 2021               | Australia                | Retrospective Clinical Audit                         | 101                                        | Develop and evaluate a peer-reviewed clinical algorithm for acute dizziness to improve BPPV management in the emergency setting.                    | ✓ | ✓ |
| Neely et al., 2023               | Australia                | Non-randomised experimental study                    | 162 (pre: 87; post: 75)                    | Assess guideline-concordant diagnosis and management of BPPV in an ED setting.                                                                      | ✓ | ✓ |
| Newman-Toker et al., 2009        | United States of America | Cross sectional study                                | 283,870 (2,712 dizzy cases)                | Assess clinical practice alignment with established guidelines for BPPV and APV diagnosis and treatment in the ED.                                  | ✓ |   |
| Oliveira J. e Silva et al., 2023 | United States of America | Systematic review                                    | 2 Systematic Reviews (12 studies, N = 660) | Conduct an umbrella review to evaluate the efficacy of corticosteroids versus placebo in the treatment of acute Vestibular Neuritis                 | ✓ | ✓ |
| Pellegrino et al., 2022          | Spain                    | Consensus/ Guideline                                 | N/A                                        | Systematically review vertigo etiopathologies in paediatric and adult populations to develop a diagnostic decision-support algorithm for the ED.    | ✓ |   |
| Pérez-Vázquez et al., 2018       | Italy                    | Systematic review                                    | 38 articles 12 paediatric and 26 Adult     | Provide a consensus-driven practical framework for the diagnosis and therapeutic management of BPPV and its variants.                               | ✓ |   |
| Polensek et al., 2008            | United States of America | Retrospective review of computerised medical records | 157                                        | Assess clinicians' evaluation and referral patterns for acute dizziness and identify provider-related factors associated with guideline compliance. | ✓ | ✓ |

|                                   |                                  |                                   |                                      |                                                                                                                                             |   |   |
|-----------------------------------|----------------------------------|-----------------------------------|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|---|---|
| Sacco et al., 2014                | United States of America         | Randomised controlled trial       | 26 (medication n=11, manoeuvre n=15) | Assess the comparative effectiveness of BPPV treatment strategies via a randomised controlled trial.                                        | ✓ | ✓ |
| Sandlund et al., 2019             | Sweden                           | Cohort study                      | 3,613 (pre: 2,126; post: 1,487)      | Evaluate the efficacy of a clinical management algorithm in improving care outcomes for dizzy patients in the ED.                           | ✓ |   |
| Shah et al., 2023                 | United States of America         | Systematic review                 | 16 studies (N = 2,149)               | Assess the diagnostic accuracy of physical examination signs for distinguishing central versus peripheral acute vertigo via meta-analysis.  | ✓ |   |
| Shah et al., 2023 (Physical Exam) | United States of America         | Systematic review                 | 43 Studies                           | Assess the diagnostic accuracy of emergency neuroimaging for acute vertigo via systematic review and meta-analysis for the GRACE-3 project. | ✓ |   |
| Sharif et al., 2023               | United States of America; Canada | Systematic review                 | 5 RCTs (N = 296)                     | Assess the therapeutic effectiveness of vestibular suppressants for BPPV via systematic review and meta-analysis.                           | ✓ | ✓ |
| Stewart et al., 2022              | Australia                        | Cohort study                      | 543 (pre n=214, post n=329)          | Assess the quality and efficiency outcomes of an ED dizziness pathway that incorporates specialised vestibular physiotherapy.               | ✓ | ✓ |
| Tarnutzer & Edlow, 2023           | United States of America; Europe | Systematic review                 | N/A                                  | Analyse the diagnostic accuracy and ROC characteristics of bedside clinical algorithms for the evaluation of acute dizziness.               | ✓ |   |
| Tu et al., 2024                   | United States of America         | Cohort study                      | 14,204                               | Compare the impact of abbreviated MRI versus conventional neuroimaging on reporting times and length of stay in acute dizziness evaluation. | ✓ |   |
| Vanni et al., 2014 (Pilot)        | Italy                            | Non-randomised experimental study | 292                                  | Assess the accuracy of the STANDING bedside algorithm versus ordinary medical evaluation for acute vertigo triage.                          | ✓ |   |
| Vanni et al., 2015                | Italy                            | Non-randomised experimental study | 98                                   | Assess the validity and interrater reliability of an Emergency Physician-led diagnostic tool for central vertigo in the emergency setting.  | ✓ |   |

|                                 |                                        |                                   |                                     |                                                                                                                                                     |   |
|---------------------------------|----------------------------------------|-----------------------------------|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|---|
| Vanni et al., 2017 (Validation) | Italy                                  | Diagnostic test accuracy study    | 352                                 | Assess the diagnostic accuracy and reliability of a bedside vestibular algorithm in the emergency setting.                                          | ✓ |
| Vanni et al., 2023 (Timing)     | Italy                                  | Non-randomised experimental study | 57                                  | Evaluate the time efficiency of bedside vestibular exams across different clinical expertise levels compared to neuroimaging turnaround in the ED.  | ✓ |
| Vanni et al., 2024              | Italy                                  | Consensus/ Guideline              | 456 (242 standing / 214 usual care) | Provide a multidisciplinary consensus for the evidence-based management and pathway development of isolated acute vertigo in the emergency setting. | ✓ |
| von Brevern et al., 2015        | United States of America; Europe; Asia | Consensus/ Guideline              | N/A                                 | Formulate a standardised clinical classification and operational diagnostic framework for BPPV through international consensus.                     | ✓ |

*Note.* Abbreviations: AVS = acute vestibular syndrome; BPPV = benign paroxysmal positional vertigo; CRM = canalith repositioning man oeuvre; CT = computed tomography; DHT = Dix-Hallpike test; ED = emergency department; RCT = randomised controlled trial; N/A = not applicable.

**Descriptive result:** This rapid scoping review maps the global literature regarding clinical practice guidelines and recommendations for managing acute vestibular syndrome within the ED.

Demographic reporting regarding participant gender was available for 54.5% ( $n = 30$ ) of the 55 included studies. Analysis of this subset revealed a distinct female predominance across the majority of investigations. Only seven studies identified a higher proportion of male participants relative to females (Aroor et al., 2017; Bierrum et al., 2023; Filippopoulos et al., 2022; Gottlieb et al., 2023; Imam et al., 2024; Masood et al., 2024; Polensek et al., 2008).

Alongside 12 systematic reviews, the evidence base included six consensus statements or clinical practice guidelines, five of which addressed the management of BPPV. Within this subset, three provided a specialised focus on BPPV protocols (Bhattacharyya et al., 2017; Perez-Vazquez et al., 2018; von Brevern et al., 2017), while the remaining two adopted a comprehensive scope encompassing acute dizziness and vertigo broadly (Edlow et al., 2023; Vanni et al., 2024). Analysis of the 12 systematic reviews revealed a distinct methodological emphasis: seven investigations prioritised the utility of bedside physical examinations or clinical interventions (Brown, 2011; Gottlieb et al., 2023; Khoujah et al., 2023; Nakatsuka & Molloy, 2022; Perez-Vazquez et al., 2018; Shah, Oliveira, Farah, Seisa, Balla, et al., 2023; Tarnutzer & Edlow, 2023), outpacing literature focused primarily on neuroimaging or pharmacological therapies (Ashiq et al., 2024; Hunter et al., 2022; Oliveira et al., 2023; Shah, Oliveira, Farah, Seisa, Kara Balla, et al., 2023; Sharif et al., 2023).

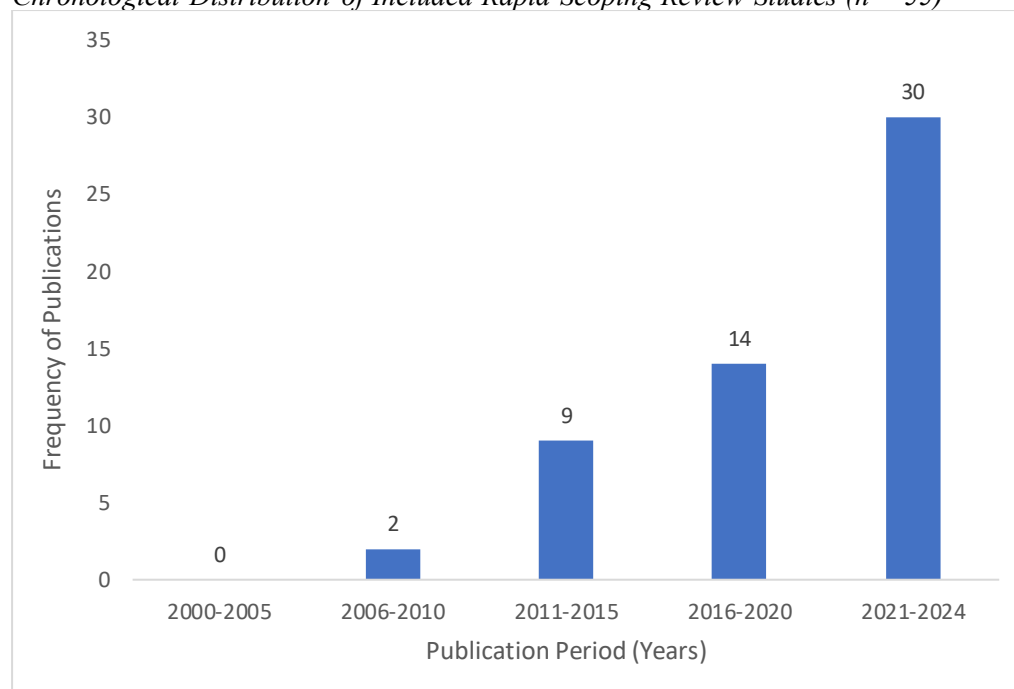
The highest tier of primary experimental evidence within the results was represented by only three randomised controlled trials, two of which featured limited sample sizes and examined a specific treatment relevant to a narrow group of emergency presentations, specifically, the Epley manoeuvre for posterior canal BPPV (Giardino et al., 2021; Kerber et al., 2020; Sacco et al., 2014). The paucity of such investigations highlights a relative deficit in robust, high-level evidence concerning interventional efficacy for acute dizziness and vertigo presentations within the ED. While the identified literature increasingly emphasises diagnostic validation and test accuracy (Edlow et al., 2023; Filippopoulos et al., 2022; Gerlier et al., 2023; Gerlier et al., 2021; Vanni et al., 2017), there remains a notable scarcity of research demonstrating improved patient-centred outcomes or systemic cost-effectiveness within the rigorously controlled, randomised trials essential for mitigating selection bias.

The remainder of the dataset constituted 12 prospective and five retrospective observational reviews ([Table 4](#)). The group of 12 prospective reviews reported an algorithmic approach to risk stratification or acute vestibular management, originating from nine lead authors. Only Gerlier et al. (2023) and Lloyd, Luscombe, et al. (2020) examined a guideline algorithm published by an external research group.

**Table 4***Methodological Characteristics of Included Studies (N = 55)*

| Primary Study Classification    | Frequency (n) | Specific Research Design Breakdown (n)                                                                                                                                                                                                                                |
|---------------------------------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Secondary research & guidelines | 18            | Systematic reviews (n = 12); consensus or clinical practice guidelines (n = 6)                                                                                                                                                                                        |
| Primary observational research  | 27            | Cohort studies (n = 8); cross-sectional studies (n = 4); diagnostic test accuracy studies (n = 4); retrospective chart reviews (n = 5); qualitative studies (n = 3); case series (n = 1); national survey analyses (n = 1); descriptive observational studies (n = 1) |
| Primary experimental research   | 8             | Non-randomised experimental studies (n = 5); randomised controlled trials (n = 3)                                                                                                                                                                                     |
| Systems & quality research      | 2             | Quality improvement initiatives (n = 1); retrospective clinical audits (n = 1)                                                                                                                                                                                        |
| Total included studies          | 55            |                                                                                                                                                                                                                                                                       |

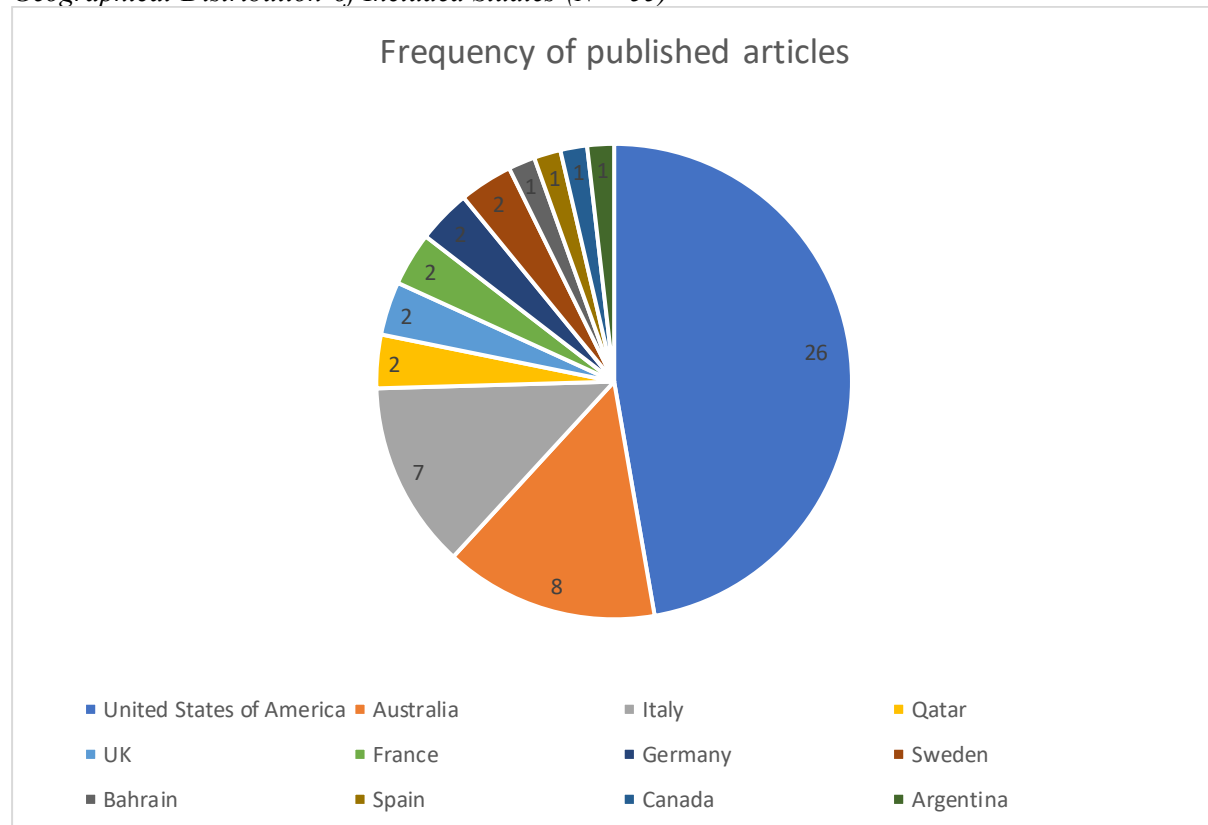
**Chronological Distribution:** The chronological trajectory of these reviews, as presented in [Figure 4](#), underscores a significant recent expansion in the field, with only two systematic reviews published prior to 2021. This trend reflects a concerted, modern research response to the diagnostic and management challenges identified in earlier clinical literature.

**Figure 4***Chronological Distribution of Included Rapid Scoping Review Studies (n = 55)*

**Geographic Distribution:** A diverse spread of 12 countries contributed to the final sample of included studies, presented in [Figure 5](#), with a notable majority originating from western nations ( $n = 52$ ). The largest single contribution was from the United States, accounting for nearly half of the total dataset ( $n = 26$ ). Although no studies from Aotearoa New Zealand met the inclusion criteria, Australia provided the second-highest yield ( $n = 8$ ).

**Figure 5**

*Geographical Distribution of Included Studies (N = 55)*



**Predominance of BPPV and the Evolving Role of Emergency Physiotherapy:** The evidence base identified in this scoping review demonstrates a notable predominance of research concerning BPPV relative to all other peripheral and central vestibular aetiologies encountered in the ED. Approximately one-third of the included literature maintained a primary thematic focus on BPPV ( $n = 18$ ), while several additional investigations presented generalised diagnostic algorithms or clinical practice guidelines that also incorporate BPPV as a core component of the tiered differential diagnostic process (Bhattacharyya et al., 2017; Cristiano et al., 2020; Giardino et al., 2021; Kerber et al., 2020; Khoujah et al., 2023; Lloyd, Luscombe, et al., 2020; Lloyd, Mackintosh, et al., 2020; Neely et al., 2023; Neely et al., 2021; Perez-Vazquez et al., 2018; Sacco et al., 2014).

Physiotherapy led investigations constitute a substantive portion of the evidence mapping, with 10 studies (18.2%) primarily directed by physiotherapy researchers. Of these, eight

investigations utilised physiotherapy practice as a core clinical component, specifically orientated towards the acute management of BPPV (Bradshaw et al., 2023; Ip et al., 2022; Khoujah et al., 2023; Lloyd, Luscombe, et al., 2020; Lloyd, Mackintosh, et al., 2020; Neely et al., 2023; Neely et al., 2021; Stewart et al., 2022). Collectively, 16 studies (29.1%) addressed specific aspects of the physiotherapy role within the emergency care setting. The therapeutic scope described in these records is broad, ranging from acute bedside assessment and interventional manoeuvres to the establishment of specialised follow-up referral pathways for patients whose symptoms remain refractory to initial emergency medical management.

### **3.3.2 *Thematic Synthesis***

This section presents a thematic synthesis of the 55 included studies, structured to address the three primary research questions of this scoping review. To provide a coherent overview of the current landscape of emergency vestibular care, the findings are organised into three thematic pillars. First, the synthesis identifies the evidence-based guidelines and algorithmic frameworks currently recommended for acute dizziness and vertigo. It maps the literature concerning diagnostic assessments and subsequent interventional strategies. Concluding with a critical appraisal of international clinical adherence to these established standards, highlighting the current evidence-to-practice gaps within the ED setting.

The second theme relates to the second rapid scoping review question and involves the evaluation of physiotherapy involvement in ED triage, specifically detailing the relationship between clinical specialisation and adherence to evidence-based practice.

Thirdly, an examination of the literature concerning Indigenous populations and health equity is presented. By identifying the evidentiary omissions in this domain, the synthesis highlights the critical absence of data necessary to address systemic inequities in the management of acute dizziness and vertigo.

### **3.3.3 *Recommended Evidence Base and the Current State of International Adherence***

**Rapid scoping review question 1:** What evidence base or established guidelines are recommended for managing acute dizziness and vertigo in the ED, and what is the current state of international adherence to these guidelines?

The evidence base for the management of acute dizziness and vertigo in the ED is characterised by significant methodological and conceptual heterogeneity. It encompasses a stratified continuum of literature, ranging from granular investigations into specific diagnostic manoeuvres to comprehensive, multifaceted clinical practice guidelines and consensus statements. The literature is predominantly focused on the establishment and validation of diagnostic standards. This focus is evidenced by a robust body of research concerning diagnostic test accuracy and assessment protocols,

with a significant emphasis on algorithmic solutions, such as the STANDING and TiTrATE protocols, which are designed to improve diagnostic precision at the bedside.

The evidence base demonstrates a clear contemporary trajectory, with a marked increase in publication frequency over the last decade. Although the geographical distribution of the literature is global, the dataset remains dominated by western clinical contexts, particularly from North American and European academic centres. Current standards prioritise the differentiation of central from peripheral aetiologies through validated clinical clusters (e.g., the HINTS battery), reflecting a transition from an imaging-led paradigm to a bedside physical examination-dominant clinical framework.

**The Adherence Gap: Measuring Clinical Reality:** Despite the abundance of literature establishing these clinical standards, there is a systemic imbalance in the evidence base regarding their real-world implementation. There is a notable deficit in quality improvement initiatives and retrospective clinical audits. The literature remains heavily weighted toward standard-setting rather than the empirical evaluation of adherence to those established standards. Findings describing international adherence are currently skewed, relying on a narrow cohort of authors and concentrated primarily in two specific nations: Australia and the United States. Current adherence data also lacks clinical diversity, with a disproportionate focus on BPPV. There remains a distinct lack of evidence regarding how clinicians adhere to guidelines for more complex presentations, such as acute vestibular syndrome or posterior circulation stroke mimics.

In summary, while the international evidence base provides a clear and increasingly sophisticated roadmap for acute dizziness and vertigo management, clinical practice appears to lag behind these theoretical benchmarks. This implementation gap is defined by a lack of rigorous, large-scale audit data that captures the diversity of the undifferentiated ED population across global healthcare systems.

### **3.3.4 Evidence Base and Guidelines**

**Synthesis of Clinical Decision Support and Algorithmic Frameworks:** The scoping review identified 14 distinct algorithmic or guideline-based approaches relevant to the ED management of acute dizziness and vertigo. Most of these frameworks were specific to individual studies, often those proposing a highly localised methodology (Cristiano et al., 2020; Neely et al., 2023), although five distinct frameworks garnered substantial multi-study validation.

**Predominant Diagnostic Frameworks:** The STANDING algorithm ( $n = 23$ ) and the HINTS/HINTS-plus framework ( $n = 22$ ) emerged as the primary evidence-based clinical pathways within the literature ([Figure 6](#)). These approaches represent the dominant clinical toolsets for

differentiating central from peripheral aetiologies, with significant cross-referencing across the validations of (Edlow et al., 2023; Gerlier et al., 2021; Vanni et al., 2017).

**Risk Stratification and Triage:** Twelve studies explicitly adopted the TiTrATE (Timing, Triggers, and Targeted Examination) philosophy, frequently utilising it in conjunction with the GRACE-3 guidelines ( $n = 12$ ) to achieve early risk stratification ([Appendix A](#)). The literature reflects a clear shift toward these objective clinical clusters, moving away from a traditional reliance on the qualitative characterisation of dizziness symptom types, the diagnostic utility of which was refuted in nine studies.

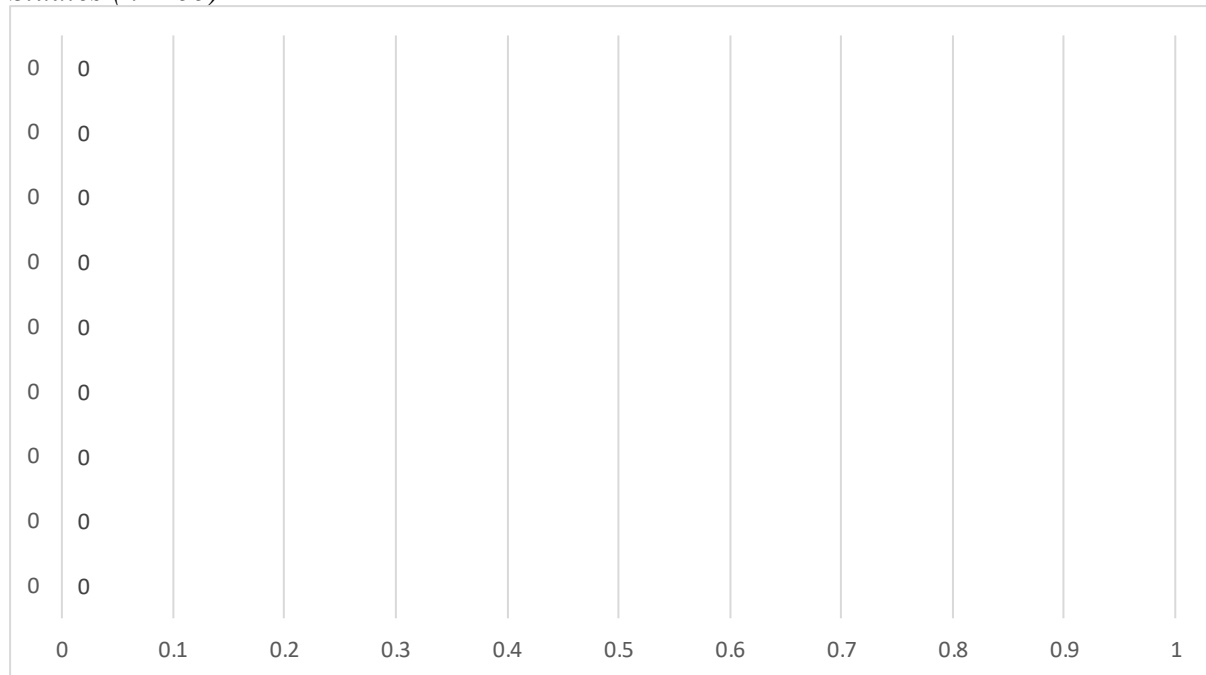
**Multidisciplinary Integration:** Significantly, the inclusion of physiotherapy within the acute management and triaging pathway was recommended in 14 studies ([Appendix A](#)). This trend reflects a growing multidisciplinary consensus regarding the value of specialised clinician involvement in the ED, and underscores a research emphasis on implementing standardised, clinician-led decision support to improve diagnostic accuracy.

**Critical Appraisal of the ABCD<sup>2</sup> Score:** A critical appraisal of the ABCD<sup>2</sup> risk stratification tool revealed a definitive lack of consensus within the acute vestibular literature. While 11 studies utilised the tool, it faced explicit opposition in six studies. Edlow et al. (2023) cited a lack of sensitivity for identifying posterior circulation ischemic events in the acute vestibular population, suggesting it is an unreliable standalone metric for this cohort.

**BPPV Guidelines and Operational Adaptability:** Adherence to BPPV-specific guidelines, primarily the Bhattacharyya et al. (2017) clinical practice guidelines, was a frequent focus of clinical audits ( $n = 8$ ). However, the review highlights significant operational challenges in translating these guidelines directly to the acute setting. While the Bhattacharyya et al. (2017) and Hall et al. (2022) standards are fundamentally sound, certain procedural elements, such as the recommended three-hour latency period between canal re-testing, lack operational feasibility within the temporal constraints of a busy ED. Consequently, authors such as Lloyd, Mackintosh, et al. (2020) and Neely et al. (2023) have sought to refine these protocols to better align with the unique operational realities of the emergency context. An important consideration in this domain is the operational definition of acute-phase management. While guidelines such as those by Hall et al. (2022) define the acute phase as the initial two-week period following symptom onset, the direct transferability of this temporal definition to the transient, high-acuity environment of the ED remains a significant clinical challenge.

**Figure 6.**

*Frequency of Clinical Algorithms and Decision Support Tools Identified Across Included Studies (n = 55)*



Note. 117 recommendations regarding clinical algorithm utilisation identified in included studies.

### 3.3.5 Evidence-Based Assessment

**Analysis of Synthesised Assessment Metrics:** The synthesis of evidence-based assessment metrics across the 55 included studies demonstrates a clear hierarchy of clinical utility, prioritising bedside examination and robust history-taking over technology-dependent diagnostics. As illustrated in [Figure 7](#), the fundamental triage pillars emerged as the most frequently cited metrics of symptom timing and triggers ( $n = 41$ ), nystagmus analysis ( $n = 40$ ), and neurological screening ( $n = 38$ ). These findings underscore a strong research emphasis on bedside clinical skills for the initial differentiation of acute dizziness and vertigo in the ED.

**Positional Assessment for BPPV:** Positional testing was a primary focus of the identified diagnostic algorithms. The Dix-Hallpike test remained the dominant metric ( $n = 29$ ), while the supine roll test was cited in less than half as many studies ( $n = 13$ ). This structural variation indicates a significant disparity in the recommended screening for posterior versus horizontal canal variants within acute pathways. This gap in documentation and clinical recommendation is reflected in current academic discourse regarding protocol simplification. Edlow et al. (2023) specifically noted the exclusion of the supine roll test from their final recommendations to ensure pragmatic utility, questioning whether non-specialist emergency clinicians could effectively manage the technical complexity of the assessment. This prioritisation of procedural accessibility likely explains why specialised assessments, such as the side-lying Semont, bow and lean, or cephalic hyperextension

tests from BPPV-specific guidelines, were largely absent from the ED focused literature (Perez-Vazquez et al., 2018).

**Diagnostic Clusters: HINTS, HINTS-plus, and STANDING:** The HINTS cluster (Head Impulse, Nystagmus, and Test of Skew) remains a cornerstone of the literature, appearing in 22 studies as a collective diagnostic framework. When individual components are considered, nystagmus analysis ( $n = 40$ ) and the head impulse test ( $n = 23$ ) were most prevalent, while the test of skew ( $n = 18$ ) was recorded less frequently.

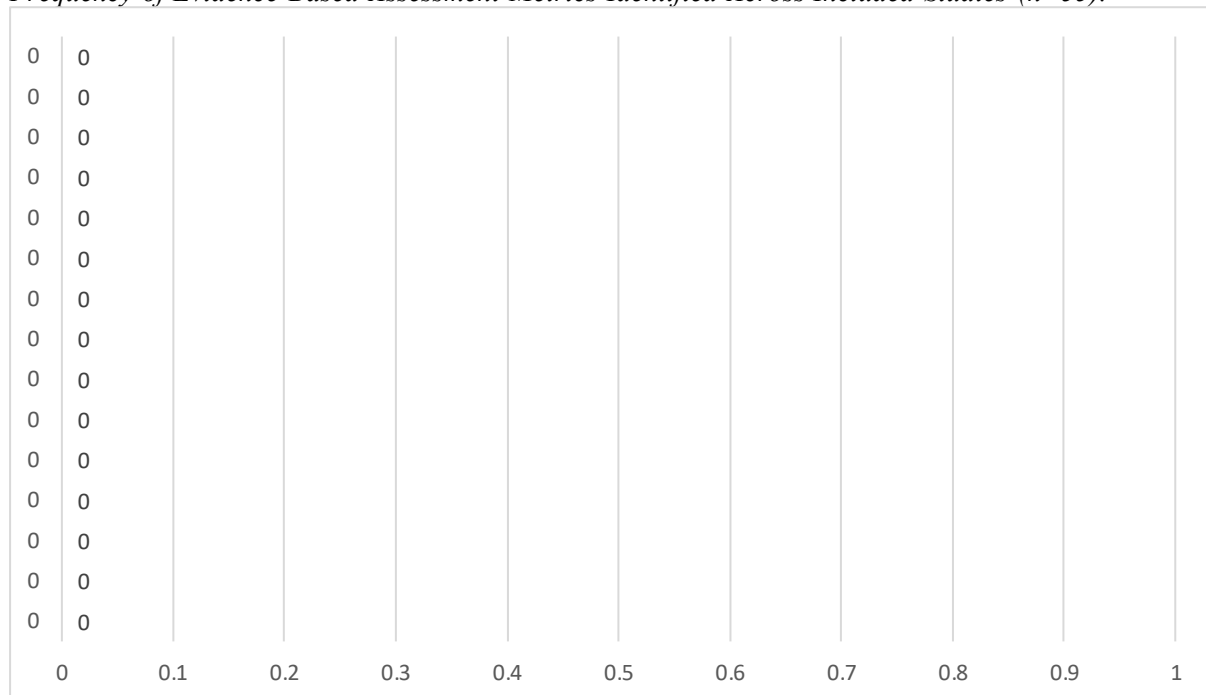
The transition to the HINTS-plus protocol, which incorporates a finger-rub hearing screen to improve sensitivity for anterior inferior cerebellar artery (AICA) territory infarcts, represents a recent progression in clinical practice. This evolution was identified in seven studies ([Appendix A](#)). Despite its clinical importance, none of the audited reports recorded specific adherence rates for the hearing screen component, suggesting that while HINTS-plus is increasingly recognised as a guideline standard, its documentation as a distinct, unified four-part battery remains an emerging practice in acute care environments.

**Physical Screening and Specialised Metrics:** Gait and postural stability analysis ( $n = 28$ ) was broadly supported across the dataset as a critical metric for initial risk stratification. However, one study noted a sensitivity of only 69.7% for identifying truncal ataxia, highlighting the absolute necessity of utilising this metric in conjunction with, rather than in place of, focal neurological screening (Shah, Oliveira, Farah, Seisa, Kara Balla, et al., 2023).

Finally, more specialised vestibulo-ocular assessments ( $n = 6$ ) and limb coordination testing ( $n = 4$ ) were cited infrequently in general triage pathways. Technological metrics, such as video head impulse testing (vHIT) ( $n = 2$ ) and formal nystagmus recording ( $n = 9$ ), were identified primarily in studies exploring highly specialised or academic, research-focused ED environments. This distribution further reinforces the literature's current operational preference for bedside clinical diagnostics in general emergency practice.

**Figure 7**

*Frequency of Evidence-Based Assessment Metrics Identified Across Included Studies (n=55).*



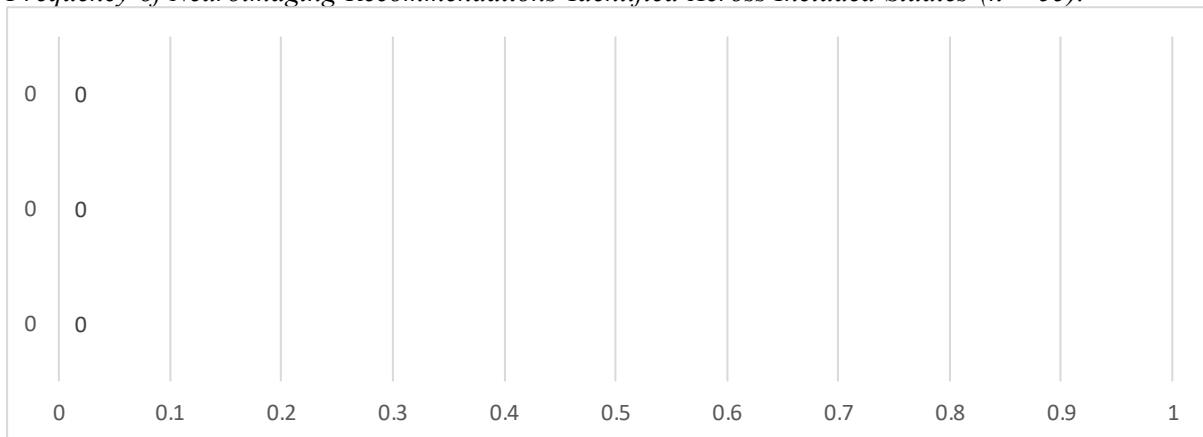
*Note.* 304 recommendations regarding assessment of acute dizziness and vertigo in ED settings identified in included studies.

**Synthesis of Neuroimaging Metric:** The synthesis of neuroimaging metrics across the included studies ( $n = 55$ ) reveals a strong, evidence-based mandate for diagnostic restraint regarding low-sensitivity imaging in the ED. As illustrated in [Figure 8](#), the most frequent recommendation identified was against the routine use of CT imaging ( $n = 25$ ). This reflects a consistent theme in the literature concerning the suboptimal sensitivity of CT for detecting acute posterior circulation ischemic events, particularly within hyper-acute timeframes. CT imaging represents the most thoroughly investigated modality within the review, with six studies specifically auditing the rates of clinical CT utilisation in acute vestibular cohorts.

Conversely, MRI was explicitly recommended as the superior diagnostic modality in 23 studies, cited for its high discriminative power compared to CT. However, a significant nuance exists, as nine studies documented specific recommendations against immediate MRI utilisation. This nuance reflects an emerging clinical consensus that expert bedside examination—specifically the HINTS-plus battery or STANDING protocol, can outperform MRI within the initial 24 to 48 hours of symptom onset. For instance, in cases of correctly diagnosed BPPV, diagnostic neuroimaging is clinically redundant. Furthermore, the logistical realities of limited MRI availability within many ED settings mean it cannot reliably meet the demand for timely diagnostic disposition. In aggregate, these findings delineate a paradigmatic shift away from routine neuroimaging models, favouring instead high-sensitivity bedside assessment pathways.

**Figure 8**

*Frequency of Neuroimaging Recommendations Identified Across Included Studies (n = 55).*



*Note.* 57 recommendations regarding neuroimaging in acute dizziness and vertigo in ED settings identified in included studies.

### **3.3.6 Evidence-Based Intervention**

**Analysis of Synthesised Intervention and Management Metrics:** The synthesis of management strategies demonstrates a clear hierarchy in the literature, prioritising definitive mechanical resolution for positional disorders and structured recovery pathways for non-mechanical vestibular syndromes. As illustrated in [Figure 9](#), vestibular referral emerged as the most prevalent management metric ( $n = 36$ ), reinforcing its significance as a diagnostic safety net and an essential component of timely specialised rehabilitation.

**Mechanical Resolution: Canal Repositioning Manoeuvres:** Interventional focus within the dataset was heavily weighted toward the management of BPPV. Canalith repositioning manoeuvres (CRM) were cited in 27 studies, with the Epley manoeuvre specifically identified in 12 instances as the primary therapeutic intervention. While the Epley remains the dominant recommendation, more comprehensive clinical guidelines advocate for a broader technical repertoire of liberatory and repositioning manoeuvres to address varied canalicular pathologies (Perez-Vazquez et al., 2018).

It is noteworthy that the research emphasis on CRMs is highly specific to the mechanical resolution of BPPV; these interventions do not address the physiological deficits associated with vestibular hypofunction. Consequently, while CRMs are universally recommended where clinically indicated, the management of acute peripheral hypofunction requires a distinct therapeutic and rehabilitative trajectory.

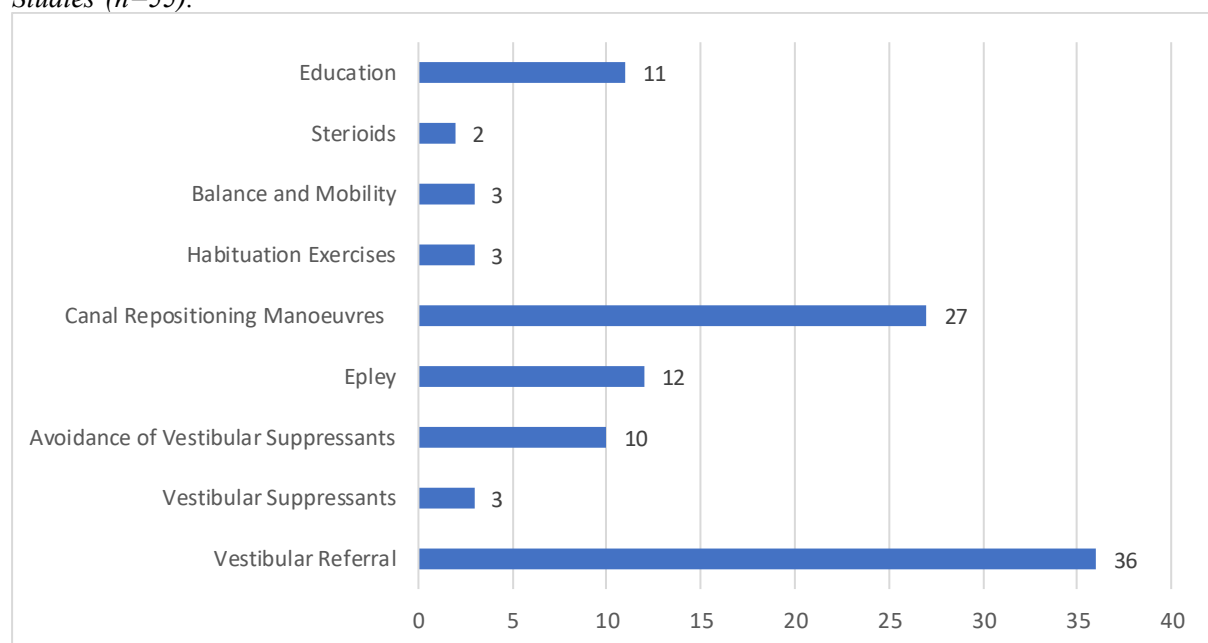
**Medical and Pharmacological Management:** The literature reflects a significant, evidence-based shift toward pharmacological restraint. Ten studies explicitly referenced evidence against the routine use of vestibular suppressants, frequently citing clinical concerns that such agents may mask focal signs or significantly delay central vestibular compensation. Conversely, the proactive

prescription of vestibular suppressants ( $n = 3$ ), corticosteroids ( $n = 2$ ), and antiemetics was cited infrequently in the context of ED-directed management.

**Rehabilitation, Education, and Disposition:** Structured recovery through patient education ( $n = 11$ ) emerged across the dataset as a recurring metric. However, proactive rehabilitation interventions, such as habituation exercises or specific balance and mobility training, were cited in only three studies each. The literature reports a high frequency of post-discharge vestibular referral ( $n = 36$ ); however, the actual initiation of vestibular rehabilitation exercises is rarely situated within the primary emergency encounter. These findings suggest that current literature for the acute setting remains heavily weighted toward the immediate resolution of mechanical disorders and the establishment of post-discharge specialist care pathways, rather than the execution of functional rehabilitation at the ED bedside.

**Figure 9**

*Frequency of Evidence-Based Intervention and Management Metrics Identified Across Included Studies ( $n=55$ ).*



*Note.* 107 recommendations regarding interventional metrics for acute dizziness and vertigo in ED settings identified in included studies.

### 3.3.7 Adherence to Evidence Base Metrics

Four primary research groups have published seven studies describing the level of clinical adherence to evidence-based standards for acute dizziness and vertigo presentations in an ED setting (Kerber et al., 2020; Kerber et al., 2011; Lloyd, Luscombe, et al., 2020; Lloyd, Mackintosh, et al., 2020; Neely et al., 2023; Neely et al., 2021; Stewart et al., 2022).

**Diagnostic and Interventional Fidelity for BPPV:** Evidence across all datasets indicates that the Dix-Hallpike manoeuvre was severely underutilised at baseline. Rates of adherence to Dix-Hallpike testing in standard care for suspected BPPV ranged from 1.5% to 26%. This metric reportedly improved following implementation of structured clinical pathways, rising to between 36% and 100%. While intervention rates lagged behind assessment metrics, canalith repositioning manoeuvres were documented between 0% and 19%, although structured pathways facilitated significant relative increases in execution. However, in large-scale, undifferentiated populations, the documented operational gains remained modest, increasing from only 0.6% to 1.8% (Kerber et al., 2020).

**Precision of Ocular Motor and HINTS Assessment:** The quality of reported bedside oculomotor examinations demonstrated substantial clinical difficulties. In a large-scale clinical audit, 80.7% of documented nystagmus descriptions were found to be clinically inconsistent with the final rendered diagnosis. Furthermore, only 5.4% of medical nystagmus records provided sufficient descriptive detail to support a meaningful diagnostic inference (Kerber et al., 2011). Baseline adherence to the head impulse test was documented at a stark 5% and 11% across cohorts. Targeted pathway implementation significantly improved head impulse test adherence, driving rates up to between 32% and 96.9% (Lloyd, Luscombe, et al., 2020).

**De-implementation of Low-Value Care:** Baseline audit data showed that 36% of patients with confirmed BPPV routinely underwent inappropriate diagnostic neuroimaging in the ED. The implementation of structured clinical pathways successfully reduced these low-value imaging rates from 55.0% to 34.4% and from 40.0% to 24.0%, respectively. Similarly, a baseline over-reliance on vestibular suppressants for mechanical BPPV presentations was recorded at a stark rate of between 58% and 96% across audited cohorts. Targeted clinical pathways achieved a 30% relative reduction in the proportion of patients discharged with an isolated prescription for chemical suppressants (Lloyd, Luscombe, et al., 2020; Stewart et al., 2022).

**Physiotherapy Integration:** Concurrently, the integration of dedicated clinicians within acute pathways drove a substantial increase in service utilisation, with post-discharge referrals to vestibular physiotherapy rising from 11% to 38% following pathway deployment (Stewart et al., 2022).

**Mapping of Evidence-Based Recommendations:** [Appendix A](#) presents a comprehensive summary matrix of the clinical quality indicators identified through the rapid scoping review process. This table provides a consolidated view of the primary literature supporting specific diagnostic manoeuvres, interventional protocols, and pharmacological considerations in acute care. This

mapping highlights the varying levels of empirical validation for established standards, and identifies the core operational components prioritised within modern clinical management algorithms.

### **3.3.8 Description of Physiotherapy**

**Rapid scoping review question 2:** What is the evidence for ED physiotherapist involvement in managing acute dizziness and vertigo, and how does this align with established guidelines and evidence-based practices?

Although physiotherapy was identified as a specific metric ( $n = 14$ ) and presented within the baseline descriptive findings, deeper thematic analysis is warranted given the precise clinical focus of this work. Of these 14 records, four were comprehensive, condition-focused clinical practice guidelines or secondary evidence syntheses that lacked a specific operational focus on physical therapy professions (Bhattacharyya et al., 2017; Edlow et al., 2023; Hall et al., 2022; Khoujah et al., 2023). Another four studies focused strictly on the macro-level implementation processes required to establish an integrated vestibular care service in the emergency department and failed to report direct clinician performance or patient outcomes (Bradshaw et al., 2023; Herdman et al., 2023; Ip et al., 2022; Kerber et al., 2020).

This distribution leaves six physiotherapy-led investigations within the scoping review dataset: five conducted within Australian healthcare networks (Lloyd, Luscombe, et al., 2020; Lloyd, Mackintosh, et al., 2020; Neely et al., 2023; Neely et al., 2021; Stewart et al., 2022) and one international study (Sacco et al., 2014). Five of these papers focused narrowly on BPPV, whereas only Stewart et al. (2022) utilised a comprehensive, undifferentiated inclusion model for acute ED vestibular conditions. In the Neely et al. (2021) trial, ED physiotherapy input was minimal and directed primarily toward basic mobility and balance screening. In contrast, the remaining five studies described ED physiotherapists as autonomous, primary assessing and treating clinicians for acute dizziness and vertigo presentations. For example, Lloyd, Luscombe, et al. (2020) implemented a specialised vestibular physiotherapy service explicitly designed to improve the delivery of evidence-based care; however, the small sample size of this pilot investigation limits its external validity.

Collectively, all six of these physiotherapy-led studies adopt a highly optimistic qualitative narrative regarding the future utility of advanced physiotherapy practitioners within acute vestibular cohorts. While each paper references a substantial theoretical benefit, none demonstrated a definitive, statistically significant added clinical value over standard emergency care models.

### **3.3.9 ED Physiotherapist Involvement**

**Analysis of the Physiotherapy Role in Vestibular Adherence:** While the broader literature highlights systemic deficits in ED vestibular management, the specific contribution of physiotherapy is characterised by significant heterogeneity in clinical skillsets and operational outcomes. Current

evidence suggests that the practical impact of the physiotherapy role is mediated more by specialised clinical competency than by professional designation alone.

Evidence from a prospective feasibility study suggests that the inclusion of specialised vestibular physiotherapy yields highly favourable adherence to gold-standard metrics, including 100% fidelity in Dix-Hallpike testing and 40.6% in canalith repositioning manoeuvres (Lloyd, Luscombe, et al., 2020). Conversely, a retrospective analysis of generalist ED physiotherapy assessments revealed inferior adherence to vestibular-specific guidelines, with clinical focus remaining largely restricted to traditional mobility and falls-risk considerations (Lloyd, Mackintosh, et al., 2020). This contrast indicates that the primary predictive feature of a physiotherapy service's impact on acute dizziness and vertigo is the level of advanced vestibular training held by the clinician. This directly aligns with contemporary observations in emergency medicine, which emphasise that clinicians require formal, targeted competency training to achieve diagnostic precision (Tarnutzer & Edlow, 2023).

The implementation of advanced physiotherapy roles also provides a critical lens through which to view interprofessional adherence and collaborative practice. Research involving the introduction of an assessment algorithm alongside a specialised vestibular physiotherapist found that the presence of the advanced practitioner did not significantly alter the day-to-day diagnostic or interventional performance of emergency medicine physicians. An odds ratio analysis demonstrated that access to a vestibular physiotherapist failed to facilitate broader knowledge transfer or improve the independent management of BPPV within the medical cohort. This lack of transfer suggests that while a specialised physiotherapist can significantly improve clinical outcomes for the specific patients they personally treat, their presence alone does not automatically mitigate evidence-to-practice gaps within the wider multidisciplinary team.

**Synthesis of Current Evidence Gaps:** The current body of literature regarding the operational role of emergency department physiotherapy in vestibular triage remains constrained by several methodological limitations. The available data are exclusively derived from Australian-based, single-site studies that focus primarily on BPPV rather than the broader, undifferentiated acute dizziness and vertigo presentation. Furthermore, the evidence base is characterised by small sample sizes (e.g.,  $n = 22$  to  $n = 150$ ), which severely limits the generalisability of the findings to larger, more socio-demographically diverse ED environments.

These mixed findings underscore the clinical necessity of clearly defining the operational roles and required competencies of ED physiotherapists. It is plausible to conclude that for physiotherapy to act as a meaningful driver of evidence-based adherence, practitioners must be equipped with additional competency training that exceeds standard undergraduate or generalist rehabilitative skillsets.

However, given the pronounced research brevity regarding ED physiotherapy involvement in acute vestibular pathways, significant limitations remain in reliably defining the precise clinical utility

of these practitioners. More descriptive, multi-site data are required to describe the physiotherapist's role within larger sample sizes that are not restricted to a narrow clinical scope (such as isolated testing for BPPV) to inform clinical policy development and systemic pathway design.

### ***3.3.10 Indigenous Health Equity and Evidence of Disparities in Emergency Vestibular Care***

**Rapid scoping review question 3:** What evidence exists on health disparities in managing acute dizziness and vertigo in Indigenous populations?

Minority groups and Indigenous populations are completely excluded from the primary study designs, stratifications, or formal analyses of all included literature concerning ED acute dizziness and vertigo management. Ethnicity data are very seldom reported, and where documented, they fail to encompass meaningful or statistically representative sample sizes. These findings represent more than just a mainstream ignorance of Indigenous health data; they demonstrate a systematic absence of acknowledgement and an ongoing omission of Indigenous voices from established clinical care registries and vestibular knowledge repositories.

The analytical scope of this rapid scoping review was explicitly expanded from its original design to map Māori clinical pathways and healthcare outcomes within New Zealand. However, preliminary searches revealed a stark, absolute absence of literature at this level of cultural specificity. To mitigate this, the review's parameters were widened to encompass more general international search terms inclusive of Indigenous and ethnic minority populations to uncover applicable health equity data.

An examination of the 55 studies included in this review identified only four citations that made any reference to reporting race, ethnicity, or health disparities in relation to acute emergency vestibular care. The only explicit reference to Indigeneity occurred in the work of Stewart et al. (2022) who reported that Indigenous Aboriginal and Torres Strait Islander peoples comprised a mere 1.0% of their study population. In contrast, Mandge et al. (2020) reported sample ethnicity for only 45.0% of their cohort, leaving 55.0% ( $n = 97$ ) undefined. Within that limited 45.0% demographic bracket, the dataset appeared to capture exclusively minority populations ( $n = 177$  total sample;  $n = 11$  Black/African American;  $n = 3$  non-Hispanic White;  $n = 4$  Asian;  $n = 22$  Hispanic).

An investigation by Imam et al. (2024) in the Middle East and North Africa (MENA) region found that the local, indigenous population was at a significantly higher risk for poor neurological outcomes when presenting to the ED with a posterior circulation ischemic stroke (which accounted for acute vestibular symptoms in half of those presentations) compared to the younger, expatriate workforce. However, because poor clinical outcomes were also heavily confounded by advanced age and male sex within this cohort, the local population's risk profile was intricately bound to an increased baseline burden of chronic metabolic health issues.

Finally, a large-scale study by Dubey et al. (2022) examining CT utilisation rates in the United States did not explicitly isolate Indigenous American groups, but did demonstrate significantly

lower head CT utilisation among structurally marginalised populations, including non-Hispanic Black, Medicaid, self-paying, and rural patients. Crucially, the racial and ethnic variables analysed in their study were artificially restricted to White non-Hispanic, Black non-Hispanic, Hispanic, and an undifferentiated "other" category. This "Other" classification demonstrated no statistically significant difference in adjusted utilisation relative to the white reference group, effectively obscuring any distinct Indigenous data vectors.

Ultimately, because this scoping review relied on standard, western centric models of systematic knowledge acquisition, it is highly probable that localised, non-Westernised pools of vestibular knowledge were missed. While a lack of secondary resourcing within this rapid scoping review timeline precluded a deeper exploration of indigenous grey literature, these findings clearly establish that mainstream emergency vestibular research operates under a profound state of evidentiary omission regarding Indigenous health equity.

### ***3.3.11 Limitations of the Rapid Scoping Review***

While the rapid scoping review was conducted with methodological rigor to map the evidence base for acute vestibular management, the expedited timeline necessitated several pragmatic shortcuts. These limitations must be acknowledged as they potentially impact the breadth and depth of the synthesised findings.

**Selection and Interpretation Bias (Single-Reviewer Protocol):** The use of a single reviewer for study screening (title, abstract, and full-text) and data extraction represents a key methodological limitation. While single-reviewer approaches are recognised within rapid review methodology, standard systematic review guidance from Cochrane and JBI recommends dual-reviewer processes to reduce bias and error (Aromataris & Munn, 2020; Tricco et al., 2017).

In the absence of independent verification, there is a risk that relevant studies may have been excluded during screening, particularly in the abstract review phase. Similarly, single-reviewer data extraction may increase the potential for interpretation or transcription errors when summarising complex clinical data. These factors may influence the completeness and consistency of the study selection and synthesis.

**Database Scope and Language Bias:** The search was limited to three databases (MEDLINE, CINAHL, and Cochrane) and to English-language publications. This may have restricted the scope of included studies, particularly those from regional or specialised sources not indexed in major biomedical databases. Limiting inclusion to English-language studies may also have excluded relevant research from non-English-speaking regions, including European and Asian cohorts. These factors may affect the representativeness of the evidence base and limit the generalisability of the findings across different healthcare settings and diagnostic approaches.

**Omission of Grey Literature and Publication Bias:** Grey literature (e.g., government reports, clinical protocols, and theses) was not included in the search strategy due to resource constraints. This may contribute to publication bias, as peer-reviewed literature is more likely to report positive or statistically significant findings, while local audits and service evaluations are less frequently published. This limitation is particularly relevant in the context of health equity. Reports relating to Māori health, including local health board protocols or iwi-led initiatives, may not be represented in academic databases.

As a result, the review may not fully capture locally developed evidence or perspectives on vestibular care for Māori populations. This may affect the completeness of the evidence base and its relevance to the Aotearoa New Zealand context.

**Search Strategy Precision (Keyword vs. MeSH):** Although search terms were developed with reference to Medical Subject Headings (MeSH), the search was conducted using keyword-based strategies across the EBSCOhost and Cochrane platforms. Keyword searches depend on the specific terms used by authors, whereas subject heading searches can identify articles indexed under relevant concepts regardless of wording. As a result, studies using alternative terminology may not have been captured by the search strategy. This may reduce the sensitivity of the search and affect the completeness of the evidence identified, particularly for older literature where standardised vestibular terminology was less consistent.

**Absence of Formal Quality Appraisal:** A formal risk-of-bias or quality appraisal of included studies was not undertaken. This aligns with standard scoping review methodology, where the primary aim is to map the extent of the literature rather than to evaluate study quality or synthesise effect sizes effect (Aromataris & Munn, 2020). As a result, the evidence identified in this review is presented without formal assessment of methodological quality. This means that studies of differing design and rigour contribute equally to the synthesis. This should be considered when interpreting the findings, particularly when applying them to clinical decision-making contexts.

**Summary of Limitations for the Rapid Scoping Review:** These methodological concessions were necessary to produce a timely evidence map to guide the subsequent audit. However, the findings should be interpreted as a foundational overview rather than an exhaustive or definitive representation of global vestibular clinical practice.

### **3.4 Summary of Rapid Scoping Review**

While the literature establishing clinical standards for acute dizziness and vertigo is substantial, there is a notable paucity of research investigating how closely real-world ED practices

reflect these recommendations. It is well documented that clinicians face significant diagnostic and management challenges with this cohort in the acute setting. In response, the evidence base has evolved through various proposed algorithms, such as the STANDING, TiTrATE, culminating in the comprehensive GRACE-3 clinical practice guidelines (Edlow et al., 2023; Newman-Toker & Edlow, 2015; Vanni et al., 2017). However, the current evidence-to-practice gap remains poorly characterised, particularly regarding the specific contributions of ED-based physiotherapy and clinical outcomes for Indigenous populations.

### ***3.4.1 Transition from Rapid Scoping Review to Clinical Audit***

While diagnostic standards for acute dizziness and vertigo have reached a state of relative maturity, the literature is characterised by a systemic scarcity of implementation focused research. Unlike other emergency medical domains where retrospective clinical audits are foundational to quality improvement, vestibular triage remains under-examined, with existing adherence data defined by its narrow geographic and clinical scope.

This global evidence-to-practice gap is magnified within New Zealand, where a profound evidentiary void exists regarding local clinical behaviours and Indigenous health outcomes. Current international data fails to capture the unique sociocultural landscape of Aotearoa, leaving the experiences of Māori populations and the professional utility of ED physiotherapy largely unmapped.

To bridge this profound evidentiary void, the following clinical audit stands as a foundational necessity, providing the inaugural characterisation of emergency department management within New Zealand regarding acute dizziness and vertigo. By rigorously contrasting localised practices against contemporary evidence-based benchmarks, this study fulfils an urgent requirement to identify and rectify systemic implementation gaps within the domestic clinical environment.

It is equally imperative that this investigation interrogates the experiences of Māori populations and the professional utility of ED-based physiotherapy, critical domains currently omitted from the global literature. This inquiry is essential to establishing professional alignment and advancing health equity within the acute vestibular setting.

## **4 Chapter 4: Retrospective Audit of Clinical Documentation**

### **4.1 Purpose of the Study**

To describe the clinical practices in managing acute dizziness and vertigo in urban New Zealand EDs and contrast these practices with the guidance and recommendations from current evidence-based literature.

This research aims to improve the quality of care by enabling ED clinicians to quantify and characterise current practice patterns, contrast these with evidence-based recommendations, and highlight any areas of discrepancy. Additionally, funders, policymakers, and health managers may access local data to inform optimal resource allocation.

#### **4.1.1 Research Questions**

The following research questions were refined following the narrative and scoping review. These questions incorporate the identified evidence to practice gaps and emerging evidence regarding the impact of ED physiotherapy on diagnostic accuracy and health system efficiency. Crucially, this research is designed to address the notable descriptive gap in the literature regarding Māori and Indigenous populations, who represent the cohort with the highest need for improved health outcomes. These questions seek to provide the primary empirical data necessary to identify disparities and facilitate the development of equitable diagnostic and care pathways in a New Zealand context.

##### **Question 1:**

How do the emergency department practices at North Shore Hospital and Waitakere Hospital in Auckland align with evidence-based guidelines for the assessment and management of acute dizziness and vertigo: Are there differences in alignment with evidence-based guidelines between emergency medicine physicians and emergency department physiotherapists?

##### **Question 2:**

At North Shore Hospital and Waitakere Hospital in Auckland, what is the level of adherence to evidence-based guidelines for acute dizziness and vertigo management in Māori and non-Māori patients? How do emergency department outcomes differ between these two groups?

### **4.2 Methodology**

#### **4.2.1 Introduction**

This section details the methodological framework and specific research methods employed to evaluate clinical practice patterns in the management of acute vestibular syndrome within the ED. It establishes this study's positioning within a post-positivist paradigm, acknowledging the necessity of an objective clinical audit while maintaining reflexivity regarding the researcher's role as a clinician. A primary focus of this methodology is the integration of health equity with the

consideration of the equal explanatory power principle, incorporating ideals of delivering results that are statistically powered toward identifying potential disparities in care for Māori cohorts. By documenting the sampling strategy, the process of data collection and analysis, and the quality assurance measures, the integrity and reproducibility of the data collection process are demonstrated.

#### **4.2.2 Methodological Framework**

**Theoretical Framework: Post-Positivism:** The foundational level of any research methodology resides in its philosophical assumptions, the "most general features of the world" that underpin the inquiry (Clark, 1998, p. 1242). Within any research paradigm, specific values and assumptions emerge from the interplay between ontology and epistemology. A researcher's ontological position, and their belief about the nature of reality, serves as a necessary constraint that dictates which epistemological positions can be logically maintained (Moon & Blackman, 2014).

Ontology is concerned with what exists and the nature of the reality about which knowledge can be acquired. Whereas, epistemology addresses the mechanics of that knowledge creation, including the validity of specific methods used to acquire it and the determination of who is qualified to hold and interpret that knowledge (Moon & Blackman, 2014; Ryan, 2006). Methodologies, therefore, function as the practical expression of these positions translating abstract beliefs into concrete modes of inquiry that define how we know the world or gain knowledge of it (Grant & Giddings, 2002).

This retrospective clinical note audit uses a post-positivist paradigm as its underpinning philosophical foundation. Post-positivism serves as a framework that encompasses both ontological and epistemological positions (Fox, 2008). It is understood not only as an approach to generating knowledge but also as a perspective concerned with the nature of reality itself. The ontological foundation of this study is critical realism, an established feature of post-positivism (Mahato, 2024). This perspective posits that an objective reality exists independent of our perceptions, represented in this study as the actual clinical management and outcomes of patients in the ED. However, unlike pure positivism, which assumes this reality can be perfectly apprehended, critical realism acknowledges that our understanding of it is critically flawed. This research acknowledges that while a true level of guideline adherence may exist, it is mediated through the imperfect documentation of clinical notes and the subjective nature of a retrospective interpretation.

Epistemologically, post-positivism maintains that objectivity remains a primary ideal but recognises that researchers are inherently biased by their professional backgrounds and theoretical frameworks. To counter this, post-positivist inquiry relies on triangulation, using different sources of information such as the use of both automated records and clinical chart audit in this study (Mahato, 2024). The dual-method data collection increases the reliability of the findings compared to a single-method approach.

Reflexivity, defined as critical self-awareness, is a cornerstone of post-positivist inquiry. It is especially vital when researching marginalised populations, as the researcher's background, biases, and power dynamics directly influence data interpretation (Solie, 2024). Conversely, this proximity can yield a greater depth of insight and understanding. In this study, the clinical expertise of the reviewers, who are practising emergency physiotherapists and physicians, provided the necessary lens to accurately interpret nuanced clinical documentation.

A post-positivist paradigm maintains the pursuit of an objective reality while acknowledging that human understanding of that reality is inherently imperfect (Burbules, 2000). This framework recognises that researcher biases and the complexities of human experience can cloud objective observation. Consequently, the researcher's role as an interpreter is centralised, necessitating a commitment to rigorous reflexivity throughout the research practice (Fox, 2008).

Mitigation of subjectivity is further operationalised in this study through use of a standardised instrument to provide an objective benchmark. Again, a form of triangulation is employed in the data extraction tool, which incorporates two established evidence-based guidelines and a synthesis of literature following a rapid scoping review. Additionally, inter-rater reliability testing is employed, along with the involvement of a third-party subject matter expert, to minimise individual reviewer bias. A structured, predefined consensus process further enhances objectivity during analysis. By adopting these positions, the methodology shifts away from positivist claims of absolute truth, providing instead the most probabilistic and rigorous account of clinical practice possible within the Waitematā locality.

#### **4.2.3 *Reflexivity***

My research positionality is shaped by a mainstream Western-centric education during the 1980s to 1990s and by an urban upbringing in New Zealand. My professional identity as a physiotherapist is integral to my worldview, driving my enthusiasm for working within the ED environment. Beyond my clinical work, I am also a husband, and a father to three Tamariki. My wife and I live within a bicultural milieu, with tikanga Māori as a central tenet of our lives. Our children attend full immersion Kura Kaupapa Māori education, fostering the use of Te Reo Māori within our home.

#### **4.2.4 *Personal Relationship with Post-Positivism***

My initial exposure to science in early education was grounded in a positivist view, positioning objective measurement as the standard required to establish clinical truth. However, positivism has long been critiqued as an insufficient framework for healthcare, failing to capture complex biological, psychological, and social variables (Popper, 1972). Given that my undergraduate physiotherapy education placed significant emphasis on the biopsychosocial model, a post-positivist ontological framework serves as a logical alignment with my research approach.

### 4.3 Study Design

To achieve the objectives of this study, a retrospective chart audit methodology was utilised. Retrospective audits have historically contributed significantly to the ED-specific knowledge base, constituting up to 25% of the literature in this field (Gilbert et al., 1996; Worster et al., 2005).

**Retrospective Audit:** A retrospective chart audit is a systematic research method involving the examination of previously recorded patient medical data to evaluate clinical outcomes, service delivery, or adherence to established standards of care (Lowenstein, 2005). The design utilises real-world data already documented within electronic health records and clinical notes, providing direct insight into baseline clinical behaviours (Gilbert et al., 1996). For this study, the methodology allows for a comprehensive evaluation of how acute vestibular presentations were managed in the ED over a one-year period, identifying systemic patterns in diagnostic processes, imaging utility, and intervention rates that might not be captured in a controlled trial environment.

In the context of healthcare research, medical records remain some of the most widely used and studied sources of information for assessing quality of care and patient outcomes (Kaji et al., 2014; Lilford et al., 2007). These records provide both patient-oriented and practice-oriented data that offer valuable insights into quality audits, including the assessment of variations in care and adherence to clinical guidelines (Lowenstein, 2005).

In recognition of this study's underlying quality improvement intent, the SQUIRE 2.0 (Standards for Quality Improvement Reporting Excellence) guidelines served as the overarching framework. SQUIRE 2.0 provides a systematic structure for reporting new knowledge regarding the improvement of healthcare, ensuring that the findings are both transparent and applicable to clinical practice (Ogrinc et al., 2015). The SQUIRE guidelines have been previously used in similar retrospective observational chart reviews, including a recent Australian study examining the clinical management of BPPV in the ED (Neely et al., 2023). Consistent with SQUIRE's encouragement of specific methodological guidance, RECORD (Reporting of studies Conducted using Observational Routinely collected health Data) guidelines informed the data extraction strategy from electronic health records (Benchimol et al., 2015). The synergy of these frameworks informs a robust data extraction strategy, ensuring that routinely collected health data is analysed with both clinical precision and reporting transparency.

#### 4.3.1 Ethical Approval and Data Privacy

Ethics approval was granted by the Auckland University of Technology Ethics Committee (AUTEC; Ref 25/259) ([Appendix B](#)). A formal waiver was obtained from the Health and Disability Ethics Committees (HDEC), as the research fell outside their statutory scope. Locality approval was

also obtained from Health New Zealand – Waitematā, and the Auckland University of Technology School of Clinical Sciences Mātauranga Māori Komiti provided cultural feedback.

This retrospective clinical audit was classified as a minimal-risk project. As there was no direct interaction with participants, there were no risks of physical, psychological, or emotional harm. The primary operational risk was a potential breach of confidentiality, which was mitigated through rigorous de-identification of all data prior to analysis. The research team, as Health New Zealand – Waitematā employees, accessed and transferred data in accordance with institutional security policies. Identifiable information remained within the hospital's secure digital infrastructure, ensuring that patient privacy was upheld throughout the audit.

#### **4.3.2 Operationalising *Te Tiriti o Waitangi***

This research is grounded in the principles of *Te Tiriti o Waitangi*, as articulated by the Waitangi Tribunal (Wai 2575) and the Ministry of Health (Ministry of Health, 2023). In the context of an ED clinical audit, the principles of *Tino Rangatiratanga* (Self-determination), *Mana Taurite* (Equity), *Whakamarumarū* (Active Protection), *Kōwhiringa* (Options), and *Pārinitanga* (Partnership) are applied to ensure the research contributes to the elimination of health disparities for Māori. (Ministry of Health, 2023; Treaty of Waitangi Tribunal, 2019).

***Whakamarumarū: Active Protection:*** Evidence suggests that Māori often experience disparate access to timely specialist assessment and diagnostic imaging in acute settings (Bhat et al., 2022; Prisk et al., 2016). Additionally, the preceding rapid scoping review identified a notable paucity of literature specific to Indigenous populations presenting with acute dizziness and vertigo to ED. These presentations require high-level decision-making and a combination of specialised bedside assessments and advanced imaging (Edlow et al., 2023). This audit examines the management of acute dizziness to determine whether current ED pathways deliver equitable outcomes, consistent with the obligation to actively monitor and address inequities in healthcare delivery.

***Mana Taurite (Equity):*** To give effect to equity, this study employed a disproportionate stratified sampling strategy. A complete census of all eligible Māori records was undertaken. Conventional proportional sampling can obscure Māori data within a majority non-Māori dataset, leading to underpowered conclusions. Oversampling was therefore used to strengthen the Māori cohort and maximise statistical clarity and analytical power within the available dataset.

***Pārinitanga (Partnership):*** Partnership was operationalised through consultation with Māori health stakeholders and a commitment to *Te Tiriti*-led research practice. This prioritised Māori health aspirations and institutional accountability. Consultation informed the study design, including the refinement of research questions, sampling strategy, and selection of metrics within the data

extraction tool. Involvement of Māori clinical and cultural leaders ensured that the methodology and analysis reflected Māori health priorities. Consultation also highlighted systemic barriers to equitable healthcare and supported the prioritisation of Māori representation within the dataset.

Consultation further addressed the handling of retrospective records belonging to deceased individuals. To respect the *tapu* (sanctity) associated with these records, guidance was provided on appropriate cultural protocols, including the use of *karakia* (prayer) and symbolic cleansing practices. These processes supported the cultural and spiritual wellbeing of the research team while acknowledging the mana of the patient data.

***Kōwhiringa (Options):*** This principle is addressed by examining the range of clinical pathways available to Māori presenting with acute dizziness. This audit identifies potential gaps where standard protocols may lack flexibility to meet Māori needs. It evaluates whether Māori have equitable access to high-quality, evidence-based care, including allied health assessments alongside traditional medical management.

***Tino Rangatiratanga (Self-determination):*** Tino Rangatiratanga was upheld through a commitment to Māori Data Sovereignty. Although the data are retrospective and anonymised, they represent the lived experiences of Māori patients and their whānau. Data management protocols were designed to respect the *tapu* of this information. Analysis avoids deficit-based framing and instead focuses on improving systemic and institutional performance within the ED.

Integration of these principles across the study is summarised in [Table 5](#).

**Table 5***Mapping Te Tiriti Principles to Research Methods and Actions*

| <b>Te Tiriti Principle</b> | <b>Methodological Application</b> | <b>Specific Action in The Clinical Audit</b>                                                                                                                                                                   |
|----------------------------|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Self-Determination         | Māori Data Sovereignty            | Ensuring data is managed according to institutional Māori Research policies and results are returned to Māori health and ED leadership.                                                                        |
| Partnership                | Consultation & Governance         | Engaging with the Māori Health Research Advisory Group at Health NZ to align audit questions with Māori health priorities.                                                                                     |
| Equity                     | Disproportionate Sampling         | Using stratified sampling to ensure the Māori cohort is large enough for meaningful statistical analysis, rather than just a "representative" (smaller) percentage.                                            |
| Active Protection          | Proactive Disparity Monitoring    | Measuring for low value care and describing any gaps in diagnosis or treatment.                                                                                                                                |
| Options                    | Pathway Analysis                  | Evaluating if Māori were offered equitable access to high-quality, evidenced based care and also to specialised allied health assessments as an alternative/addition to standard medical management in the ED. |

#### **4.3.3 Research Setting and Context**

The study was conducted across two metropolitan EDs within Health New Zealand – Waitematā in Auckland, Aotearoa New Zealand. These departments serve the largest catchment population in New Zealand and operate continuously. Collectively, they manage more than 100,000 ED presentations annually, placing them among the highest-volume emergency care environments in the country. Upon presentation, patients are triaged by a triage nurse, after which emergency medicine physicians select patients based on triage priority. ED physiotherapists autonomously select patients for assessment but also receive referrals. All patients seen by a physiotherapist have also been reviewed by an emergency physician. The Australasian Triage Scale (ATS) is used to assign clinical urgency, generating a score from 1 to 5. These categories also provide an indication of patient acuity at presentation. Each category has a corresponding maximum recommended time to medical assessment: ATS 1 (immediate), ATS 2 (within 10 minutes), ATS 3 (within 30 minutes), ATS 4 (within 60 minutes), and ATS 5 (within 120 minutes).

**The Emergency Department Physiotherapy Service:** The ED includes a dedicated secondary-contact physiotherapy service, with three full-time equivalent (FTE) clinicians at North Shore Hospital and one FTE at Waitākere Hospital. The service covers both the ED and the adjacent Assessment and Diagnostic Unit (ADU), which supports patient flow through observation and short-stay management. The physiotherapy service operates Monday to Friday from 07:30 to 16:00. An on-call service for urgent and life-preserving care is available 24 hours a day. Weekend coverage is provided for five hours on Saturdays and Sundays at North Shore Hospital, and for five hours on Sundays at Waitākere Hospital.

#### **4.3.4 Sampling and Sampling Bias**

**Sampling Strategy:** A one-year study period across 2022 and 2023 was purposively selected to represent a stable baseline of usual ED care. This period preceded a targeted clinical education initiative focused on acute dizziness and vertigo assessment. Inclusion of more recent data may have introduced a Hawthorne effect or education-related bias, whereby clinical documentation reflects short-term behavioural change rather than baseline practice (McCambridge et al., 2014). This timeframe therefore provides a more accurate representation of routine clinical behaviour.

**Disproportional Stratification for Equity:** In clinical research, sampling bias occurs when certain subgroups are systematically excluded or under-represented, resulting in reduced external validity and limited generalisability (Ferguson, 2004). Although simple random sampling is often considered the gold standard for minimising researcher bias, this approach was insufficient for the health equity objectives of this study.

A key concern in New Zealand health research is the dilution of minority data within large datasets (Patu et al., 2023; Robson, 2002). If a simple random sample had been used, the resulting Māori cohort would have been structurally underpowered, limiting meaningful descriptive analysis. This would have introduced a selection bias by omission, compromising the study's capacity to accurately reflect the experiences of Māori patients.

**The Equal Explanatory Power Principle:** To address this risk, disproportionate stratified sampling was employed. The study operationalised the *principle* of equal explanatory power by conducting a purposive census of all eligible Māori records, while randomly sampling the remaining cohort. This approach provides several methodological advantages over simple random sampling. It ensures statistical adequacy by generating a sufficiently large subgroup to detect patterns in Māori treatment and health outcomes that might otherwise remain obscured. It also aligns with Te Tiriti obligations by supporting Tino Rangatiratanga through recognition of Māori data sovereignty and reinforcing a commitment to equity by prioritising Māori health data within the analysis.

In addition, this approach functions as a mechanism of active protection by ensuring Māori health outcomes are explicitly considered within the research design. It reduces the marginalisation of Indigenous data, a limitation often associated with standard random sampling that does not account for population proportions, and thereby mitigates ethical risk (Robson, 2002).

#### **4.3.5 Sample Size Power and Participant Selection**

This study included adults aged 20 years and over who presented to the ED at North Shore or Waitākere Hospitals. The estimated sample size was 250 participants. This was calculated using OpenEpi's "sample size for a proportion" tool and guided by an AUT biostatistician (Dr I Zeng).

A review of comparable studies indicated adherence to evidence-based recommendations at rates of approximately 15% to 30%. Assuming an adherence rate of 30% and a 95% confidence level, the calculated minimum sample size was 231. This was increased to 250 to strengthen the dataset and allow for incomplete records.

This sample size is consistent with similar retrospective ED studies of acute dizziness and vertigo, including Lloyd, Mackintosh, et al. (2020), Neely et al. (2021), Neely et al. (2023), and Stewart et al. (2022), which reported sample sizes of 96, 101, 162 and 214 respectively.

The primary inclusion criterion was a presenting complaint of acute dizziness or vertigo. Records were subsequently categorised according to the physician-documented diagnosis description on the discharge summary. Use of International Classification of Diseases (ICD) coding was not feasible due to its historically inconsistent and infrequent application in this context.

**Inclusion Criteria:** Records were included if they met the following criteria:

- Adults aged 20 years and over at the time of ED presentation.

- Presentation to the ED with a primary complaint of acute vestibular symptoms, including vertigo, dizziness, or imbalance where a vestibular origin was clinically plausible. This included potential vestibular mimics, such as posterior circulation stroke without clear neurological deficits documented at triage.
- Complete and accessible ED medical records available for review and data extraction.

**Exclusion Criteria:** Records were excluded if they met any of the following criteria:

- Dizziness secondary to a systemic medical condition (e.g., cardiovascular instability such as syncope, orthostatic hypotension, or arrhythmia; metabolic disturbances; acute intoxication; or psychiatric conditions), rather than a primary vestibular disorder.
- Exacerbations of pre-existing neurological conditions (e.g., multiple sclerosis), to avoid confounding chronic symptoms with acute vestibular events. Acute neurological presentations were included if dizziness or vertigo was the predominant presenting symptom, enabling assessment of bedside diagnostic approaches for differentiating central and peripheral causes.
- Presentations with incomplete diagnostic evaluation due to self-discharge or redirection to primary care, resulting in insufficient documentation for guideline assessment.
- Cases in which primary assessment and management were undertaken by inpatient specialty teams rather than emergency medicine physicians, as the study focuses on ED-led care

#### **4.4 Data Collection and Management**

The data collection for this audit utilised a dual-phase approach, integrating automated system queries in the first phase, with manual retrospective chart review in the second phase.

##### **4.4.1 Phase One: Data Acquisition Process for Sample Selection**

A dataset of patient records was generated in accordance with established local data access processes. This was conducted onsite at Health New Zealand – Waitematā using Qlik Sense software, specifically the *Explorer-ED* dashboard.

The dataset included presentations that met the inclusion criteria, between 1 July 2022 and 30 June 2023. Multiple presentations by the same patient were included where relevant. Extracted variables included National Health Index (NHI) number, hospital site, age at presentation, sex, ethnicity, diagnosis description, ED length of stay, discharge disposition, re-presentation within 72 hours, ward admission, subsequent attendance date, clinician role at initial assessment, Australasian Triage Scale (ATS) category, and a secure hyperlink to electronic clinical records.

The data were exported to a password-protected Microsoft Excel spreadsheet, accessible only onsite at Health New Zealand – Waitematā and restricted to authorised personnel under the approved ethics protocol. A priori exclusion criteria were applied by the primary researcher using the discharge

disposition and diagnosis description fields. Records with a discharge status of self-discharge (signed or unsigned) and those issued a primary health voucher were excluded. Primary health vouchers are provided to lower-acuity patients redirected to external primary or urgent care services following triage; these patients do not receive emergency physician assessment or ED physiotherapy input. Similarly, patients who self-discharge could leave prior to completion of clinical assessment, rendering their records unsuitable for guideline adherence evaluation. The diagnosis description, a free-text entry recorded by the discharging clinician, was used for initial eligibility screening. Records clearly meeting inclusion criteria were included and assigned a unique study identification number, while those outside of scope were excluded. Records that could not be classified on this basis underwent further review of emergency medicine documentation via the clinical portal hyperlink.

Where eligibility remained unclear, records were flagged for a consensus process. A hierarchical review approach was applied: the primary researcher first screened each record to determine whether bedside vestibular assessment would have been indicated. Records were then independently reviewed by a research assistant. Where agreement was reached, records were included or excluded accordingly. Where disagreement persisted, a third reviewer with subject-matter expertise facilitated discussion until consensus was achieved.

Following consensus, all included records were de-identified and assigned unique study identifiers. Reasons for exclusion were systematically documented to ensure transparency and reproducibility of the sampling process.

#### ***4.4.2 Randomisation and Sampling Procedures***

All eligible Māori records were purposively included. The remaining non-Māori records were subjected to simple random sampling using a computer-generated sequence. Each record was assigned a unique random number using a standard Microsoft Excel function and then sorted in ascending order. Records were selected sequentially from this list until the total sample, including all Māori records, reached 250.

During the clinical audit phase, some records were subsequently found to meet exclusion criteria upon detailed review (e.g., identification of self-discharge not apparent in initial screening). These records were removed and replaced with the next sequential record from the randomised list to maintain the target sample size and preserve the integrity of the original random sequence.

**Addressing Potential Researcher Bias:** The risk of researcher bias during sample selection was minimised through automated data extraction and the application of a priori criteria within Qlik Sense. Subsequent random sampling of the non-Māori cohort was performed using computer-generated sequences, removing subjective influence from the selection process.

#### 4.4.3 Phase Two: Data Extraction Process

The retrospective audit of clinical records was conducted onsite at Health New Zealand – Waitematā. The study sample was presented in an Excel spreadsheet, and embedded hyperlinks were used by the primary researcher and research assistant to access individual patient records.

Access was obtained via Health New Zealand computers using individual staff logins, linking directly to each patient's Clinical Portal. The relevant presentation was identified using the *Centric Snapshot* feature, which allowed documentation to be filtered by admission date and encounter.

Only emergency medicine and physiotherapy documentation were reviewed. Physiotherapy entries were identified using the “filter notes” function. Only physiotherapy input provided within the ED or Assessment and Diagnostic Unit (ADU) was included. Documentation from other providers (e.g., nursing, social work, or specialty teams) was not reviewed. Discharge summaries were included where completed by an emergency medicine physician, as part of the ED clinical record.

Data extraction for all included records was completed by the primary researcher using a bespoke data extraction tool ([Appendix C](#)), designed to capture variables of specific clinical relevance. Guided by the SQUIRE 2.0 framework's focus on practice-oriented data, and informed by cultural consultation, the following variables were extracted:

- Are the records appropriate for data extraction (any exclusion criteria evident)
- Emergency Medicine or Physiotherapy notes reviewed
- Is the timing of vertigo clearly established
- Are vertigo symptoms established as having a trigger or as spontaneous
- Nystagmus assessment is documented
- Nystagmus characteristics documented adequately
- Head Impulse Test assessment documented
- Head impulse test findings adequately described
- Test of skew assessment documented
- Test of skew findings adequately documented
- Finger rub or similar acute hearing loss screen documented
- HINTS or HINTS-plus documented
- HINTS or HINTS-plus results analysis documented adequately
- Degree of gait or balance unsteadiness documented
- BPPV Positional Tests documented
- Which positional test was performed
- Free text name of 'other' positional test if relevant
- BPPV assessment adequately interpreted
- CT Head ordered by Emergency Medicine

- MRI ordered or documented plan for MRI by Emergency Medicine
- Medication for vertigo symptoms documented, named medications recorded
- CRM used in treatment
- CRM documented correlates to previously documented assessment
- Referral to vestibular follow-up documented

While the data extraction parameters were applied consistently across both emergency medicine and physiotherapy records, items pertaining to CT/MRI imaging and medication administration were excluded from the physiotherapy cohort, as these interventions fall outside the current scope of practice for ED physiotherapists.

#### **4.4.4 Data Extraction Tool**

A bespoke data extraction tool was used by the primary researcher and research assistant to capture key clinical variables from emergency medicine and ED physiotherapy records. The tool and accompanying documentation are provided in [Appendix C](#).

**Data Extraction Tool Development:** The tool was developed within the REDCap (Research Electronic Data Capture) platform hosted by Auckland University of Technology to support retrospective audit of clinical documentation. REDCap is a secure, web-based platform designed for research data capture, offering structured data entry and automated export to statistical software (Harris et al., 2019; Harris et al., 2009). The tool was structured to reflect the clinical workflow of a patient's journey through the ED. Data extraction variables were derived through integration of three evidence sources:

1. Comprehensive and setting-relevant general guidelines for acute dizziness and vertigo in ED (Edlow et al., 2023),
2. Established condition specific BPPV guidelines (Bhattacharyya et al., 2017),
3. A rapid scoping review of the international literature as completed in Chapter 3.

This approach ensured the tool reflected a synthesis of current evidence rather than reliance on a single source, this synthesis is further portrayed in [Appendix D](#). To support reliability and usability, the tool underwent an iterative pilot phase consisting of three one-hour trial extractions. This was followed by expert review by an emergency medicine specialist, with feedback incorporated into the final version. Consistent with the study's post-positivist framework, the tool was designed to reduce subjectivity inherent in retrospective chart review. Data were primarily recorded using categorical and binary variables (0 = not documented, 1 = documented), providing a consistent basis for assessing guideline adherence and supporting statistical analysis.

Of the 15 GRACE-3 recommendations, 11 were included as primary benchmarks. Recommendations relating to clinician training and specific transient ischaemic attack (TIA) diagnostic strategies were excluded as they fell outside the study scope (Edlow et al., 2023).

Findings from the scoping review further informed benchmark selection. Data from 55 studies were synthesised to identify consensus vestibular assessments and interventions ([Appendix A](#)). Metrics supported by at least 10 studies were included. While there was strong alignment between the scoping review and GRACE-3 recommendations, a divergence was identified regarding horizontal canal benign paroxysmal positional vertigo.

This discrepancy was addressed through sequential synthesis of evidence. Although Edlow et al. (2023) did not provide specific recommendations for horizontal canal BPPV due to diagnostic complexity, the guideline acknowledges that trained clinicians may assess and manage this condition. Given the advanced vestibular expertise of ED physiotherapists, horizontal canal BPPV metrics were retained. Further assurance was obtained using Bhattacharyya et al. (2017) to specify expected diagnostic and therapeutic manoeuvres and confirm the horizontal canal inclusion was reasonable. The scoping review also provided strong support for inclusion of these assessments and for treatment using canal repositioning techniques.

The Epley canalith repositioning manoeuvre was originally described with mastoid vibration (Epley, 1992); however, omission of this component does not reduce clinical effectiveness (Hunt et al., 2012). Accordingly, contemporary practice refers to a modified *Epley manoeuvre*. Consistent with GRACE-3 guidance (Edlow et al., 2023) no distinction was made between original and modified variants in this study.

**Limitations of the data tool:** The tool was inherently limited by its reliance on retrospective clinical documentation; as such, findings may reflect incomplete documentation rather than absence of clinical intervention. Despite an iterative pilot phase and expert consultation, the extraction process remains susceptible to researcher interpretation, particularly where clinical notes are vague or use non-standardised terminology (e.g., describing a Dix–Hallpike test as “no nystagmus on head turn”). The use of binary coding, while supporting objective measurement of guideline adherence, does not capture the technical proficiency or accuracy of documented assessments and interventions.

The intentional exclusion of concussion, vestibular migraine, Meniere’s disease and TIA-specific diagnostic metrics, while necessary to maintain the study’s scope, represents a limitation in fully capturing the diagnostic breadth required for the heterogeneous “dizzy” population in the ED.

A further limitation relates to the evidence base underpinning the tool. There is a lack of New Zealand-specific or Indigenous-focused literature informing both the scoping review and key clinical guidelines (Bhattacharyya et al., 2017; Edlow et al., 2023). These sources have not been validated within the Aotearoa New Zealand healthcare context and do not incorporate the cultural safety

requirements essential for equitable Māori health outcomes. Reliance on international benchmarks may inadvertently perpetuate a Western biomedical bias that does not fully reflect the holistic needs of Māori patients (Durey & Thompson, 2012; Wilson et al., 2021). As the *Guidelines for reasonable and appropriate care in the ED 3(Grace-3): Acute dizziness and vertigo in the emergency department* (Edlow et al., 2023) are foundational in supporting the data extraction framework, a detailed critique of this guideline is presented in the Discussion section ([4.7.11](#))

#### **4.4.5 Data Management and Storage**

**Access:** Data access complied with the Privacy Act 2020 and the Health Information Privacy Code 2020. Data collection was limited to that required for the defined quality improvement purpose, with safeguards to prevent identification and restrict use. Access to patient data was obtained through Health New Zealand – Waitematā in accordance with established data access procedures, with approval from the AUT Ethics Committee and locality approval from Health New Zealand – Waitematā. The primary researcher (K Nickles), research assistant (S Bastkjaer), and subject-matter expert (E De Beer) accessed identifiable data during the extraction phase. All are employees of Health New Zealand – Waitematā and were bound by organisational policies and professional standards governing the use of patient information.

**Storage:** Two data sources were used: Qlik-generated administrative data and information extracted from clinical records. Identifiable Qlik data, including National Health Index (NHI) numbers, were accessed and stored exclusively within Health New Zealand – Waitematā systems in password-protected folders. De-identified datasets were assigned unique study identifiers and stored separately for analysis within REDCap at Auckland University of Technology. Transfer of de-identified data to AUT was conducted via encrypted email. Access was restricted to authorised members of the research team. Data will be retained for 10 years in accordance with health data storage requirements, after which electronic records will be securely deleted and any physical materials disposed of as confidential waste. Recognising principles of data sovereignty, the authors acknowledge Ngāti Whātua as the predominant iwi associated with the Waitematā rohe, with Te Kawerau ā Maki holding specific interests in the Waitākere region. This study recognises the rights of Tangata Whenua to ownership, control, access, and possession of data derived from them, their rohe, and their knowledge. To uphold these principles, all data were stored and analysed within Aotearoa New Zealand. The study also aligned with the Te Ara Tika framework for Māori data governance, with appropriate consultation informing study design, analysis, and dissemination (Hudson et al., 2010).

#### 4.4.6 Reviewer Characteristics and Training

The primary researcher and research assistant are New Zealand registered physiotherapists with specialised experience in the ED setting. Both have a clinical interest in vestibular rehabilitation and are involved in delivering vestibular education to healthcare professionals. The third reviewer, who served as subject-matter expert during the consensus process, is a senior emergency physician with extensive experience in emergency medicine. All reviewers received training on the screening and consensus protocols. Written guidance outlining inclusion and exclusion criteria was available throughout the process to support consistent decision-making.

#### 4.5 Data Analysis Plan

Data analysis incorporated both descriptive and inferential statistics, guided by a biostatistician (Dr I Zeng) and informed by methods used in comparable retrospective audits (Lloyd, Mackintosh, et al., 2020; Neely et al., 2023; Neely et al., 2021; Stewart et al., 2022) consistent with the quality improvement framework underpinning this work.

##### 4.5.1 Statistical Interpretation of Strength of Agreement

Inter-rater reliability was assessed to evaluate the consistency of data extraction, using Cohen's kappa as applied in similar studies (Neely et al., 2023). A research assistant independently repeated data extraction on a randomly selected subset of 50 records. The extraction tool included structured nominal variables and supplementary free-text fields. Presence of documented items (e.g., medications, positional testing) was analysed using Cohen's kappa, while free-text entries were treated as qualitative supplementary data. Variables with no observed variation across the dataset were excluded from reliability analysis. Discrepancies identified during validation were resolved through discussion until consensus was reached.

Inter-rater agreement was interpreted using the benchmarks established by Landis and Koch (1977). This framework classifies  $\kappa$  values from poor ( $< .00$ ) to almost perfect ( $.81$ – $1.00$ ), as summarised in [Table 6](#). While these categories guided interpretation, any metric below the “substantial” threshold was subject to formal adjudication to ensure data accuracy and consistency.

**Table 6**

*Interpretation of Cohen's Kappa ( $\kappa$ ) Strength of Agreement Benchmarks*

| Kappa Value ( $\kappa$ ) | Strength       | Action for your Audit                         |
|--------------------------|----------------|-----------------------------------------------|
| 0.81 – 1.00              | Almost Perfect | No further review needed.                     |
| 0.61 – 0.80              | Substantial    | Good reliability; standard for clinical data. |
| 0.41 – 0.60              | Moderate       | Adjudication/Consensus review required.       |
| < 0.40                   | Fair / Poor    | Adjudication/Consensus review required.       |

**Data Validation and Inter-rater Reliability:** Inter-rater reliability demonstrated high consistency across both the HINTS-plus and BPPV clinical assessment batteries, with Cohen’s kappa ( $\kappa$ ) values ranging from substantial (0.64) to perfect (1.00) across most variables in both medical and physiotherapy records. Agreement for key diagnostic variables was particularly strong, with 100% observed agreement across several ED physiotherapy metrics. A single instance of discordance was observed in the doctor-documented “finger rub” variable ( $\kappa = 0.00$ ); however, this reflected a statistical artefact due to low prevalence (1 positive case in 50 records), rather than true disagreement. This discrepancy was resolved through third-party adjudication, using the corresponding physiotherapy record as the reference standard. Variables with zero variance (e.g., supine roll test) reflected consistent agreement regarding the absence of documented assessment. Discordance was most evident in narrative fields, such as documentation of findings in positional BPPV assessment ( $\kappa = 0.64$ ), but these differences were resolved through the predefined adjudication process.

**Reliability of HINTS-plus and BPPV clinical metrics:** [Table 7](#) summarises the inter-rater reliability of the core clinical variables. This matrix demonstrates the consistency of data extraction across both primary medical records and ED physiotherapy documentation.

**Table 7**

*Inter-rater Reliability for HINTS-plus and BPPV Clinical Metrics (N = 50)*

| Variable                     | Observed Agreement (%) | Cohen’s Kappa ( $\kappa$ ) | Interpretation (Landis & Koch) |
|------------------------------|------------------------|----------------------------|--------------------------------|
| <b>HINTS-plus Metrics</b>    |                        |                            |                                |
| Nystagmus                    | 100                    | 1                          | Perfect                        |
| Head Impulse Test            | 100                    | 1                          | Perfect                        |
| Test of Skew                 | 100                    | 1                          | Perfect                        |
| Bedside Hearing (Finger Rub) | 98                     | 0.00*                      | Poor                           |
| Overall HINTS Assessment     | 100                    | 1                          | Perfect                        |
| <b>BPPV Metrics</b>          |                        |                            |                                |
| Positional Test (Any)        | 98                     | 0.94                       | Almost Perfect                 |
| Dix-Hallpike Test (DHT)      | 96                     | 0.92                       | Almost Perfect                 |
| Supine Roll Test (SRT)       | 100                    | N/A**                      | Universal Agreement            |
| <b>BPPV Intervention</b>     |                        |                            |                                |
| CRM                          | 94                     | 0.88                       | Almost Perfect                 |

*Note:*  $\kappa$  = Cohen’s kappa. \*The  $\kappa$  of 0.00 was driven by a single discordant extraction in a high-prevalence negative sample (1/50); this record was resolved via the pre-defined adjudication process. N/A\*\* indicates variables where zero variance was observed (all records identical), precluding the mathematical calculation of  $\kappa$ ; this represents 100% observed agreement.

#### **4.5.2 Descriptive Statistics**

Frequencies ( $n$ ) and percentages (%) were used to summarise categorical variables, including demographics (ethnicity, sex) and the proportion of records documenting specific assessments, treatments, and physiotherapy input. For proportions, 95% confidence intervals (CIs) were calculated using the adjusted Wald method to account for sample size and low-frequency clinical findings. Medians and interquartile ranges (IQRs) were reported for continuous variables, including age and ED length of stay. Normality was assessed using visual inspection of histograms and the Shapiro–Wilk test, consistent with established approaches ([Appendix E](#), for age distribution data).

#### **4.5.3 Inferential Statistics**

The adjusted Wald method was used to calculate 95% confidence intervals for proportions, consistent with approaches applied in similar studies (Neely et al., 2021). Quantile regression was used to compare time-based outcomes (e.g., ED length of stay and time to assessment) between groups. This method is robust to non-normal distributions commonly observed in ED flow data and enables direct comparison of median values.

#### **4.5.4 Comparative Audit Analysis**

Consistent with clinical audit methodology and the SQUIRE framework, analysis prioritised descriptive and quality improvement outcomes over formal hypothesis testing (Ogrinc et al., 2015). A paired comparison was undertaken for patients assessed by both emergency medicine physicians and ED physiotherapists. Clinical performance was evaluated using four measures of agreement and discordance:

- Agreement Rate: Proportion of cases where both groups documented the same clinical metric, including instances where both recorded or both omitted the item.
- Overall Discordance Rate: Proportion of cases where documentation differed between groups (i.e., a clinical metric recorded by one group but not the other).
- Emergency medicine only Discordance: Proportion of cases where a clinical metric was documented by the emergency physician but not by the physiotherapist, representing incremental diagnostic contribution from emergency medicine.
- Physiotherapy only Discordance: Proportion of cases where a clinical metric was documented by the physiotherapist but not by the emergency physician, representing incremental diagnostic contribution from physiotherapy.

Group-specific discordance provides a measure of each profession’s contribution to diagnostic coverage. Higher rates may indicate greater diagnostic yield or adherence to evidence-based assessment within that professional role. To quantify differences between groups, 95% confidence intervals were calculated for all paired proportions.

#### 4.5.5 Statistical Analysis of Interprofessional Concordance

Diagnostic performance and documentation fidelity between emergency medicine and physiotherapy cohorts were evaluated using paired binary data analysed within a  $2 \times 2$  contingency matrix ([Table 8](#)). This approach enabled quantification of clinical alignment and the incremental diagnostic contribution of the ED physiotherapy role.

**Table 8**

*Outline of Interprofessional Concordance Matrix for Paired Clinical Documentation*

| Clinical Metric               | Physiotherapy (positive) | Physiotherapy (negative) | Total        |
|-------------------------------|--------------------------|--------------------------|--------------|
| Emergency Medicine (Positive) | a                        | b                        | Total EM (+) |
| Emergency Medicine (Negative) | c                        | d                        | Total EM (-) |
| Total                         | Total PT (+)             | Total PT (-)             | N            |

##### Definition of Matrix Cells:

- Cell a (Concordant Positive): Both professional groups documented the presence of the clinical finding or assessment.
- Cell d (Concordant Negative): Both professional groups documented the absence of the clinical finding or assessment.
- Cell b (Emergency Medicine-only finding): The assessment was documented solely by the emergency medicine physician and was absent from the physiotherapy record.
- Cell c (Physiotherapy-only finding): The assessment was documented solely by the physiotherapist and was absent from the medical record.

**Calculation of Performance Metrics:** Clinical performance was evaluated through four primary metrics of agreement and discordance, calculated as proportions of the total paired sample. An example of the below calculation for “head impulse test” is presented below in [Table 9](#). A complete census of the study’s  $2 \times 2$  concordance matrices is provided in [Appendix F](#).

1. Agreement Rate: The proportion of cases where both professional groups reached the same clinical finding or documented the same assessment:

$$\text{Agreement Rate} = \frac{a + d}{N}$$

2. Overall Discordance Rate: The proportion of cases where clinical documentation differed between the two professional groups:

$$\text{Overall Discordance Rate} = \frac{b + c}{N}$$

- Emergency medicine-only Discordance: A measure of incremental diagnostic capacity, defined as the proportion of cases where the clinical assessment was documented solely by the emergency medicine physician:

$$\text{Emergency medicine-only Discordance} = \frac{b}{N}$$

- Physiotherapy-only Discordance: A measure of incremental diagnostic capacity, defined as the proportion of cases where the clinical assessment was documented solely by the physiotherapist:

$$\text{Physiotherapy-only Discordance} = \frac{c}{N}$$

**Table 9**

*Example of Interprofessional Concordance Matrix for Paired Clinical Documentation*

| Head Impulse Test             | Physiotherapy<br>(positive) | Physiotherapy<br>(negative) | Total  |
|-------------------------------|-----------------------------|-----------------------------|--------|
| Emergency Medicine (Positive) | 31                          | 2                           | 33     |
| Emergency Medicine (Negative) | 16                          | 0                           | 16     |
| Total                         | 47                          | 2                           | n = 49 |

## 4.6 Results

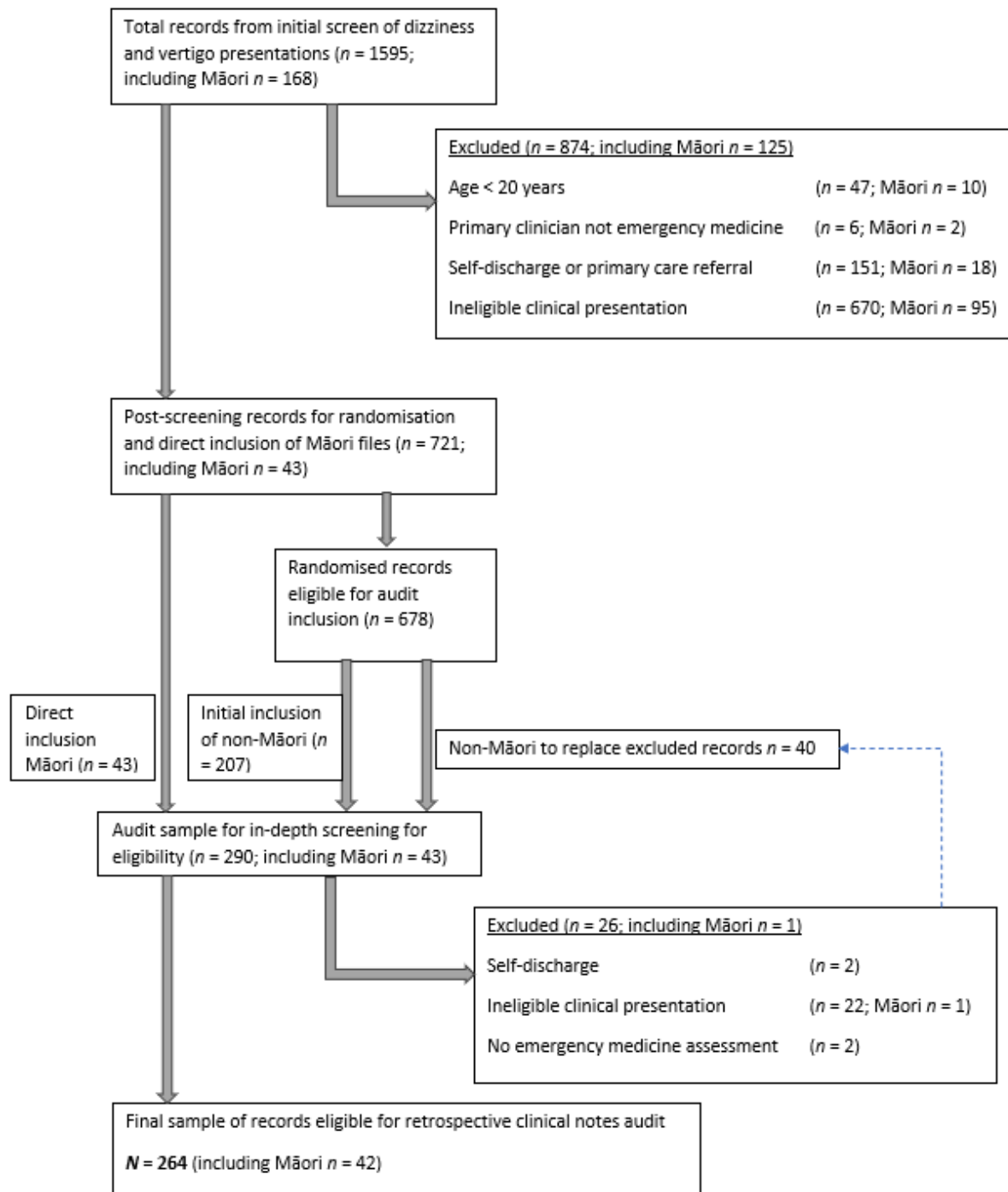
This section presents the findings of a retrospective clinical audit conducted at North Shore and Waitākere Hospitals. Findings are structured to examine alignment with evidence-based guidelines, with condition-specific analyses of adherence for acute vestibular syndrome and BPPV. Comparative performance between emergency medicine physicians and ED physiotherapists is analysed within a subset of cases involving both professions. A further subset analysis compares Māori and non-Māori cohorts to identify potential disparities in care.

### 4.6.1 Sample

A total of 1,595 ED presentations for dizziness and vertigo were identified between 1 July 2022 and 30 June 2023. Application of initial exclusion criteria removed 874 records. Reasons for exclusion ([Figure 10](#)) included age under 20 years ( $n = 47$ ), primary clinician not an emergency medicine physician ( $n = 6$ ), self-discharge or referral to primary care ( $n = 151$ ), and ineligible clinical presentation ( $n = 670$ ). Of the remaining 721 records, all Māori patients ( $n = 43$ ) were included for in-depth eligibility screening without randomisation. From the 678 non-Māori records, 207 were randomly selected for screening. Following in-depth review, 26 records were excluded. To maintain the target sample size, an additional 40 records were randomly selected from the non-Māori pool in two successive groups of 20. In total, 290 records underwent in-depth screening, resulting in a final sample of 264 records included in the retrospective clinical audit.

**Figure 10.**

*Patient Selection Flow Diagram*



*Note.* Blue arrows indicate the sequential replacement protocol for excluded cases identified during the in-depth review phase. This process occurred on two separate occasions, involving the replacement of 20 records per instance.

#### 4.6.2 Characteristics of Sample

The median age was 61.0 years for non-Māori participants and 51.5 years for Māori participants. The final cohort was predominantly female (60.6%). Ethnicity was primarily European

(41.7%), with Māori comprising 15.9% of the sample. Demographics and full ethnicity distribution is presented in [Table 10](#). Records were sourced from both hospitals, with 143 (54.2%) from North Shore Hospital and the remainder from Waitākere Hospital.

**Table 10**

*Demographic Characteristics of the Total Population*

| Category                          | Total Population<br>(N = 264) | Māori (n = 42) | non-Māori (n = 222) |
|-----------------------------------|-------------------------------|----------------|---------------------|
| <b>Demographics</b>               |                               |                |                     |
| Age (Years) Median [ <i>IQR</i> ] | 60 [44-73]                    | 51.5 [29.8-63] | 61 [47.3-74]        |
| Female n (%)                      | 160 (60.6)                    | 26 (61.9)      | 134 (60.4)          |
| <b>Ethnicity n (%)</b>            |                               |                |                     |
| European                          | 110 (41.7)                    |                |                     |
| Asian                             | 82 (31.1)                     |                |                     |
| Māori                             | 42 (15.9)                     |                |                     |
| Pacific Peoples                   | 21 (8.0)                      |                |                     |
| Other                             | 9 (3.4)                       |                |                     |

#### **4.6.3 Emergency Department Service Delivery and System Performance**

Initial clinical assessments were most commonly conducted by senior emergency medicine physicians (57.6%; *n* = 152), followed by registrars (24.6%; *n* = 65) and junior doctors (13.3%; *n* = 35). Clinician role was not documented in 4.5% of records (*n* = 12) ([Table 11](#)). Australasian Triage Scale (ATS) categories ranged from ATS 2 to ATS 4. Most patients were triaged as ATS 3 (79.2%; *n* = 209), with a smaller proportion classified as ATS 2 (2.3%; *n* = 6). The median ED length of stay for the overall cohort was 299 minutes (*IQR* 211–395). Patients with a peripheral vestibular diagnosis had a median length of stay of 275 minutes (*IQR* 191–357), compared with 404 minutes (*IQR* 340–637) for those with a central vestibular diagnosis. Most patients were discharged directly from the ED (90.5%; *n* = 239), while 25 (9.5%) required inpatient admission. Admission rates were higher in the physiotherapy-paired cohort (16.3%; *n* = 8) than in the non-physiotherapy cohort (7.9%; *n* = 17). The 72-hour re-presentation rate was 3% (*n* = 8).

**Table 11**

*Clinician Involvement and Primary Outcomes for Patients with Acute Dizziness and Vertigo, Stratified by Ethnicity (n = 264)*

| Category                            | Total Population<br>(n = 264)<br>n (%) | Māori<br>(n = 42)<br>n (%) | non-Māori<br>(n = 222)<br>n (%) |
|-------------------------------------|----------------------------------------|----------------------------|---------------------------------|
| Physiotherapist                     | 49 (18.6)                              | 3 (7.1)                    | 46 (20.7)                       |
| <b>First Seen By</b>                |                                        |                            |                                 |
| Senior emergency medicine physician | 152 (57.6)                             | 32 (76.2)                  | 120 (54.1)                      |
| Registrar                           | 65 (24.6)                              | 6 (14.3)                   | 59 (26.6)                       |
| Junior doctor                       | 35 (13.3)                              | 2 (4.7)                    | 33 (14.7%)                      |
| Unknown clinician role              | 12 (4.5)                               | 2 (4.7)                    | 10 (4.5)                        |
| <b>Outcomes</b>                     |                                        |                            |                                 |
| Admit to ward                       | 25 (9.5)                               | 2 (4.8)                    | 23 (10.4)                       |
| ED Length of Stay (mins)            | *299 [211-395]                         | *277 [196-406]             | *304 [217-395]                  |
| Re-presentation (72 hours)          | 8 (3.0)                                | 0                          | 8 (3.6)                         |

*Note.* Median ED Length of stay in minutes; \*Minutes [Interquartile Range]; Physiotherapist involvement is in addition to an emergency medicine physician, who first consulted with all patients.

**Comparative Distribution of Medical Diagnoses by Management Pathway:** Diagnoses were assigned by emergency medicine physicians. Most presentations were classified as peripheral vestibular disorders (64.8%;  $n = 171$ ), followed by dizziness of uncertain origin (17.0%;  $n = 45$ ), central vestibular disorders (11.4%;  $n = 30$ ), and other diagnoses (6.8%;  $n = 18$ ) ([Table 12](#)). Within the peripheral vestibular group, 44.4% of cases ( $n = 76$ ) were recorded without further diagnostic specification beyond a general “peripheral” label.

The ED physiotherapy service was utilised more frequently in cases classified as central or of uncertain origin compared with those managed solely by emergency physicians ([Table 12](#)). Among patients seen by physiotherapy, 49.0% ( $n = 24$ ) had a peripheral vestibular diagnosis and 28.6% ( $n = 14$ ) had a central diagnosis. By comparison, central diagnoses were documented in 7.4% ( $n = 16$ ) of patients managed without physiotherapy input. Cases of uncertain origin were also more common in the physiotherapy group (22.4%;  $n = 11$ ) than in the non-physiotherapy group (15.8%;  $n = 34$ ).

**Physiotherapy Service Integration and Characteristics of the Paired Assessment Cohort:** Of the total cohort ( $n = 264$ ), 49 patients (18.6%) received a paired assessment by both an emergency physician and the ED physiotherapy service. This subgroup formed the basis for paired analyses of diagnostic and intervention concordance. The physiotherapy service was available 31.3% of the time compared with continuous (24-hour) emergency physician coverage. Most presentations (62.5%;  $n = 165$ ) occurred during physiotherapy operating hours. Within the paired cohort, more records were

sourced from North Shore Hospital ( $n = 32$ ) than Waitākere Hospital ( $n = 17$ ). The demographic characteristics of this subgroup were otherwise consistent with the overall study population.

**Table 12**

*Comparative Distribution of Medical Diagnoses between Physiotherapy-Managed and Non-Physiotherapy Cohorts ( $n = 264$ )*

| Diagnostic Classification by<br>Emergency Medicine | ED Physiotherapy and EM<br>( $n = 49$ )<br>$n$ (%) | Emergency Medicine only<br>( $n = 215$ )<br>$n$ (%) |
|----------------------------------------------------|----------------------------------------------------|-----------------------------------------------------|
| Peripheral                                         | 24 (49.0)                                          | 147 (68.4)                                          |
| Central                                            | 14 (28.6)                                          | 16 (7.4)                                            |
| Uncertain                                          | 11 (22.4)                                          | 34 (15.8)                                           |
| Other                                              | nil                                                | 18 (8.4)                                            |

*Note.* ED Physiotherapy cohort is a paired sample with Emergency Medicine (EM)

#### 4.6.4 Clinical Practice Alignment with Evidence-Based Guidelines

This section presents findings addressing Research Question 1.

##### Research Question 1:

How do emergency department practices at North Shore Hospital and Waitākere Hospital align with evidence-based guidelines for the assessment and management of acute dizziness and vertigo, and are there differences in alignment between emergency medicine physicians and ED physiotherapists?

Overall alignment with evidence-based quality indicators was variable across both diagnostic assessment and management domains. To provide a structured evaluation, findings are presented across four clinical areas that reflect key stages in the clinical pathway:

- a) **Initial triage and secondary screening:** Assessment of symptom characterisation and use of gait and balance screening.
- b) **Management of acute vestibular syndrome:** Documentation of the HINTS-plus battery (Head Impulse, Nystagmus, Test of Skew, plus hearing).
- c) **Management of BPPV:** Use of positional testing (Dix–Hallpike and supine roll) and implementation of canalith repositioning manoeuvres and pharmacological management.
- d) **Resource allocation and clinical disposition:** Use of vestibular referrals, CT imaging, and MRI.

#### 4.6.5 Initial Triage and Secondary Screening

Documentation of the temporal and provocative characteristics of vestibular presentations was recorded in 54.9% of cases ( $n = 145$ ; 95% CI 48.9, 60.8). Assessment of gait and postural stability was the most frequently documented clinical measure across the cohort (70.5%;  $n = 186$ ;

95% CI 64.7, 75.6). As shown in [Table 13](#), documentation rates differed between professional groups. The physiotherapy-included cohort demonstrated higher rates of symptom characterisation (71.4% vs 48.9%) and gait assessment (91.8% vs 62.1%) compared with records managed by emergency medicine alone.

**Table 13:**

*Alignment with Evidence-Based Clinical Guidelines for Initial Triage and Secondary Screening Metrics Across Professional Cohorts (n = 264)*

| Category                            | Total ED cohort<br>(n = 264)<br>n (%; [95% CI]) | Medical Records<br>(n= 264)<br>n (%; [95% CI]) | ED Physiotherapy<br>Records (n = 49)<br>n (%; [95% CI]) |
|-------------------------------------|-------------------------------------------------|------------------------------------------------|---------------------------------------------------------|
| <b>Initial Triage &amp; History</b> |                                                 |                                                |                                                         |
| Symptom Timing & Triggers           | 145 (54.9; [48.9, 60.8])                        | 129 (48.9; [42.9, 54.9])                       | 35 (71.4; [57.5, 82.2])                                 |
| <b>Secondary Physical Screen</b>    |                                                 |                                                |                                                         |
| Gait / Postural Stability           | 186 (70.5; [64.7, 75.6])                        | 164 (62.1; [56.1, 67.8])                       | 45 (91.8; [80.3, 97.3])                                 |

#### **4.6.6 Management of Acute Vestibular Syndrome**

Documentation of evidence-based assessment for suspected acute vestibular syndrome was low ([Table 14](#)). Complete HINTS or HINTS-plus examinations (head impulse, nystagmus, test of skew, plus hearing) were documented in 9.5% of records (n = 25; 95% CI 6.5, 13.7).

Individual components of the HINTS examination were documented more frequently. Nystagmus assessment was recorded in 79.5% of cases (n = 210; 95% CI 74.3, 84.0), and was considered adequately described in 88.1% of those cases (n = 185/210). Assessment of acute hearing loss, required to complete the HINTS-plus protocol, was infrequently documented (6.1%; n = 16; 95% CI 3.7, 9.7).

**Table 14**

*Alignment with Evidence-Based Clinical Guidelines for Acute Vestibular Syndrome Assessment Across Professional Cohorts (n = 264)*

| Category                             | Total ED cohort<br>(n = 264)<br>n (%; [95% CI]) | Medical Records<br>(n = 264)<br>n (%; [95% CI]) | ED Physiotherapy<br>Records (n = 49)<br>n (%; [95% CI]) |
|--------------------------------------|-------------------------------------------------|-------------------------------------------------|---------------------------------------------------------|
| <b>HINTS+</b>                        |                                                 |                                                 |                                                         |
| Adequately Completed<br>HINTS/HINTS+ | 25 (9.5; [6.5, 13.7])                           | 7 (2.7; [1.2, 5.5])                             | 20 (40.8; [28.2, 54.8])                                 |
| Nystagmus                            | 185 (70.1; [64.3, 75.3])                        | 170 (64.4; [58.5, 69.9])                        | 47 (95.9; [85.5, 99.7])                                 |
| Head Impulse Test                    | 63 (23.9; [19.1, 29.4])                         | 21 (8.0; [5.2, 11.9])                           | 47 (95.9; [85.5, 99.7])                                 |
| Test of Skew                         | 74 (28.0; [23.0, 33.7])                         | 37 (14.0; [10.3, 18.8])                         | 46 (93.9; [82.9, 98.5])                                 |
| Finger Rub Hearing<br>Screen         | 16 (6.1; [3.7, 9.7])                            | 8 (3.0; [1.4, 6.0])                             | 11 (22.5; [12.9, 36.0])                                 |

**HINTS/HINTS-plus Assessment Utilisation:** Adherence to evidence-based documentation varied across metrics between professional groups ([Table 15](#)). For complete HINTS or HINTS-plus examinations, the overall discordance rate was 36.7% (95% CI 24.6, 50.8). This discordance was entirely unidirectional, with all discrepant assessments documented only by physiotherapists, resulting in a physiotherapy-only discordance of 36.7% (95% CI 24.6, 50.8). Differences were more pronounced for individual components of the HINTS examination. The head impulse test and test of skew demonstrated high discordance rates of 85.7% (95% CI 73.3, 93.0) and 73.5% (95% CI 59.7, 83.9), respectively. In both cases, discordance was again unidirectional, with documentation occurring only in physiotherapy records.

Agreement was higher for nystagmus assessment and finger rub hearing screens (63.3% and 69.4%, respectively). However, differences between groups remained evident, with physiotherapy-inclusive records showing higher documentation of nystagmus characterisation (32.7% vs 4%) and hearing assessment (16.3% vs 14.3%). These findings indicate differences in documentation of evidence-based assessment practices between emergency medicine and ED physiotherapy records.

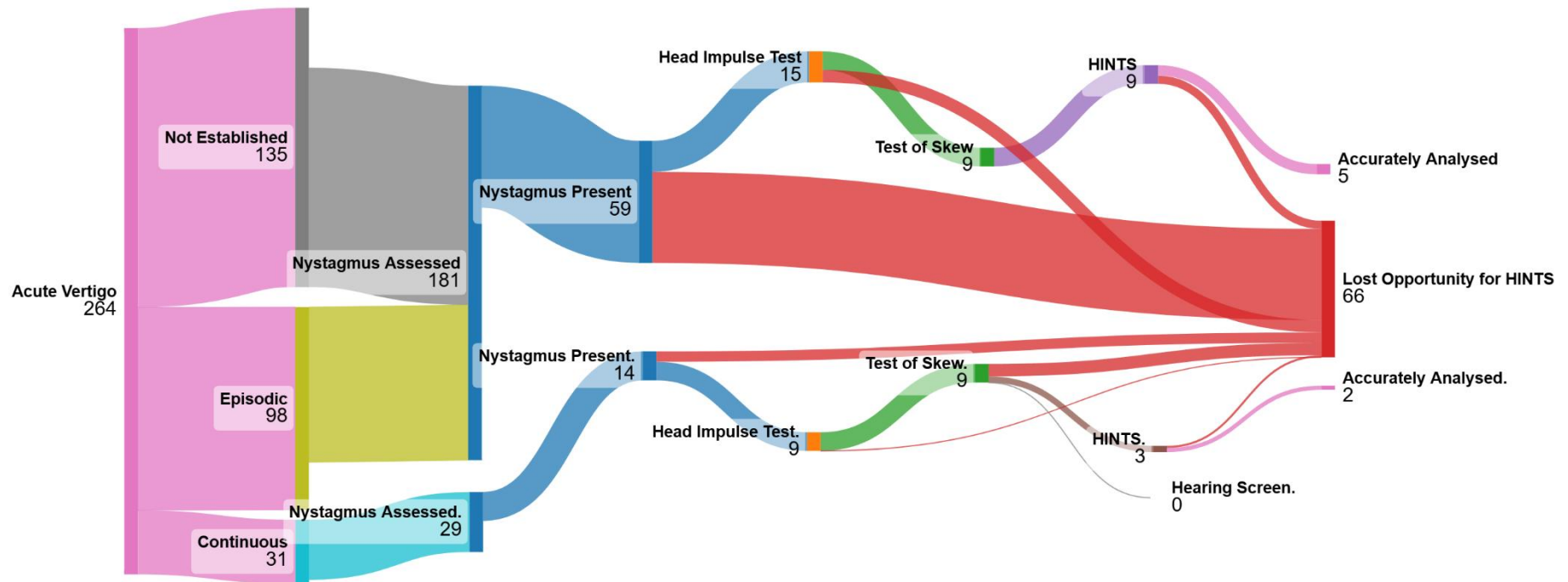
**Standard Medical Care Pathway and Utilisation of HINTS-plus:** Clinical eligibility for the HINTS examination was identified in 73 records based on documentation of spontaneous nystagmus by emergency medicine physicians. Among these, a complete HINTS or HINTS-plus assessment was recorded in 7 cases (9.6% of the eligible subset; 2.7% of the total cohort; 95% CI 1.2, 5.5). In the remaining 66 eligible presentations, a HINTS-based assessment was not documented. [Figure 11](#) illustrates the progression of emergency physician assessments from initial symptom characterisation to nystagmus identification and subsequent components of the HINTS-plus protocol.

**Table 15***Inter-professional Agreement and Discordance in HINTS-plus Documentation: A Paired Analysis (n = 49)*

| <b>Category</b>                              | <b>Agreement Rate</b> | <b>Overall<br/>Discordance Rate</b> | <b>Physio-only Yield</b> | <b>EM-only yield</b> |
|----------------------------------------------|-----------------------|-------------------------------------|--------------------------|----------------------|
|                                              | % [95% CI]            | % [95% CI]                          | % [95% CI]               | % [95% CI]           |
| <b>Adequately Completed<br/>HINTS/HINTS+</b> | 63.3 [49.2, 75.4]     | 36.7 [24.6, 50.8]                   | 36.7 [24.6, 50.8]        | 0 [0.0, 7.3]         |
| <b>Nystagmus</b>                             | 63.3 [49.2, 75.4]     | 36.7 [24.6, 50.8]                   | 32.7 [21.2, 46.7]        | 4 [0.4, 14.5]        |
| <b>Head Impulse Test</b>                     | 14.3 [6.8, 27.0]      | 85.7 [73.0, 93.2]                   | 85.7 [73.0, 93.2]        | 0 [0.0, 7.3]         |
| <b>Test of Skew</b>                          | 26.5 [16.1, 40.4]     | 73.5 [59.6, 83.9]                   | 73.5 [59.6, 83.9]        | 0 [0.0, 7.3]         |
| <b>Finger Rub Hearing<br/>Screen</b>         | 69.4 [55.4, 80.6]     | 30.6 [19.4, 44.6]                   | 16.3 [8.2, 29.3]         | 14.3 [6.8, 26.9]     |

**Figure 11**

*Emergency Medicine Physicians Documentation Nystagmus Assessment and HINTS-plus Utilisation in Acute Dizziness and Vertigo Presentations*



**Note.** This Sankey diagram illustrates the implementation fidelity of the HINTS+ examination across sequential clinical metrics. The flow identifies the attrition of diagnostic potential from the initial nystagmus assessment through to the completion of the “plus” (hearing) component. Data are representative of emergency medicine physician clinical records, ( $n = 264$ ) within the clinical audit of the metropolitan Auckland ED setting. Subjective categorisation of symptom pattern is represented by; Not Established, Episodic or Continuous.

#### 4.6.7 Management of Benign Paroxysmal Positional Vertigo

Documentation of positional testing for BPPV was recorded in 39.4% of presentations ( $n = 104$ ; 95% CI 33.7, 45.4), with adequate documentation in 23.5% ( $n = 62$ ; 95% CI 18.8, 29.0) (Table 16). The Dix–Hallpike test was documented in 38.3% of cases ( $n = 101$ ; 95% CI 32.6, 44.3), compared with 15.9% for the supine roll test ( $n = 42$ ; 95% CI 12.0, 20.8).

Among emergency medicine records, positional testing was documented in 26.1% of cases (95% CI 21.2, 31.8), all of which involved the Dix–Hallpike test ( $n = 69$ ). No supine roll tests were documented. In contrast, ED physiotherapy records demonstrated higher documentation rates for positional testing (87.8%;  $n = 43$ ; 95% CI 75.4, 94.6), including the Dix–Hallpike test (81.6%;  $n = 40$ ; 95% CI 68.4, 90.3) and the supine roll test (85.7%;  $n = 42$ ; 95% CI 73.0, 93.2).

**Table 16**

*Alignment with Evidence-Based Clinical Guidelines for Benign Paroxysmal Positional Vertigo Assessment Across Professional Cohorts ( $n = 264$ )*

| Category                              | Total ED cohort<br>( $n = 264$ )<br>$n$ (%; [95% CI]) | Medical Records<br>( $n = 264$ )<br>$n$ (%; [95% CI]) | ED Physiotherapy<br>Records ( $n = 49$ )<br>$n$ (%; [95% CI]) |
|---------------------------------------|-------------------------------------------------------|-------------------------------------------------------|---------------------------------------------------------------|
| <b>BPPV</b>                           |                                                       |                                                       |                                                               |
| Positional                            |                                                       |                                                       |                                                               |
| Assessment for BPPV                   | 104 (39.4; [33.7, 45.4])                              | 69 (26.1; [21.2, 31.8])                               | 43 (87.8; [75.4, 94.6])                                       |
| Dix-Hallpike Test                     | 101 (38.3; [32.6, 44.3])                              | 69 (26.1; [21.2, 31.8])                               | 40 (81.6; [68.4, 90.3])                                       |
| Supine Roll Test                      | 42 (15.9; [12.0, 20.8])                               | 0 (0.0; [0.0, 1.7])                                   | 42 (85.7; [73.0, 93.2])                                       |
| BPPV Assessment Adequately Documented | 62 (23.5; [18.8, 29.0])                               | 42 (15.9; [12.0, 20.8])                               | 43 (87.8; [75.4, 94.6])                                       |

**Comparative Analysis for BPPV Diagnostic Metrics:** The overall discordance rate was high and equivalent to the physiotherapy-only discordance (Table 17), indicating that all discordant assessments were documented exclusively in physiotherapy records. The supine roll test demonstrated the lowest level of interprofessional agreement (14.3%; 95% CI 6.8, 27.0), with a corresponding physiotherapy-only documentation rate of 85.7% (95% CI 73.0, 93.2). Agreement for adequately documented BPPV assessment was observed in 20.4% of encounters (95% CI 11.3, 33.8), with a physiotherapy-only documentation rate of 79.6% (95% CI 66.2, 88.7).

**Table 17***Inter-professional Agreement and Discordance in BPPV Assessment and Management: A Paired Analysis (n = 49)*

| <b>Category</b>                              | <b>Agreement Rate</b> | <b>Overall Discordance Rate</b> | <b>Physio-only Yield</b> | <b>EM-only yield</b> |
|----------------------------------------------|-----------------------|---------------------------------|--------------------------|----------------------|
|                                              | % [95% CI]            | % [95% CI]                      | % [95% CI]               | % [95% CI]           |
| <b>Positional Assessment for BPPV</b>        | 28.6 [17.8, 42.5]     | 71.4 [57.5, 82.2]               | 71.4 [57.5, 82.2]        | 0 [0.0, 7.3]         |
| <b>Dix-Hallpike Test</b>                     | 34.7 [22.9, 48.7]     | 65.3 [51.3, 77.1]               | 65.3 [51.3, 77.1]        | 0 [0.0, 7.3]         |
| <b>Supine Roll Test</b>                      | 14.3 [6.8, 27.0]      | 85.7 [73.0, 93.2]               | 85.7 [73.0, 93.2]        | 0 [0.0, 7.3]         |
| <b>BPPV Assessment Adequately Documented</b> | 20.4 [11.3, 33.8]     | 79.6 [66.2, 88.7]               | 79.6 [66.2, 88.7]        | 0 [0.0, 7.3]         |
| <b>CRM Performed Adequately</b>              | 69.4 [55.4, 80.6]     | 30.6 [19.4, 44.6]               | 30.6 [19.4, 44.6]        | 0 [0.0, 7.3]         |

*Note.* Physio-only yield represents the percentage of cases where only the ED Physiotherapist performed the specific metric. In this dataset, there were zero instances of emergency medicine physician (EM)-only yield for these categories.

**Benign Paroxysmal Positional Vertigo Interventions:** Vestibular suppressant medications were documented in 84.6% of cases (95% CI 74.9, 91.1), compared with 26.9% for canalith repositioning manoeuvres (95% CI 18.3, 37.7). Differences in management between professional groups are presented in [Table 18](#). Among patients managed by the ED physiotherapy service ( $n = 16$ ), canalith repositioning manoeuvres were documented in 100% of cases (95% CI 77.3, 100). In contrast, 19.2% of patients managed by emergency medicine alone received a canalith repositioning manoeuvre ( $n = 15$ ; 95% CI 11.9, 29.5). Agreement in the documentation of canalith repositioning manoeuvres was higher than for diagnostic metrics, with an agreement rate of 69.4% (95% CI 55.4, 80.6) ([Table 17](#)).

**Table 18**

*Professional Alignment with BPPV Intervention Guidelines within Clinician-Specific Diagnosed Cohorts*

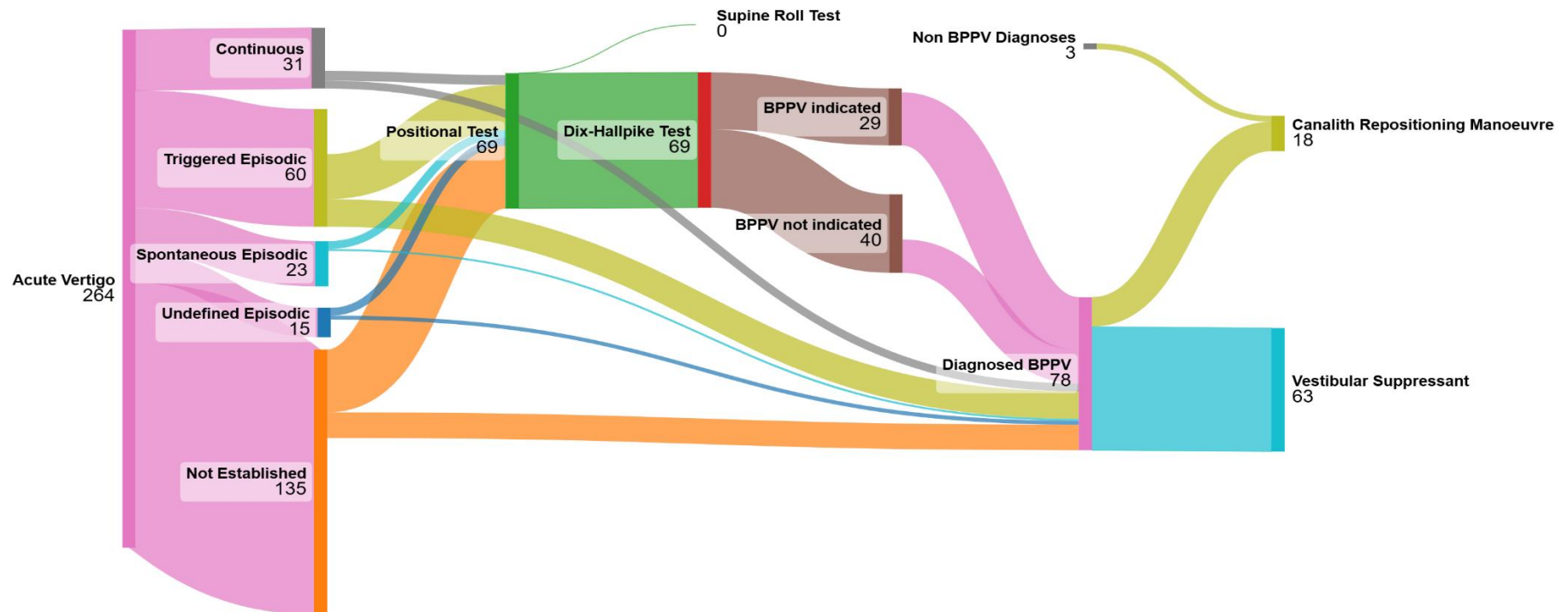
| Category                       | Total ED cohort of Medically Diagnosed BPPV ( $n = 78$ )<br>$n$ (%; [95% CI]) | Medical Records of Diagnosed BPPV ( $n = 78$ )<br>$n$ (%; [95% CI]) | ED Physiotherapy Records of PT Diagnosed BPPV ( $n = 16$ )<br>$n$ (%; [95% CI]) |
|--------------------------------|-------------------------------------------------------------------------------|---------------------------------------------------------------------|---------------------------------------------------------------------------------|
| <b>BPPV</b>                    |                                                                               |                                                                     |                                                                                 |
| CRM in diagnosed BPPV          | 21 (26.9; [18.3, 37.7])                                                       | 15 (19.2; [11.9, 29.5])                                             | 16 (100; [77.3, 100])                                                           |
| Vestibular suppressant in BPPV | 66 (84.6; [74.9, 91.1])                                                       | 66 (84.6; [74.9, 91.1])                                             | N/A                                                                             |

*Note.* Vestibular suppressant prescription is outside of the scope of physiotherapy, therefore data describing vestibular suppressant use was not attributed to the ED physiotherapy dataset. CRM = canalith repositioning manoeuvre.

**BPPV Diagnosed Cohort Analysis:** Within the emergency medicine cohort, 78 presentations (29.5% of the total sample;  $n = 264$ ) were assigned a diagnosis of BPPV. Among these, 27 cases (34.6%) included documentation of a positional assessment consistent with BPPV. In the remaining 51 cases (66.4%), a BPPV diagnosis was recorded without documentation of a confirmatory positional test. In 17 records, positional testing was documented as negative for BPPV but a diagnosis of BPPV was subsequently recorded. In addition, the overall frequency of BPPV diagnoses ( $n = 78$ ; 29.5%) exceeded the number of documented positional assessments ( $n = 69$ ; 26.1%). Within the BPPV-diagnosed cohort, canalith repositioning manoeuvres were documented in 19.2% of cases ( $n = 15$ ; 95% CI 11.9, 29.5), while vestibular suppressant medications were recorded in 84.6% ( $n = 66$ ; 95% CI 74.9, 91.1). Emergency medicine physicians also documented three canalith repositioning manoeuvres in patients without a recorded BPPV diagnosis. [Figure 12](#) illustrates patterns of BPPV assessment and management within emergency medicine practice.

**Figure 12**

*Emergency Medicine Benign Paroxysmal Positional Vertigo Diagnostic Pathway and Management*



**Note.** This Sankey diagram details the care pathways for patients presenting with suspected BPPV, mapping the progression from initial assessment to positional testing and the subsequent therapeutic interventions recorded. The visualisation highlights the attrition of evidence-aligned care and represents audited data from emergency medicine physician clinical records ( $n = 264$ ) within the Auckland metropolitan ED setting. Subjective categorisation of symptom pattern is represented by; Not Established, Continuous or a variant of Episodic.

#### 4.6.8 Neuroimaging and Vestibular Referral

CT was performed in 48.1% of the total cohort ( $n = 127$ ; 95% CI 42.2, 54.1). Among patients with a diagnosis of BPPV, CT imaging was documented in 25.6% of cases ( $n = 20$ ; 95% CI 17.2, 36.4). The diagnostic yield for acute pathology among CT scans was 3.1% ( $n = 4/127$ ). For presentations classified as unilateral vestibular hypofunction ( $n = 17$ ), CT imaging was performed in 17.6% of cases ( $n = 3$ ), a lower proportion than observed in the BPPV cohort. The overall referral rate for vestibular follow-up was 14.8% ( $n = 39$ ; 95% CI 11.0, 19.6). As detailed in [Table 19](#), referrals were more frequently documented in the physiotherapy group (53.0%;  $n = 26$ ) compared with the medical-only group (6.1%;  $n = 16$ ).

**Table 19**

*Alignment with Evidence-Based Clinical Guidelines for Diagnostics and Disposition Across Professional Cohorts (N = 264)*

| Category                             | Total ED cohort<br>( $n = 264$ )<br>$n$ (%; [95% CI]) | Medical Records<br>( $n = 264$ )<br>$n$ (%; [95% CI]) | ED Physiotherapy<br>Records ( $n = 49$ )<br>$n$ (%; [95% CI]) |
|--------------------------------------|-------------------------------------------------------|-------------------------------------------------------|---------------------------------------------------------------|
| <b>Diagnostics &amp; Disposition</b> |                                                       |                                                       |                                                               |
| Referral vestibular follow up        | 39 (14.8; [11.0, 19.6])                               | 16 (6.1; [3.7, 9.7])                                  | 26 (53.0; [39.4, 66.3])                                       |
| CT imaging                           | 127 (48.1; [42.2, 54.1])                              | 127 (48.1; [42.2, 54.1])                              | N/A                                                           |
| MRI                                  | 13 (4.9; [2.8, 8.3])                                  | 13 (4.9; [2.8, 8.3])                                  | N/A                                                           |

*Note.* MRI May not have occurred while patient was in the ED, at minimum was arranged in the ED setting.

#### 4.6.9 Equity of Care

This section presents findings related to Research Question 2.

##### Research Question 2:

At North Shore Hospital and Waitākere Hospital, what is the level of adherence to evidence-based guidelines for acute dizziness and vertigo management in Māori and non-Māori patients, and how do ED outcomes differ between these groups?

**Sample composition:** Of the 1,595 presentations identified, 10.5% were Māori ( $n = 168$ ). Following application of exclusion criteria, 43 Māori records (6.0%) remained eligible for clinical audit. In the final sample ( $n = 264$ ), disproportionate stratified sampling resulted in 15.9% Māori representation ( $n = 42$ ). Exclusion criteria resulted in removal of 75.0% of Māori records ( $n = 126$ ) and 54.2% of non-Māori records ( $n = 774$ ) ([Figure 10](#)). Among the 721 records initially eligible for screening, only three Māori patients were documented as having received ED physiotherapy input.

**Clinical characteristics:** Māori patients had a median ED length of stay of 277 minutes (*IQR* 196–406), compared with 304 minutes (*IQR* 217–395) for non-Māori patients. A lower proportion of Māori patients were admitted to an inpatient ward (4.8%;  $n = 2$ ) compared with non-Māori patients (10.4%;  $n = 23$ ) ([Table 11](#))

**Clinician access:** Māori patients were more frequently assessed by senior emergency medicine physicians. However, access to ED physiotherapy differed between groups, with 6.1% of Māori patients ( $n = 3$ ) and 20.7% of non-Māori patients ( $n = 46$ ) receiving physiotherapy input ([Table 11](#)).

**Clinical quality and guideline adherence:** Across 13 of 16 assessed metrics, Māori patients had lower rates of documented evidence-based assessment and treatment ([Table 20](#)). For example, adequately documented BPPV assessment occurred in 11.9% of Māori cases ( $n = 5$ ; 95% CI 4.7, 25.5), compared with 26.1% in non-Māori cases ( $n = 58$ ; 95% CI 20.8, 32.3). Full comparisons of clinical metrics and outcomes between groups are presented in Table 20.

**Table 20**

*Equity Analysis of Diagnostic and Therapeutic Adherence: A Comparison of Practice Patterns for Māori and Non-Māori Patients.*

| Category                                  | Non-Māori $n=222$<br>$n$ (%)         | Māori $n=42$<br>$n$ (%)              |
|-------------------------------------------|--------------------------------------|--------------------------------------|
| <b>Initial Triage &amp; History</b>       |                                      |                                      |
| Symptom timing characteristic established | 122 (55.0; [48.4, 61.4])             | 24 (57.1; [42.2, 70.9])              |
| <b>HINTS+</b>                             |                                      |                                      |
| Adequately completed HINTS/HINTS+         | 22 (9.9; [6.6, 14.6])                | 3 (7.1; [1.8, 19.7])                 |
| Nystagmus                                 | 158 (71.2; [64.9, 76.7])             | 29 (69.0; [53.9, 81.0])              |
| Head impulse test                         | 66 (29.7; [24.1, 36.1])              | 7 (16.7; [8.0, 30.9])                |
| Test of skew                              | 60 (27.0; [21.6, 33.2])              | 10 (23.8; [13.3, 38.7])              |
| Finger rub hearing screen                 | 16 (7.2; [4.4, 11.5])                | 1 (2.4; [0.0, 13.4])                 |
| <b>Secondary Physical Screen</b>          |                                      |                                      |
| Gait unsteadiness                         | 153 (68.9; [62.5, 74.7])             | 32 (76.2; [61.3, 86.7])              |
| <b>BPPV Assessment</b>                    |                                      |                                      |
| Positional assessment for BPPV            | 91 (41.0; [34.7, 47.6])              | 12 (28.6; [17.1, 43.7])              |
| Dix-Hallpike test                         | 91 (41.0; [34.7, 47.6])              | 11 (26.2; [15.2, 41.2])              |
| Supine roll test                          | 40 (18.0; [13.5, 23.6])              | 3 (7.1; [1.8, 19.7])                 |
| BPPV assessment adequately documented     | 58 (26.1; [20.8, 32.3])              | 5 (11.9; [4.7, 25.5])                |
| <b>BPPV Intervention</b>                  |                                      |                                      |
| CRM in diagnosed BPPV population          | 19 (29.2; [19.5, 41.3]) <sup>b</sup> | 2 (15.4; [3.1, 43.5]) <sup>b</sup>   |
| Vestibular suppressant in BPPV population | 52 (80; [68.6, 88.1]) <sup>b</sup>   | 11 (84.6; [56.5, 96.9]) <sup>b</sup> |
| <b>Diagnostics &amp; Disposition</b>      |                                      |                                      |
| Referral vestibular follow Up             | 16 (7.2; [4.4, 11.5])                | 1 (2.4; [0.0, 13.4])                 |
| CT imaging                                | 111 (50; [43.5, 56.5])               | 18 (42.9; [29.1, 57.8])              |
| MRI                                       | 11 (5.0; [2.7, 8.8])                 | 1 (2.4; [0.0, 13.4])                 |

Note. b = BPPV Intervention group with sample of diagnosed BPPV ( $n = 78$ ) Diagnosed BPPV in non-Māori ( $n = 65$ ), diagnosed BPPV in Māori ( $n = 13$ ).

#### **4.6.10 Summary of Key Findings**

Overall adherence to evidence-based clinical metrics for acute dizziness and vertigo varied across both hospital sites. Differences in practice patterns were observed between clinician groups ([Figure 13](#)). Within emergency medicine records, documentation of bedside vestibular assessment was low across several metrics, while pharmacological management was frequently recorded. Vestibular suppressant medications (e.g., prochlorperazine and cyclizine) were commonly documented, including in cases where a peripheral vestibular diagnosis was assigned. The diagnostic yield of computed tomography was 3.1%.

ED physiotherapy records demonstrated higher rates of documentation across multiple evidence-based clinical metrics. Individual components of the HINTS examination were frequently recorded; however, complete HINTS or HINTS-plus assessments were less commonly documented. All physiotherapy-managed cases of BPPV included documentation of canalith repositioning manoeuvres, and a substantial proportion of presentations were referred for vestibular follow-up.

Differences were also observed between Māori and non-Māori cohorts. Māori patients had lower rates of documented adherence across multiple clinical metrics and were less likely to receive ED physiotherapy input compared with non-Māori patients.

**Figure 13**

*Concordance to Evidence-Based Clinical Metrics Between; Emergency Medicine Physicians and ED Physiotherapist, and Māori and non-Māori Cohorts*

|                                             | Emergency<br>Medicine | ED Physiotherapy | Māori | Non-Māori |
|---------------------------------------------|-----------------------|------------------|-------|-----------|
| Established pattern of dizziness            | 49%                   | 71%              | 57%   | 55%       |
| Adequately completed<br>HINTS/HINTS+        | 8%                    | 41%              | 7%    | 10%       |
| Nystagmus                                   | 64%                   | 96%              | 69%   | 71%       |
| Head impulse test                           | 8%                    | 96%              | 17%   | 30%       |
| Test of skew                                | 14%                   | 94%              | 24%   | 27%       |
| Finger rub hearing screen                   | 3%                    | 22%              | 2%    | 7%        |
| Gait unsteadiness                           | 62%                   | 92%              | 76%   | 69%       |
| Positional assessment for BPPV              | 26%                   | 88%              | 29%   | 41%       |
| Dix-Hallpike                                | 26%                   | 82%              | 26%   | 41%       |
| Supine roll test                            | 0%                    | 86%              | 7%    | 18%       |
| BPPV assessment adequately<br>documented    | 16%                   | 88%              | 12%   | 26%       |
| CRM in diagnosed BPPV                       | 19%                   | 100%             | 15%   | 29%       |
| Vestibular suppressant in BPPV<br>diagnosed | 85%                   | N/A              | 85%   | 80%       |
| Referral to vestibular follow up            | 6%                    | 53%              | 2%    | 7%        |
| CT imaging                                  | 48%                   | N/A              | 43%   | 50%       |
| MRI                                         | 5%                    | N/A              | 2%    | 5%        |

## 4.7 Discussion

This study aimed to describe current clinical practice in Aotearoa New Zealand for patients presenting to the ED with acute dizziness and vertigo. To guide the reader through the dense multi-faceted data generated by this study, the discussion is systematically structured into four progressive thematic frameworks.

The first section establishes the methodological boundaries and baseline operational metrics of the research. It evaluates the initial study design, analyses data fidelity and extraction reliability, and frames these departmental findings and diagnostic patterns against established international literature. The second section addresses the first primary research question by examining clinical presentation patterns and diagnostic behaviours within the emergency department. This includes an in-depth critique of acute vestibular syndrome assessment, BPPV evaluation and management, and clinical imaging utilisation, culminating in an appraisal of how local clinical practice aligns with current evidence-based guidelines.

Building upon this clinical baseline, the third section provides a critical evaluation of the GRACE-3 guidelines, which serve as a central evaluative benchmark for this thesis. This critique informs a comparative analysis of clinical quality between distinct professional roles, directly addressing the secondary dimensions of the first research question regarding workforce optimisation. Finally, the chapter shifts from localised operational metrics to systemic evaluation, dedicating its fourth section to the third research question regarding health equity. The discussion then concludes by transparently outlining the limitations of the clinical audit, proposing clear future research directions, and articulating the immediate clinical and policy implications for acute vestibular service design.

Consistent with international literature describing the complexity of this patient group, the findings indicate challenges in aligning emergency department care with evidence-based standards (Bradshaw et al., 2023; Kerber & Newman-Toker, 2015; Ohle et al., 2020). Physiotherapy input was associated with higher rates of documented assessment and intervention, as reflected in agreement and discordance patterns ([Tables 14, 15 and 16, 17](#)). This was most evident in BPPV management, where physiotherapy records showed higher use of positional testing and canalith repositioning manoeuvres. More broadly, ED physiotherapy contributed additional documented assessments and interventions within the department. This is reflected in increased documentation of vestibular assessments and higher rates of referral for further vestibular follow-up.

Previous studies have reported the effectiveness of physiotherapists in managing BPPV (Lloyd, Luscombe, et al., 2020; Neely et al., 2021). However, these studies primarily focused on BPPV and provided limited detail on specific diagnostic manoeuvres. Another focused on acute vestibular syndrome, but not BPPV (Stewart et al., 2022). This study extends existing evidence by examining a broader range of vestibular presentations and capturing variation in clinical practice across multiple diagnostic approaches.

Our study is one of the first in New Zealand to provide a descriptive account of vestibular care for a Māori population. Through purposive sampling, Māori patients were included in sufficient numbers to enable comparative analysis. However, the relatively small sample size ( $n = 42$ ) limits the precision of these estimates and highlights the need for further research in this area.

Differences between Māori and non-Māori patients were also observed. Māori patients had lower rates of documented assessment and treatment across multiple clinical metrics. In addition, Māori patients were less likely to receive ED physiotherapy input. Access to ED physiotherapy was low for Māori patients within the study sample. Interpretation of physiotherapy access requires consideration of both population characteristics and clinical need. The Māori population within the Waitematā region is approximately 10% (Waitematā Annual Report, 2021/22). Equitable care requires that access to services reflects not only population distribution but also clinical need, which may necessitate allocation of resource exceeding simple demographic parity (Treaty of Waitangi Tribunal, 2019). These findings indicate that Māori patients had lower access to a service associated with higher rates of documented evidence-based care. This difference in access may contribute to the observed variation in clinical documentation and management between Māori and non-Māori patients.

#### **4.7.1 Study Design**

**Methodological Justification: The Retrospective Audit as Systemic Lens:** The use of a retrospective clinical audit was a deliberate methodological choice aimed at examining the gap between guideline recommendations and clinical practice. While retrospective observational designs are common in emergency medicine research (Kaji et al., 2014; Lowenstein, 2005), the scoping review conducted in this study identified fewer such audits within the specific field of acute dizziness and vertigo. Only 9% of included studies ( $n = 5$ ) used retrospective clinical audits, a figure significantly lower than published norms for general ED research (Gilbert et al., 1996; Kaji et al., 2014), indicating limited direct examination of real-world clinical practice in this area ([Figure 4](#) and [Table 3](#)). The distribution of study types (27 observational studies versus 18 guidelines) suggests that much of the existing literature focuses on problem description and guideline development, with relatively few studies assessing implementation in practice. Such work is needed to inform future improvements in emergency vestibular care.

Although prospective randomised controlled trials are considered the standard for evaluating intervention efficacy, they may not capture clinical practice as it occurs in routine emergency care (Andrade, 2018). In contrast, retrospective audits allow analysis of clinical decision-making under typical working conditions, including time constraints and service pressures. The use of existing clinical records also reduces the likelihood of altered behaviour due to observation (Hawthorne effect). This approach enabled examination of clinical practice within the operational context of the emergency department, where factors such as patient flow and resource availability may influence diagnostic and management decisions. Whilst the retrospective audit design enhances ecological

validity by capturing routine practice, it introduces systematic measurement bias, as documented activity may not reflect actual clinical assessment. This limitation is particularly relevant for high-skill vestibular tests, which may be performed but incompletely recorded.

While the single healthcare system over two sites limit generalisability, it provides a focused evaluation of practice within a defined clinical environment. This supports detailed assessment of care processes and offers a basis for identifying areas for service improvement.

**Systemic Performance and Structural Accountability:** This study design captures clinical practice across a range of providers, including junior doctors, senior physicians, and ED physiotherapists. This allowed an assessment of care at a system level rather than focusing on individual clinician performance. In contrast, studies restricted to expert clinicians may not reflect variation in training, documentation, and practice across the wider workforce. The use of a retrospective audit highlights patterns that may not be evident in controlled research settings. For example, vestibular suppressant medications were frequently documented in patients with BPPV, despite guideline recommendations favouring repositioning manoeuvres. Such patterns reflect routine clinical practice and may not be observable within controlled trial designs. These findings suggest that differences in adherence to evidence-based care are not limited to individual decision-making but may also reflect broader features of clinical workflows and service delivery. This supports a focus on system-level factors when considering opportunities for improvement in ED care.

#### **4.7.2 Data Fidelity and Extraction Reliability**

The reliability of data extraction was high, with Cohen's kappa ( $\kappa$ ) values ranging from 0.88 to 1.00, indicating strong agreement between extractors. This supports the consistency of the data collected and suggests that the findings reflect the underlying clinical documentation rather than variation in the audit process. The observed discrepancies in clinical assessment are therefore likely to represent differences in documented practice.

Inter-rater reliability was higher within the physiotherapy records compared with the medical records. This may reflect more standardised documentation and clinical terminology within the physiotherapy service. The extractors' clinical background as ED physiotherapists may also have influenced interpretation of specialised terminology, which may have contributed to greater consistency in extracting physiotherapy-related data. Overall, the high level of agreement supports the reliability of the dataset and strengthens confidence in the subsequent analysis of clinical practice patterns (Andrade, 2018).

#### **4.7.3 Comparison to Similar Established Literature**

To contextualise these findings, a comparative synthesis was undertaken using comparable international studies (Kerber et al., 2013; Lloyd, Luscombe, et al., 2020; Lloyd, Mackintosh, et al.,

2020; Neely et al., 2023; Neely et al., 2021; Stewart et al., 2022) ([Appendix G](#)). This comparison situates the New Zealand cohort (n = 264) alongside studies from Australia (Lloyd et al., 2020; Stewart et al., 2022; Neely et al., 2023) and the United States (Kerber et al., 2013). It provides a basis for examining how local clinical practice compares with international patterns in emergency vestibular care.

**Comparative Synthesis:** Overall, the findings are consistent with trends reported in Australian studies, particularly the low rates of documentation identified by Stewart et al. (2022) and Lloyd, Luscombe, et al. (2020). However, this study provides additional detail regarding differences between clinician groups. This study highlights differences in the assessment of horizontal canal pathology. Previous studies have focused primarily on the Dix–Hallpike test, the current findings show that the supine roll test was not documented in emergency medicine records. In contrast, this assessment was frequently documented in physiotherapy records. This suggests variation in the assessment of different BPPV subtypes between professional groups. Lloyd, Luscombe, et al. (2020) also reported a low frequency of horizontal canal assessment, this, however, remains largely unaddressed in the wider literature.

Inclusion of Māori health outcomes provides an additional perspective not reported in comparable studies. Access to physiotherapy input was lower for Māori patients. These differences in service access may influence observed variation in clinical care between groups.

#### **4.7.4 Departmental Findings**

**Temporal Misalignment and the Underutilisation of Specialised Resource:** Despite a physiotherapy service being available in ED for 62.5% of the participants in the audit physiotherapy involvement remained limited. This indicates a difference between the availability of the service and its utilisation within the clinical pathway. Therefore, opportunities may exist to increase integration of physiotherapy input during periods when both service availability and patient presentations overlap.

**Temporal Barriers to Equity:** The discrepancy in Māori access to ED physiotherapy, where only three Māori patients were reviewed by a physiotherapist, demands a theoretical investigation into structural exclusion. This finding requires careful interpretation and consideration of potential contributing factors. While granular data on the exact time of Māori presentations was not captured in this audit, consideration needs to be given to the role of temporal determinants in driving this disparity. Further research is required to determine whether differences in presentation patterns or service access contribute to the observed variation in physiotherapy utilisation between Māori and non-Māori patients. If presentation patterns differ from service availability, this may contribute to variation in access to physiotherapy assessment. Possibly factors such as employment patterns and whānau responsibilities may influence when care is accessed. In this context, the timing of

physiotherapy service provision may influence which patients are able to access this component of care.

**Te Tiriti and the Mandate for Service Redesign:** Under the principles of Te Tiriti o Waitangi, health services are required to provide care that is accessible and equitable. The findings of this study indicate differences in access to ED physiotherapy between Māori and non-Māori patients, which warrant consideration. Aligning service delivery with patterns of patient need may support more equitable access to physiotherapy within the ED setting. These considerations highlight the importance of designing services in a way that reflects the needs of the populations they serve.

**Institutional Resource Optimisation:** Increased use of structured bedside assessment may also offer several potential service benefits:

- *Reduced diagnostic cost:* Bedside assessments such as the HINTS examination and supine roll test may reduce reliance on neuroimaging.
- *Reduction in downstream service use:* More accurate initial assessment may reduce the need for repeated consultations and ongoing management of unresolved symptoms.
- *Workforce efficiency:* Expanding the role of clinicians trained in vestibular assessment may support distribution of workload within the ED and allow emergency physicians to focus on other clinical priorities.

These findings suggest that greater use of bedside assessment approaches may support clinical decision-making in acute vestibular presentations. Integration of these approaches into routine practice may provide an alternative to reliance on imaging-based diagnostic pathways.

#### 4.7.5 *Diagnosis Patterns*

##### **Diagnostic Stratification and the Paradigm Shift in Physiotherapy Integration:**

A critical interpretation of these findings suggests reconsideration of how ED physiotherapy services are utilised in acute vestibular care. The rapid scoping review identified that existing literature primarily associates ED physiotherapy with the management of peripheral BPPV (Lloyd, Luscombe, et al., 2020; Neely et al., 2023; Sacco et al., 2014), or as a secondary component of care focused on rehabilitation and discharge planning (Edlow et al., 2023).

In the present study, physiotherapy input was associated with higher rates of documented adherence to evidence-based assessment and management. These findings indicate that physiotherapy involvement extended beyond positional testing to include documentation of assessments relevant to acute vestibular syndrome. This is relevant given the clinical complexity of this patient group, where approximately 25% of acute vestibular syndrome presentations in the ED originate from central

aetiologies such as posterior circulation strokes (Saber Tehrani et al., 2018; Tarnutzer et al., 2025). Within this context, physiotherapy records demonstrated consistent use of several recommended assessment components, although complete HINTS or HINTS-plus examinations were less frequently documented.

**Inverting the Conventional Diagnostic Profile:** The role of ED physiotherapy is further evident when clinician involvement is considered by final diagnosis. Previous assumptions suggest that emergency physicians manage complex or uncertain presentations, while physiotherapists focus on peripheral conditions. In this study, physiotherapy involvement was proportionally higher in presentations classified as central or of uncertain origin compared with the emergency medicine cohort.

These findings suggest that ED physiotherapy may be integrated into the assessment of more complex or diagnostically uncertain presentations. Previous studies have linked physiotherapy involvement in vestibular care with higher rates of specific diagnoses (Lloyd, Luscombe, et al., 2020). While this study did not analyse physiotherapy diagnostic assignment directly, it observed that physiotherapy involvement was more frequent in cases where the diagnosis remained uncertain.

Given the retrospective design, causality cannot be determined. Several explanations may account for this pattern. One explanation is targeted use of physiotherapy input, where clinicians refer more complex or unclear presentations for further assessment. This is consistent with the higher rates of documented vestibular assessment observed in physiotherapy records ([Tables 14, 15, 16, 17](#)). An alternative explanation is variation in documentation within emergency medicine records. As demonstrated in the pathway analyses ([Figures 11 and 12](#)), documentation of key clinical assessments was often incomplete. This may influence the classification of vestibular presentations and contribute to differences in recorded diagnosis. These factors highlight the complexity of interpreting diagnostic patterns in retrospective data and suggest that both referral practices and documentation differences may contribute to the observed findings.

### **The Theory-Practice Gap: A Critique of Emergency Medicine Diagnostic Fidelity:**

While the relatively small Māori and ED physiotherapy cohorts limit generalisability, the findings indicate a gap between recommended assessment approaches and documented clinical practice in emergency medicine.

Within the emergency medicine cohort, lower rates of documented adherence were observed across both HINTS-plus and BPPV diagnostic pathways. In particular, the use of key assessment manoeuvres was limited, indicating variation between guideline recommendations and recorded practice. Similar findings were reported in the Australasian studies (Lloyd, Luscombe, et al., 2020; Neely et al., 2023; Stewart et al., 2022). The low fidelity to guideline-recommended assessment is

unlikely to be solely attributable to knowledge deficits. Instead, it reflects a mismatch between guideline expectations and the operational realities of emergency care.

#### **4.7.6 Acute Vestibular Syndrome Assessment**

**HINTS-plus and the Assessment of Acute Vestibular Syndrome:** Nystagmus assessment represented the main shared diagnostic component across both professional groups. Despite this, medical documentation rates for nystagmus (64.4%) were higher than those reported in previous studies (51% and 31%) (Lloyd, Mackintosh, et al., 2020; Stewart et al., 2022). The ED physiotherapy cohort demonstrated higher documentation rates (95.9%), consistent with other published findings.

In contrast, documentation of the remaining HINTS components was limited within the medical cohort. These findings are similar to those reported by Stewart et al. (2022), who identified low uptake of these assessments among medical staff. This pattern may reflect the technical demands of these assessments, particularly the head impulse test, which emergency physicians demonstrate variable proficiency in performing as it requires both manual skill and clinical interpretation (McDowell & Moore, 2016). This may influence clinician confidence in performing and documenting these components. A gap was also observed between clinical eligibility for HINTS-based assessment and its implementation. The infrequent completion of the full HINTS-plus examination (2.7%) was similar to (Stewart et al., 2022). From a systems perspective, this represents a missed opportunity to utilise a validated, high-yield bedside assessment in a cohort where it is most clinically informative. Addressing this gap may improve diagnostic precision and reduce reliance on resource-intensive investigations, particularly in the assessment of acute vestibular presentations in the emergency setting.

**Hearing Screen: A Neglected Component:** The hearing assessment component of the HINTS-plus examination was infrequently documented across both professional groups. This is consistent with previous findings, where hearing assessment was not routinely included in vestibular evaluation (Lloyd, Luscombe, et al., 2020). The low use of this component may affect the identification of conditions such as labyrinthine pathology or anterior inferior cerebellar artery (AICA) stroke, where hearing loss is a relevant clinical feature.

**The Risk of Negative CT Findings:** The rate of neuroimaging in this audit (48.1%) falls within the range reported in previous studies (33% - 64%) (Kerber et al., 2013; Neely et al., 2023). Reliance on imaging alone in the assessment of acute vestibular syndrome has recognised limitations. Computed tomography can miss up to 80% of posterior circulation strokes within the first 24 hours of symptom onset (Newman-Toker et al., 2015). Therefore, the combination of a negative CT and an incomplete HINTS represents a high-risk diagnostic strategy.

Within this context, limited use of the full HINTS-plus assessment may affect diagnostic certainty. Physiotherapy involvement was associated with higher rates of documented vestibular assessment, including head impulse testing and positional manoeuvres. These assessments support differentiation between central and peripheral causes of dizziness. The low agreement rate for the head impulse test (14.3%), alongside high physiotherapy-only discordance 85.7%, indicates that these elements were not consistently documented across all clinicians. These findings suggest the safety of the discharge pathway for acute vestibular syndrome patients was disproportionally dependent on ED physiotherapy.

**The Scope of Diagnostic Underestimation:** Variation in the reliability of emergency vestibular diagnosis may have implications beyond immediate clinical risk, including effects on the wider epidemiological evidence base. Grill et al. (2018) suggest that the overall rate of diagnostic error in this population is not well defined and may be underestimated.

This uncertainty is further complicated by diagnostic overlap. Perloff et al. (2017) report that approximately 11% of patients with cerebellar infarction present with isolated symptoms that may resemble benign peripheral disorders, however the percentage of patients presenting with isolated dizziness who harbour an underlying cerebellar stroke is unknown.

**The Audit as an Empirical Perspective on Prevalence:** The findings of this audit provide an empirical perspective on the challenges of interpreting vestibular prevalence data. In this cohort, low completion rates for HINTS-plus and frequent assignment of BPPV diagnoses without documented confirmatory testing indicate variation in diagnostic practice.

Where clinical records do not consistently include structured bedside assessments, the reliability of diagnostic coding within these datasets may be affected. This has implications for studies that rely on retrospective clinical data to estimate disease prevalence. These findings suggest that accurate estimation of the burden of acute vestibular conditions depends on consistent application and documentation of evidence-based assessment methods. Observational audits provide a means of evaluating this alignment between clinical practice and diagnostic standards.

#### **4.7.7 BPPV Assessment**

**Disordered Emergency Medicine BPPV Diagnosis:** The audit identified differences between documented diagnoses and recorded clinical assessment. The rate of Dix-Hallpike (26%) and supine roll (0%) assessment recorded by emergency medicine was mirrored in a recent Australian study of 96 ED visits (Lloyd, Mackintosh, et al., 2020). A total of 78 BPPV diagnoses were recorded, however only 27 cases included documentation of any positive positional test consistent with the reference standard required to make a BPPV diagnosis. In addition, 17 cases of BPPV diagnosis had recorded negative Dix-Hallpike tests, therefore 40% of cases documenting objective findings *against*

BPPV still went forward with a BPPV diagnosis. There were no instances of the supine roll test documented. While 13 cases received a BPPV diagnosis without any recorded subjective (other than an acute vertiginous presentation) or objective evidence-based assessments recorded.

These findings highlight the importance of consistent documentation of established assessment procedures when assigning vestibular diagnoses in the emergency department. These disordered findings suggest a lack of documentation or performance of specific objective assessments. Limitations in utilising evidence-based objective assessments introduces risk of mis-diagnosis or underdiagnosis of other conditions.

**Interpretation of Horizontal Canal BPPV Prevalence:** The complete absence of supine roll test use may influence how horizontal canal BPPV is represented in the literature and considered by clinicians. This condition is often reported as less prevalent than posterior canal BPPV; however, lower reported rates may reflect under-detection rather than true differences in occurrence. When specific diagnostic tests are not routinely performed, cases may not be identified or recorded. This may contribute to lower reported prevalence, which in turn may influence clinical expectations and the ongoing use of these assessments, creating an epistemological feedback loop. In addition, horizontal canal BPPV has been described as more symptomatic and aggressive in its presentation than posterior canal BPPV. Arguably, the ED could be a setting where horizontal canal BPPV presents in higher proportions (Martens et al., 2019). By failing to look for this variant, the ED may systemically overlook the very patients most burdened by their symptoms, leading to under-treating and under-reporting of horizontal canal BPPV.

**Benign Bias and the Failure of Disposition:** Deferment of positional testing may reflect the prioritisation of serious diagnoses within emergency care. Emergency clinicians are trained to discern critical diagnoses amidst a high-volume cohort, prioritising the exclusion of life-threatening pathology such as stroke. Once central causes are deemed unlikely, peripheral conditions like BPPV are frequently classified as benign and relegated to outpatient follow-up.

This pattern may be compounded by a lack of robust referral pathways. These findings suggest that, within standard medical pathways, patients may be discharged after exclusion of central pathology without a confirmed peripheral diagnosis or planned follow-up. This may affect ongoing symptom management and the need for further healthcare contact.

#### **4.7.8 Advanced Imaging Use**

**Radiological Heuristics and Diagnostic Reassurance:** The findings indicate frequent use of CT in the assessment of acute vestibular presentations. This occurs despite recognised limitations in the sensitivity of CT for detecting posterior circulation strokes in the acute phase (Ashiq et al., 2024; Pavlovic et al., 2018).

In this context, a negative imaging result may influence clinical decision-making. Where imaging is relied upon in the absence of complete bedside assessment, negative findings may contribute to a perception of reduced diagnostic risk.

**Technological Reliance and Clinical Decision-Making:** The persistent use of imaging may reflect a reliance on technological investigation within emergency care. Advanced imaging can be perceived as providing a clear and definitive outcome, particularly in high-pressure clinical environments. In this context, clinical focus may shift away from detailed bedside assessment toward imaging-based decision-making. This may be reinforced where specific examination skills, such as the head impulse test, are not routinely performed. The findings of this study demonstrate low rates of documentation of these assessments, suggesting that variation in clinical skill application may influence the balance between bedside evaluation and imaging use.

**Technology as Symbolic Value in Clinical Care:** Patient and whānau expectations may also influence diagnostic decision-making. In contemporary healthcare, advanced imaging can be perceived as an indicator of thorough assessment. For some patients, visual investigation methods may be seen as more reliable than bedside examination.

In settings where there may be reduced trust in healthcare systems, the absence of imaging may be interpreted as incomplete evaluation or reduced care (Komene et al., 2024; Palmer et al., 2019). This context may influence clinical decision-making, particularly where there is concern about meeting patient expectations. These factors may contribute to greater reliance on imaging and may affect the use of bedside assessment techniques. Although tools such as HINTS-plus offer a structured and evidence-based approach, their use may be influenced by both clinical and non-clinical factors. Together, these findings suggest that the adoption of bedside assessment models may depend not only on clinical training, but also on a high degree of cultural safety and sophisticated, empathetic education that validates whānau concerns.

#### **4.7.9 BPPV Treatment**

**Therapeutic Yield and the Resolution Gap:** Identification of BPPV in the emergency department provides an opportunity for immediate treatment using canalith repositioning manoeuvres. In this audit, a difference was observed between diagnosis and treatment. While rates of BPPV diagnosis were similar across emergency medicine and physiotherapy groups, the proportion of patients receiving repositioning treatment differed. This indicates variation in the use of evidence-based treatment following diagnosis.

**Comparative Yield and Diagnostic–Therapeutic Alignment:** The number of canalith repositioning manoeuvres performed was similar in absolute terms between groups. Variation was

also observed in the alignment between diagnosis and treatment. Of the 18 manoeuvres performed by the medical cohort, three were documented in patients without a recorded diagnosis of BPPV. This pattern is consistent with previous literature, where medical use of repositioning manoeuvres has been reported to range from 0% to 31% (Lloyd, Mackintosh, et al., 2020; Neely et al., 2021). In contrast, the physiotherapy cohort in this study demonstrated consistent use of repositioning treatment following diagnosis, comparable with previously reported rates (Lloyd, Luscombe, et al., 2020). These findings indicate differences in the application of treatment following diagnosis across clinician groups.

**Pharmacological Palliation versus Definitive Treatment:** Although clinical guidelines advise against the use of vestibular suppressants for BPPV, medication was frequently prescribed within the medical cohort (Bhattacharyya et al., 2017; Edlow et al., 2023). In this study, 80.8% of patients diagnosed with BPPV (63 of 78 cases) received vestibular suppressant medication.

This indicates a difference between guideline recommendations and clinical practice. While these medications may provide short-term symptom relief, they do not address the underlying mechanism of BPPV. In contrast, repositioning manoeuvres offer a targeted treatment approach. The lower use of these interventions within the medical cohort suggests variation in the application of evidence-based management. Physiotherapy involvement was associated with greater use of repositioning manoeuvres and may contribute to more consistent delivery of definitive treatment in the emergency department setting.

**Physiotherapy Discordance-Only Yield and Treatment Initiation:** The physiotherapy discordance-only yield reflects cases in which diagnostic or treatment interventions were performed by physiotherapists but not documented by medical clinicians. In this dataset, no instances of emergency physician-only treatment were identified for BPPV-related interventions. In all cases where canalith repositioning manoeuvres were performed in the context of discordance, this was documented in physiotherapy records only. This indicates that, in cases of differing practice, repositioning treatment was initiated by physiotherapists rather than by emergency physicians.

#### ***4.7.10 Clinical Practice Alignment with Evidence-Based Guidelines***

**HINTS-plus versus the STANDING Algorithm:** This audit was based on the HINTS-plus examination, which is widely used for the assessment of acute vestibular syndrome. This approach aligns with the TiTrATE (Timing, Triggers, and Targeted Examination) framework, which emphasises symptom timing, triggers, and focused bedside assessment, including gait and balance evaluation (Newman-Toker & Edlow, 2015). These components are reflected in the GRACE-3 clinical guidelines which recommend structured bedside assessment for patients presenting with acute dizziness and vertigo (Edlow et al., 2023).

**The STANDING Protocol as a Comparative Consideration:** In selecting a diagnostic framework, the STANDING algorithm (nystagmus assessment, positional testing, head impulse test, and gait evaluation) is an important comparator. Developed within Italian emergency medicine cohorts, STANDING has demonstrated sensitivity comparable to HINTS-plus, with higher reported specificity (Vanni et al., 2014; Vanni et al., 2017). In addition, the STANDING algorithm incorporates assessment of BPPV within its structure, whereas HINTS-plus requires separate positional testing for these presentations.

There is emerging evidence that STANDING may be more readily adopted by emergency physicians due to its structured, stepwise approach (Vanni et al., 2017). However, HINTS-plus was selected for this study for several reasons. Much of the existing vestibular literature is centred on HINTS-plus, which allows for comparison with previously published cohorts. Although the GRACE-3 guidelines include both approaches, HINTS-plus is more prominently represented in the guidelines and in the current evidence base identified in the scoping review. Importantly, while STANDING was not explicitly used as a named protocol in this audit, the component assessments recorded, (nystagmus evaluation, head impulse testing, positional manoeuvres, and gait assessment), align with the core elements of the STANDING framework.

**Skills-Based Limitations vs. Protocol Selection:** It is unlikely that the use of an alternative framework, such as the STANDING algorithm, would have substantially changed the patterns observed in this study. The findings indicate that the primary limitation relates to the execution and documentation of key clinical assessments, rather than the specific diagnostic framework applied. Both HINTS-plus and STANDING rely on similar core examination skills, including the head impulse test and interpretation of nystagmus. The low rates of documented assessment observed in the emergency medicine cohort suggest that these challenges may persist regardless of which framework is used. In this context, HINTS-plus serves as an operational benchmark to measure departmental practice. This leads to a necessary critique of the GRACE-3 guidelines, specifically regarding how these highly validated diagnostic tools are translated into the pressured, generalist environment of the modern ED within Aotearoa New Zealand.

#### ***4.7.11 A Critique of GRACE-3: Acute dizziness and vertigo in the emergency department***

As the GRACE-3 guidelines are integral to the primary framework of the following retrospective clinical audit a closer critique and consideration of their relevance to the context of an Aotearoa New Zealand ED was deemed necessary. The GRACE-3 guidelines formed a key component of the framework used to develop the data extraction tool (Chapter 4, [4.4.5](#)). This tool also incorporated elements from the updated American Academy of Otolaryngology BPPV guidelines, and

findings from the rapid scoping review (Bhattacharyya et al., 2017; Edlow et al., 2023). Together, these sources were used to define the clinical metrics evaluated in this audit.

Given the central role of GRACE-3 guidelines within the study design, it is important to consider its applicability to routine emergency department practice within Aotearoa New Zealand.

**HINTS Validation:** A common critique of the GRACE-3 recommendations relates to the use of the HINTS examination in general emergency practice. While the HINTS test has demonstrated high sensitivity in research settings, this performance has not consistently translated to emergency physician use (Ohle et al., 2020; Srinivasan & Tirschwell, 2023). The original validation study was conducted by a neuro-ophthalmologist using specialised equipment (Kattah et al., 2009). Subsequent studies have highlighted challenges in applying this test in routine care. Dmitriew et al. (2021) reported that the criteria required for accurate HINTS application were not met in the majority of cases in clinical practice. When performed by emergency physicians, reported sensitivity has been lower (approximately 83%), which may limit its use as a standalone tool to rule out central causes such as stroke (Ohle et al., 2020). Concerns have also been raised regarding the consistency of interpretation and the level of training required to perform the test reliably (Srinivasan & Tirschwell, 2023). Lower rates of HINTS use in practice (5 - 19.5%) may further affect clinician familiarity and accuracy (Dmitriew et al., 2021; Quimby et al., 2018). The GRACE-3 guidelines acknowledge this limitation and emphasise the need for targeted training to support implementation.

Supporting evidence for HINTS includes a pooled sensitivity of 92.9% reported in a recent meta-analysis (Shah, Oliveira, Farah, Seisa, Balla, et al., 2023). However, many of the included studies involved assessments performed by specialists rather than emergency physicians. The reported confidence interval (95% CI 79.1%, 97.9%) also reflects variability in performance (Shah, Oliveira, Farah, Seisa, Balla, et al., 2023). In the context of emergency care, where HINTS is used to exclude serious pathology, this variability is an important consideration for an exclusionary test in a life-threatening condition like stroke, the 79% lower bound could be considered to represent unacceptable risk. While GRACE-3 represents a high-quality synthesis of available evidence, its applicability in routine ED settings is constrained by the requirement for advanced clinical skill in vestibular examination, an expectation that may not align with generalist emergency medicine training.

**Alternatives to HINTS and Guideline Prioritisation:** The STANDING algorithm includes gait and positional assessments that may be more consistent in routine clinical practice and has also undergone multicentre validation in generalist emergency settings, whereas much of the evidence supporting HINTS is derived from specialist-led studies (Vanni et al., 2017). Despite this, the GRACE-3 guidelines continue to prioritise HINTS within their recommendations, reflecting its established role within the existing evidence base.

**HINTS-plus external validity:** The emergency department environment is often characterised by high levels of noise and clinical activity, which may affect the consistency of bedside hearing assessments such as the finger-rub test. Although this component is used to identify hearing loss in suspected anterior inferior cerebellar artery (AICA) strokes, its reliability may be reduced in non-controlled settings. As a result, the sensitivity reported in specialised clinical environments may not be directly generalisable to routine ED practice. This raises considerations regarding the external validity of HINTS-plus when applied in high-intensity clinical settings, such as an ED.

**Imaging debate:** The GRACE-3 guidelines prioritise bedside assessment over advanced neuroimaging, advising against routine use of CT or MRI in 5 of their 13 core recommendations. While imaging is recommended in specific scenarios, such as suspected transient ischaemic attack, the guidelines emphasise clinical examination as the primary diagnostic approach. In contrast, Srinivasan and Tirschwell (2023) argue that neuroimaging should remain a central component of acute vestibular syndrome assessment. Both positions aim to reduce the risk of missed stroke diagnoses but differ in how this is achieved. Current literature suggests that early neuroimaging may not have sufficient sensitivity to reliably exclude acute posterior circulation infarcts, which is itself an underlying tenet of the development of structured bedside examinations.

Srinivasan and Tirschwell (2023) argue that CT angiography is important for identifying large-vessel occlusions or arterial dissections, particularly in “stuttering” presentations that may indicate evolving basilar artery occlusion. They suggest that inappropriate use of bedside tools, such as HINTS, in these cases may increase the risk of missed diagnosis. However, this perspective may not fully account for the structure of the GRACE-3 framework. The guidelines include recommendations for imaging in patients with spontaneous episodic presentations where transient ischaemic attack is suspected, addressing higher-risk clinical scenarios. Although MRI sensitivity improves after the first 24 hours, this delayed performance is less useful in the acute emergency department setting. Clinical decision-making in this environment requires assessment tools that support early risk stratification at the point of presentation.

**Horizontal Canal BPPV:** A notable exclusion within the GRACE-3 recommendations is the assessment and management of horizontal canal BPPV. The consensus panel considered that emergency physicians may not have the level of training required to consistently identify and treat this variant. This exclusion is important when considered alongside evidence that horizontal canal BPPV can be associated with greater patient-reported symptom severity and functional impact compared with posterior canal BPPV (Martens et al., 2019). In the emergency department context, patients with more severe symptoms may be more likely to present for acute care, this may influence the observed distribution of vestibular conditions, potentially making the ED environment more prone to horizontal canal variants.

The GRACE-3 panel acknowledged the clinical relevance of horizontal canal BPPV but identified several factors limiting its inclusion in routine ED management pathways. First, diagnosis is more complex than for posterior canal BPPV and requires interpretation of horizontal nystagmus, including differentiation between geotropic (earth-beating) and apogeotropic (away from earth) variants. Second, the additional training required to perform and interpret these assessments, along with associated treatment manoeuvres (e.g., supine roll test, Gufoni manoeuvre), was considered substantial within the context of generalist emergency practice. Finally, the decision was influenced by prevalence. Posterior canal BPPV accounts for the majority of cases (approximately 70–90%), and the guidelines therefore prioritise interventions with the greatest expected clinical impact. Horizontal canal BPPV, representing a smaller proportion of presentations, was not included in the core recommendations.

**Clinical Implications of the horizontal canal exclusion:** Exclusion of horizontal canal BPPV from guideline recommendations may influence diagnostic decision-making in the emergency department. This condition can present with horizontal, direction-changing nystagmus, a feature also associated with central pathology. Without routine use of the supine roll test to distinguish between peripheral and central causes, patients may undergo additional investigation to exclude serious conditions. This may contribute to increased use of neuroimaging and associated resource demands.

A simplified diagnostic approach to BPPV may also affect clinical reasoning. Where the Dix-Hallpike test is used in isolation, a negative result may lead to the assumption that positional vertigo is absent, limiting further assessment. This may reduce the likelihood of identifying alternative BPPV variants and delay the use of appropriate repositioning manoeuvres. In such cases, patients may instead receive non-specific management, including imaging or pharmacological treatment, in the absence of a confirmed diagnosis.

Variation in guideline focus may also influence which patient groups are prioritised within clinical care. Evidence suggests that horizontal canal BPPV can be associated with greater symptom severity and functional impact compared with posterior canal presentations. Exclusion of this subgroup from routine assessment pathways may therefore limit access to targeted treatment for patients experiencing more severe symptoms at the point of ED presentation.

**Multidisciplinary Integration and Guideline Structure:** The GRACE-3 guidelines are primarily oriented around a physician-led model of care. This may not fully reflect the roles of multidisciplinary teams within contemporary emergency departments or promote patient and whānau centred care. Current literature increasingly recognises the contribution of advanced-scope physiotherapists and nurse practitioners within acute care pathways. However, these roles are often described as supporting triage or follow-up, rather than as contributors to diagnostic assessments.

Although GRACE-3 occasionally uses the term “emergency clinician,” the recommendations largely assume that diagnostic decision-making rests with the medical practitioner.

This structure may limit the integration of allied health clinicians who demonstrate specific expertise in vestibular assessment. In the absence of clear guidance on how findings from multidisciplinary assessments should be incorporated into clinical decision-making, opportunities for collaborative care may not be fully realised. This may affect implementation in settings where care is delivered across multiple professional groups. The exclusion of horizontal canal BPPV management is an example of the physician centred position of the guideline, where the balance of excluding this was weighed towards considering the difficulty faced by a physician, rather than implications for the patient or wider emergency department clinicians.

Therefore, consideration of multidisciplinary roles and communication pathways may support the practical application of vestibular assessment guidelines within emergency department practice.

**New Zealand Context and Implementation Considerations:** The GRACE-3 recommendations present challenges when applied in rural and regional healthcare settings. While the guidelines prioritise bedside clinical assessment over neuroimaging, their application relies on either clinician proficiency in HINTS or access to advanced imaging when this expertise is unavailable. This dependency may be difficult to meet in some settings, given the limited availability of specialist clinicians and the variable access to MRI services, particularly outside major centres.

In the Aotearoa New Zealand context, these constraints are evident. In 2021, New Zealand had 16.62 MRI units per million people, compared with 37.99 per million in the United States, where the majority of the GRACE-3 committee is based (McCall et al., 2025). In addition, only 30 of the country’s 80 MRI scanners were located in the public sector, with the remainder in private facilities.

These factors may limit timely access to imaging in acute care settings. As a result, in some cases, the recommended GRACE-3 pathway may be difficult to implement, particularly where neither specialist bedside assessment nor rapid imaging is available. This highlights the importance of considering local resource availability when applying international guidelines.

**The Biomedical Paradigm and its Limitations:** The GRACE-3 guidelines are based on a positivist approach, using systematic reviews and quantitative evidence to support clinical decision-making in the emergency department. While this provides a clear and structured framework, it may not fully capture the broader context in which care is delivered. A strictly biomedical focus can overlook important social, cultural, and experiential factors that influence patient care (Grant & Giddings, 2002). In Aotearoa New Zealand, this is particularly relevant, as differences in health needs, communication styles, and access to care may affect how services are experienced by Māori and other populations (Came, 2013). This highlights the clinical guidelines, while evidence-based, may require adaptation to reflect the local context and the needs of diverse patient groups.

**Linguistic Bias and Semantic Interpretation:** Contemporary vestibular assessment frameworks, including TiTrATE (Timing, Triggers, and Targeted Examination), rely on patients describing symptoms using defined categories such as ‘continuous’, ‘episodic’, or ‘triggered’. While this structure supports clinical decision-making, it may not fully reflect how patients describe their experiences. For patients for whom English is an additional language, or whose cultural expressions of illness differ from these categories, there may be difficulty translating symptoms into the expected framework. This may affect how clinical presentations are interpreted and classified.

As a result, the accuracy of initial assessment may be influenced by how well patient descriptions align with the language used in diagnostic algorithms. This highlights the importance of considering communication and cultural context within vestibular assessment in the emergency department.

**Conceptual Mismatch and Culturally Safe Practice:** There is a fundamental conceptual mismatch between the reductionist focus on timing and triggers and the holistic ontologies central to many indigenous cultures, including Māori. Within a Māori health framework, physical symptoms are rarely viewed in isolation; rather, they are understood as part of a wider narrative of *hauora* (wellbeing), encompassing physical, mental, spiritual, and familial dimensions. A clinical insistence on isolating temporal patterns could be perceived as culturally reductive or alienating. For patients who communicate their health through a narrative-driven or holistic framework, the rigid constraints of a Western vestibular screen may result in a clinical encounter that is perceived as culturally unsafe, ultimately undermining the diagnostic alliance and exacerbating health inequities.

**Institutional Bias and the Historic Gatekeeping of Imaging:** GRACE-3 strongly recommends that clinicians do not routinely use MRI if a trained HINTS clinician is available. However, in the New Zealand context, data indicates that Māori are already less likely to receive radiographs or bloodwork in the ED and are more likely to be discharged early (Prisk et al., 2016). While application of a guideline to care pathways can be a tool to mitigate racist institutional practices, a judicious application is required so as not to perpetuate the current inequity.

**The Power Balance of Shared Decision-Making:** Recommendation 14 of GRACE-3 suggests shared decision-making for the use of corticosteroids in vestibular neuritis. Effective shared decision-making requires a level playing field. For indigenous populations with a history of medical paternalism and systemic racism, the power imbalance in the ED can make shared decision-making impossible. Where a culturally safe environment is not established, agreement with treatment decisions may reflect deference to clinical authority rather than informed participation. This may limit the extent to which shared decision-making reflects patient values and preferences in practice.

#### **4.7.12 Clinical Quality Comparison between Professional Roles**

**Proficiency and Role Design:** Current literature, including the GRACE-3 guidelines, places emphasis on developing emergency physician capability in performing the HINTS-plus examination. This audit identified that a high level of proficiency in these assessments was present within the ED physiotherapy service. The association between physiotherapy involvement and higher adherence to evidence-based practice should be interpreted with caution. This relationship may reflect selection bias, whereby patients with clearer vestibular presentations are more likely to be referred to or selected by physiotherapists, rather than a causal improvement attributable to professional role alone. Previous work has highlighted skill acquisition as a key barrier to implementation (Bradshaw et al., 2023; Edlow et al., 2023; Herdman et al., 2023), there is less focus on the potential role of other clinicians who already demonstrate competency in these assessments.

The findings of this study suggest that differences in performance may relate to trained proficiency rather than professional designation alone. This highlights the potential contribution of multidisciplinary team members in delivering specialised vestibular assessment within the emergency department. These observations indicate that, alongside clinician training, consideration of workforce roles may be relevant when implementing guideline-based care in acute vestibular presentations.

#### **4.7.13 Equity**

**Equity and Access:** The analysis identified differences in the provision of evidence-based care between Māori and non-Māori patients. Māori patients received slightly lower rates of guideline-adherent assessment; however, this difference in clinical concordance was modest. Although absolute differences were modest, the consistent direction of effect suggests a systematic disparity rather than random variation. This effect may be pertinent considering the access deficit to ED physiotherapy noted in Chapter 4.7.

**Inter-professional Access:** The study identified differences in patterns of clinician involvement by ethnicity. Māori patients presenting with acute dizziness were more likely to be assessed by senior emergency medicine physicians than non-Māori patients. In contrast, Māori patients were less likely to receive ED physiotherapy input. This pattern suggests that, while Māori patients had greater engagement with senior medical staff, access to specialised vestibular assessment pathways was lower. This may influence the consistency of diagnostic assessment for this group.

**Equity and Outcomes of the Māori Cohort:** This study's findings align with findings by Prisk et al. (2016), who reported higher rates of self-discharge among Māori patients and lower use of baseline diagnostic testing prior to departure. This pattern suggests that a proportion of Māori patients may leave before completion of assessment, which may affect both clinical outcomes and the

representation of care within the dataset. In this study, Māori patients presenting with acute dizziness had a shorter median length of stay compared with non-Māori patients. Similar findings have been reported in previous research, where Indigenous patients have comparable or shorter emergency department stays (Thomas & Anderson, 2006). However, shorter length of stay does not necessarily indicate more efficient or equitable care. Previous literature has associated shorter stays with higher rates of dissatisfaction and increased likelihood of leaving before completion of care. When length of stay is shorter but clinical assessment is less robust, the metric ceases to be a measure of performance and instead becomes a marker of service-level attrition, where reduced length of stay may reflect differences in engagement or completion of assessment rather than improved service delivery. In today's ED of a political directive to achieve "shorter stays in ED" targets this is a salient point to consider.

Māori patients in this cohort were younger and were admitted less frequently than non-Māori patients (4.8% vs. 10.4%). Similar patterns have been described previously (Prisk et al., 2016). While age differences may influence admission decisions, lower admission rates in the context of reduced assessment may indicate variation in clinical management pathways.

Across 13 of the 16 clinical metrics in this audit, Māori patients had lower rates of documented evidence-based assessment and treatment. This suggests differences in the application of vestibular assessment between groups and is consistent with broader literature describing variation in healthcare delivery for Indigenous populations (Thomas & Anderson, 2006). Equity, as defined by Te Tiriti o Waitangi principles, requires equivalence of outcome, this is inconsistent with the study of findings deficit across most of the clinical metrics. The fact that Māori were less likely to receive the recommended standard of vestibular care, even when they stay for the duration of the visit, indicates that the standard of care may have been applied in an ethnically disparate manner. These findings highlight the need to consider how equity is reflected in both access to care and the delivery of evidence-based assessment within emergency department practice.

**Implementing Evidence-Based Guidelines in a Te Ao Māori Context:** While the physiological mechanisms of vestibular conditions are consistent across populations, the way symptoms are experienced and communicated is influenced by cultural context. Western clinical models often require symptoms to be described in discrete terms, whereas Māori health perspectives may express illness through broader physical (*taha tinana*), emotional (*taha hinengaro*), spiritual experiences (*taha wairua*) or social (*taha whānau*). This difference may affect the accuracy of history-taking and initial clinical assessment (Edmonds et al., 2024; Pitama et al., 2007; Rochford, 2004). The GRACE-3 guidelines recognise the limitations of relying on symptom descriptors such as "vertigo" or "lightheadedness"; however, this challenge may be greater within a Te Ao Māori framework (Edlow et al., 2023).

Guideline implementation also relies on access to specialist referral pathways, including otorhinolaryngology, neurology, and vestibular physiotherapy. In rural communities, that typically include a higher proportion of Māori, access to these services may be limited by geography, transport, and workforce distribution. Where recommended care is not readily accessible, this may affect treatment pathways and patient outcomes. A healthcare system that recommends care it cannot practically deliver additionally fails in its duty of active protection under Te Tiriti o Waitangi.

The challenge of implementing evidence-based vestibular care within Aotearoa New Zealand is not merely a matter of clinical adherence, but one of cultural translation. To bridge this, the healthcare system must move beyond a monolithic application of Western guidelines and instead foster an interwoven model where clinical excellence and Te Ao Māori perspectives achieve equitable outcomes.

#### ***4.7.14 Limitations of the Clinical Audit***

**Retrospective Documentation:** A key limitation of this study is the use of retrospective clinical documentation as a proxy for clinical practice. Routinely collected health data are generated for clinical care and administrative purposes, rather than for research accuracy; therefore, absence of documentation does not necessarily indicate that an assessment was not performed (Benchimol et al., 2015). This limitation is reflected in the use of binary data extraction (0 = not documented, 1 = documented), which does not capture the quality or accuracy of undocumented assessments. It is possible that some examinations, such as the supine roll test, were performed but not recorded. The reliance on retrospective documentation likely underestimates actual clinical assessment rates, particularly for nuanced examinations such as HINTS, thereby biasing the study toward apparent underperformance. However, in an acute diagnostic environment, the failure to document is, in itself, a failure to meet evidence-based standards, as it renders the clinical reasoning invisible to the rest of the multidisciplinary team and obscures the patient's diagnostic trajectory.

**Geographic and Institutional Generalisability:** This audit was conducted in two metropolitan emergency departments within the Health New Zealand. SQUIRE 2.0 Item 15 highlights the need to consider the transferability of findings to other settings (Ogrinc et al., 2015). Although these hospitals manage a high volume of presentations and operate within a shared emergency medicine framework, their allied health services differ in structure and availability. The patterns of vestibular management observed in this study may therefore reflect local workforce configuration and service delivery models. As a result, the findings may not be directly transferable to rural emergency departments or those without dedicated physiotherapy services, where staffing models and referral pathways differ.

**Selection Bias and Self-Discharge Attrition:** The study's exclusion criteria resulted in the removal of presentations where the diagnostic process was truncated due to self-discharge or redirection to primary care. In accordance with the principle of *Mana Taurite* (Equity), this research identified that Māori were disproportionately excluded from the audit due to self-discharge, which potentially masks the very disparities the study sought to uncover. By excluding patients who left the ED before a physician or physiotherapist could complete their assessment, the audit focuses only on the successful patient journeys that reached a point of documentation. This creates a selection bias by omission, meaning the audit findings may over-represent completed care pathways and may not fully capture differences in access, engagement, or outcomes for all patient groups.

**Interpretive Subjectivity and Researcher Bias:** The manual extraction process was performed by a primary researcher and research assistant who are both registered physiotherapists with specialised experience in the ED setting. While a coding manual and consensus process were used to support consistency, ( $\kappa = 0.81 - 1.00$  for many metrics), the retrospective review remains subject to the clinical perspectives of the reviewers. A post-positivist framework was used to mitigate stochasticity, the reviewers' expertise in vestibular assessment may have influenced how ambiguous clinical documentation was interpreted. For example, a note describing "no nystagmus on head turn" required researcher interpretation to categorise it as a specific positional test result, introducing a level of clinical judgment that may differ between reviewers.

**Temporal Scope and the Static Snapshot:** Data extraction was limited to a single-year period (2022–2023), selected to represent a post-COVID baseline of care. While this approach reduces the influence of recent interventions, retrospective audits provide a cross-sectional view that does not capture changes over time (Gilbert et al., 1996). Clinical practice is dynamic and may vary with staffing patterns, departmental pressures, and local initiatives. As a result, this study cannot determine whether the observed practice patterns reflect sustained differences in care or variation over time.

**Summary of Audit Constraints:** The methodology was designed to maximise internal validity and align with Te Tiriti principles through disproportionate stratified sampling and inclusion of all Māori records. However, the findings should be interpreted in the context of these limitations, as the audit reflects documented care rather than the full extent of clinical practice within the emergency department.

**Audit Inclusion Criterion Limitations:** A limitation of the sampling strategy is the reliance on the triage-recorded presenting complaint to identify eligible cases. Older adults and other patient groups may present with non-specific or atypical symptoms, such as falls or palpitations, before a

vestibular cause is recognised. This is consistent with evidence that patient descriptions of dizziness are often variable and may change during the clinical encounter (Edlow et al., 2018). Focusing on presentations where dizziness was recorded as the primary complaint may therefore limit case capture. As a result, the audit may under-represent patients with atypical or mixed clinical presentations in whom vestibular pathology was not initially identified.

**The Māori Purposive Census:** Although the Māori cohort ( $n = 49$ ) was smaller than the non-Māori sample, this reflects the total number of eligible Māori presentations during the study period rather than a limitation of the sampling approach.

By including all eligible cases, the study represents a purposive census of the Māori population within this setting. This approach reduces sampling variability for this subgroup and provides a comprehensive representation of Māori patients who met the inclusion criteria. While this design may result in wider confidence intervals, it supports strong internal validity within the Māori cohort. It also aligns with Te Tiriti principles by ensuring that all available Māori data are included in the analysis. This approach enables the findings to reflect the recorded clinical experience of Māori patients within these emergency departments during the audit period.

**Deliberate Scope Simplification:** This study focused on acute vestibular presentations and excluded chronic or sub-acute conditions such as vestibular migraine, Menière's disease, and concussion-related dizziness. These conditions often require longitudinal assessment and access to specialised investigations, which are not typically available within the emergency department setting. This scope was intended to maintain focus on conditions where bedside assessments, such as HINTS-plus and BPPV manoeuvres, have the greatest diagnostic utility. By limiting the scope in this way, the study reflects the constraints and priorities of acute emergency care, supporting ecological validity within a high-pressure clinical environment.

#### **4.7.15 Future Directions Clinical Implications**

**A Mandate for Systemic Realignment:** The findings of this study highlight the need to reconsider current approaches to the management of acute vestibular presentations. The observed differences between diagnostic assessment and treatment within medical-led care pathways suggest variation in the delivery of evidence-based care. These results indicate that existing models may not consistently meet the clinical or equity requirements of emergency department practice. This supports exploration of alternative approaches, including greater integration of multidisciplinary expertise, to improve alignment between assessment, diagnosis, and treatment.

**The Multi-Faceted Implementation Strategy:** Improving care for acute vestibular presentations is unlikely to be achieved through a single intervention. Instead, a *whiria*-led (to weave

together multiple strands) approach may be required, integrating multiple strands of clinical practice, training, and service design within emergency department systems. The use of structured diagnostic frameworks, such as TiTrATE and HINTS-plus, may support more consistent clinical assessment. Providing accessible clinical pathways through organisational intranet platforms may assist clinicians in navigating diagnostic and management steps, including BPPV assessment and treatment, as standardised pathways have been associated with improvements in efficiency and clinical outcomes (Savioli et al., 2022).

While the GRACE-3 guidelines emphasise clinician upskilling, implementation of large guideline frameworks may be challenging within time-pressured emergency settings (Edlow et al., 2023). An alternative approach may involve targeted training focused on high-yield examination skills. In this study, the head impulse test was the least performed metric in the HINTS exam. However, nystagmus assessment appears as an established clinical habit. Focused training on establishing an associative heuristic that links directly from nystagmus assessment to the head impulse test could present a simple action to improve the quality of care in differentiating between peripheral and central vestibular presentations. Targeting specific examination skills within existing clinical workflows may provide a practical approach to improving diagnostic consistency, supporting a gradual integration of evidence-based assessment into routine emergency care.

**Optimising the ED Physiotherapy Resource:** The findings of this study suggest that greater utilisation of emergency department physiotherapy services may support improved assessment of acute vestibular presentations. Previous literature supports team orientated diagnostic approaches based on clinical proficiency, rather than professional designation Miner et al. (2022). During the study period, ED physiotherapists were present during weekday business hours, covering approximately 62.5% of all presentations within this dataset. However, physiotherapy involvement occurred in only 18.6% of cases. This difference between availability and utilisation suggests that physiotherapy services may be underused as a diagnostic resource within the emergency department. Further investigation into patterns of presentation, including minority groups, may assist in optimising staffing models and ensuring equitable access to physiotherapy services. Future implementation strategies should focus on structured competency-based training in vestibular examination, integration of simplified assessment pathways, and targeted expansion of specialised physiotherapy roles with defined referral criteria.

**Improved Resource Utilisation:** The findings of this study highlight potential opportunities to improve resource use within emergency department care. Imaging, particularly CT, was frequently used despite its limited sensitivity for posterior circulation pathology in acute presentations.

Greater use of structured bedside assessments, such as the HINTS examination and positional BPPV assessments, may support more targeted use of imaging. This may reduce unnecessary

radiation exposure, limit the use of low-yield investigations, and improve patient flow within the emergency department.

The study also identified differences in treatment approach for BPPV. A high proportion of patients received vestibular suppressant medication (80.8%), while low rates of canalith repositioning manoeuvres were observed in the medical cohort. Increased use of repositioning manoeuvres may reduce reliance on pharmacological management and support more definitive treatment of symptoms. This may decrease the need for repeat presentations or follow-up in primary care where symptoms remain unresolved. Where appropriate, integration with outpatient physiotherapy services may support continuity of care beyond the emergency setting (Lloyd, Mackintosh, et al., 2020; Savioli et al., 2022).

**Te Tiriti-led Solution:** The principle of options, as outlined in the Waitangi Tribunal Wai 2575 report, recognises that a single model of care may not meet the needs of Māori patients (Treaty of Waitangi Tribunal, 2019). It supports access to services that are either culturally responsive within mainstream systems or specifically designed by Māori, for Māori.

While Māori-designed emergency vestibular services may not currently be widely available, the integration of ED physiotherapy may provide an additional option within existing care models. In this context, physiotherapy services could support more equitable access to specialised assessment, provided that care is delivered in a culturally responsive manner. This approach aligns with the principle of “options” by applying a Te Tiriti led, evidence-based solution, that promotes clinical equity and patient choice.

**PT utilisation and Systems Change:** The findings suggest that the ED physiotherapy role is well suited to the demands of acute vestibular care but remains limited in scale within the current system. While physiotherapy involvement was associated with higher rates of assessment and intervention, overall adherence across the department remained variable. This suggests that improvements in care will depend on both workforce capability and organisational processes. These findings support the role of structured education and training in vestibular assessment within emergency care. Embedding these approaches within departmental systems and clinical pathways, rather than relying on individual clinician experience, may support more consistent and sustainable improvements in practice

**Systems and Governance:** The findings of this study suggest that gaps in vestibular assessment are not solely attributable to individual clinical skill, but may also reflect broader system-level factors. Low completion rates of HINTS-plus, variation in BPPV management, and differences in access to physiotherapy are unlikely to be fully addressed through clinician education alone. This indicates a need to consider organisational and governance-level approaches to change, informed by

local data and aligned with equity principles. A solution for Aotearoa New Zealand should be developed in partnership between governmental and Māori health representative organisations, based on a framework of equity and flexible enough to include individual solutions integrated into a stronger coherent resolution. One potential framework to support this is *Whiria te Muka Tangata: The Anti-Racism Kaupapa*, which outlines a system-level approach to health service transformation in Aotearoa New Zealand (McMeeking et al., 2022). Although originally developed for anti-racism initiatives, its structure may be adaptable to the redesign of acute vestibular care pathways. This framework is based on four interconnected threads: Kawa (leadership), Tikanga (culture and practice), Ritenga (capability), and Putanga (outcomes and monitoring). The framework conceptualises the binding of these four threads, made up of constituent strands which when combined deliver a greater strength.

- **Kawa (Leadership and Governance):**

System change requires leadership to define priorities, communicate the purpose for change, and support implementation.

Example: Establishing a multidisciplinary leadership group, including medical, allied health, and Māori health representation, to guide service development based on local data.

- **Tikanga (Culture and Practice):**

This element focuses on embedding consistent, evidence-based practice within clinical pathways.

Example: Developing standardised vestibular assessment pathways incorporating HINTS-plus and BPPV evaluation within routine ED care.

- **Ritenga (Capability and Training):**

This relates to workforce capability and the integration of training into clinical environments.

Example: Structured education programmes supported by clinical mentorship and multidisciplinary training, including physiotherapy-led teaching.

- **Putanga (Outcomes and Monitoring):**

Ongoing evaluation is required to assess impact and ensure alignment with intended outcomes.

Example: Regular audit cycles with equity-focused indicators, including monitoring differences in assessment and access between Māori and non-Māori patients.

Woven together, these threads provide a structured approach to implementing change that integrates clinical practice, workforce development, and governance. The findings of this audit demonstrate both the progress made in recognising vestibular conditions and the remaining variation in care.

Application of a coordinated systems approach may support more consistent and equitable delivery of vestibular assessment within emergency departments. In applying the four threads of Whiria te Muka Tangata, we could ensure the next stage of the journey is not just faster, but more just.

## 4.8 Conclusion

This study was designed to generate locally relevant data describing the assessment and management of acute dizziness and vertigo within an urban Aotearoa New Zealand emergency department. Using an equity-focused sampling approach, it provides an empirical basis for examining adherence to evidence-based practice and variation in clinical care.

**Synthesis of Findings:** This research provides novel insight into emergency department vestibular care within Aotearoa New Zealand, including one of the first documented analyses incorporating Māori patient data in this context. The findings contribute to a growing body of evidence that questions the reliability of routine diagnostic practices and highlights the importance of structured, evidence-based assessment in acute vestibular presentations. Patients presenting with acute vestibular symptoms received low levels of documented evidence-aligned care across both assessment and treatment domains. This pattern was observed in both Māori and non-Māori cohorts, although Māori patients received slightly lower rates of guideline-adherent care and had reduced access to ED physiotherapy services. The findings highlight variation in clinical practice, including low completion of structured assessments such as HINTS-plus and differences in BPPV management. Physiotherapy involvement was associated with higher rates of evidence-based assessment and treatment, indicating the value of specialised clinical expertise within the emergency department setting. More broadly, the study demonstrates a gap between guideline recommendations and clinical practice, suggesting that current care pathways may not consistently support optimal diagnostic and management approaches for acute vestibular presentations. Overall, the study supports the need for system-level approaches to improve consistency, equity, and alignment with evidence-based care in the management of acute dizziness and vertigo.

### 4.8.1 Clinical Implications

#### 1. Systemic Reform and Leadership Responsibility

The findings suggest a gap between diagnosis and treatment within current care pathways. Addressing this may require system-level approaches that integrate multiple aspects of care delivery. Emergency department leadership has an important role in coordinating, supporting and assuming responsibility for implementation of these changes.

#### 2. Digital Clinical Decision Support

The development of structured clinical pathways for acute vestibular presentations may support more consistent assessment. Making these tools accessible via organisational intranets may assist clinicians in navigating diagnostic and management decisions at the point of care.

#### 3. Targeted Training Approaches

Training approaches may be more effective when focused on high-yield examination skills rather than

broad guideline coverage. Linking established clinical practices (such as nystagmus assessment) with additional steps (such as the head impulse test) may support improved uptake. In this study, omission of the head impulse test was a key contributor to incomplete HINTS assessments.

#### **4. Optimisation of ED Physiotherapy**

The degree of ED physiotherapy inclusion described in Chapter 4.7.15 indicates that physiotherapy may be underutilised as a diagnostic resource. Greater integration of physiotherapy at earlier stages of assessment may support more consistent application of evidence-based care.

#### **5. Resource Use and Patient Safety**

Frequent use of CT imaging, despite its known limitations in acute vestibular presentations, highlights opportunities for more targeted investigation. Increased use of bedside assessment may reduce unnecessary imaging, radiation exposure, and healthcare costs. Similarly, greater use of repositioning manoeuvres may support more definitive management of BPPV and reduce reliance on pharmacological treatment.

#### **6. Te Tiriti-led Equity Considerations: Principle of Options**

The Wai 2575 report emphasises the importance of providing care options that are both accessible and culturally appropriate. Expanding access to physiotherapy services, while ensuring cultural responsiveness, may support more equitable delivery of care.

#### **4.8.2 Organisational Recommendations**

Addressing the gap between knowledge and practice in the management of acute dizziness and vertigo requires more than individual clinician education. The findings suggest that variation in care may reflect broader organisational structures and processes.

Within healthcare systems, clinical outcomes are shaped by the design of service pathways, resource allocation, and governance decisions. As such, improving care may depend on system-level changes that align organisational priorities with evidence-based practice and equity principles. This highlights the importance of organisational accountability in supporting consistent, high-quality care. By reviewing and adapting existing systems, there is an opportunity to improve both clinical outcomes and equity in emergency department settings.

#### **4.8.3 Future Research**

**Māori Health Experiences and Co-Design:** Future qualitative research is needed to explore Māori experiences of acute vestibular presentations and to better understand factors influencing low presentation rates to the emergency department. The limited representation of Indigenous perspectives in vestibular research highlights the need for locally relevant evidence to support equitable service

design. Future work should prioritise Māori involvement across all stages of research, including data collection, analysis, and co-design of care models.

**Local Barriers to Evidence-Based Care:** Further research is required to identify barriers to implementing evidence-based vestibular assessment within local emergency departments. While implementation challenges have been described in the literature (Bradshaw et al., 2023; Herdman et al., 2023; Ip et al., 2022), understanding local organisational and clinical factors is essential. This may include exploration of clinician perspectives, workflow constraints, and system-level influences on care delivery.

**Interdisciplinary Knowledge Translation:** Future studies should examine approaches to translating specialised vestibular assessment skills across professional groups. This may include development of interdisciplinary training models, such as mentorship frameworks, where experienced clinicians support interdisciplinary peers in the use of complex bedside assessments. Such approaches may assist with skill adoption and retention in emergency care settings.

**Systems Analysis and Closed-Loop Auditing:** A comprehensive systems analysis should be conducted to map the institutional stakeholders, cultural drivers, and behavioural incentives that perpetuate current clinical outcomes. Identifying these systemic leverage points is essential for establishing institutional accountability and driving meaningful organisational change. Finally, a formal, closed-loop re-audit must be scheduled to measure the long-term success and sustainability of any implemented interventions.

#### **4.8.4 Concluding Statement**

This study highlights a persistent gap between evidence-based recommendations and their application within emergency department care for acute vestibular presentations. Despite the availability of validated diagnostic tools, translation into routine practice remains inconsistent. The findings demonstrate variation in both assessment and management, alongside differences in access to specialised services. While physiotherapy involvement was associated with higher rates of evidence-aligned care, reliance on a single professional group is unlikely to provide a complete solution. Addressing these challenges requires system-level approaches that integrate clinical practice, workforce capability, and organisational governance. In this context, improving care will depend not only on individual clinician skill, but on the design and accountability of the systems within which care is delivered. Overall, this study supports the need for coordinated, equity-focused approaches to ensure consistent, safe, and effective management of acute dizziness and vertigo within emergency departments.

## References

- Abraham, S., Tauranga, M., & Moore, D. (2018). Adult Māori patients' healthcare experiences of the emergency department in a district health facility in New Zealand. *International Journal of Indigenous Health*.
- Agrawal, Y., Zuniga, M. G., Davalos-Bichara, M., Schubert, M. C., Walston, J. D., Hughes, J., & Carey, J. P. (2012). Decline in semicircular canal and otolith function with age. *Otol Neurotol*, 33(5), 832-839. <https://doi.org/10.1097/MAO.0b013e3182545061>
- Andrade, C. (2018). Internal, external, and ecological validity in research design, conduct, and evaluation. *Indian J Psychol Med*, 40(5), 498-499. [https://doi.org/10.4103/IJPSYM.IJPSYM\\_334\\_18](https://doi.org/10.4103/IJPSYM.IJPSYM_334_18)
- Andreev, A., & Mindova, S. (2024). Advancements in vestibular physiotherapy: A comprehensive review. *Journal of IMAB - Annual Proceeding (Scientific Papers)*.
- Ardagh, M. (2017). The 'six hour target' in New Zealand is associated with reduced mortality and greater efficiency. *The New Zealand medical journal*, 130(1455), 12.
- Ardagh, M., & Drew, L. (2015). What have five years of the shorter stays in the emergency department health target done to us. *The New Zealand medical journal*.
- Armstrong, R., Hall, B. J., Doyle, J., & Waters, E. (2011). Cochrane update. 'Scoping the scope' of a cochrane review. *J Public Health (Oxf)*, 33(1), 147-150. <https://doi.org/10.1093/pubmed/fdr015>
- Aromataris, E., & Munn, Z. (2020). *JBIM manual for evidence synthesis*. JBI. <https://doi.org/10.46658/JBIMES-24-01>
- Aroor, S., Singh, R., & Goldstein, L. B. (2017). BE-FAST (Balance, Eyes, Face, Arm, Speech, Time): Reducing the proportion of strokes missed using the FAST mnemonic. *Stroke*, 48(2), 479-481. <https://doi.org/10.1161/STROKEAHA.116.015169>
- Arrich, J., Raff, T., Hohenstein, C., & Behringer, W. (2017). Adequate staffing in the emergency department. *Hospital Healthcare Europe*.
- Arshad, Q., & Seemungal, B. M. (2016). Age-related vestibular loss: Current understanding and future research directions. *Front Neurol*, 7, 231. <https://doi.org/10.3389/fneur.2016.00231>
- Ashiq, I. N., Khan, S., & Yousaf, A. (2024). Comparative diagnostic accuracy of computed tomography scan versus magnetic resonance imaging in the emergency department for the evaluation of dizziness: A systematic review. *Indian J Radiol Imaging*, 34(3), 488-495. <https://doi.org/10.1055/s-0044-1778726>
- Atzema, C. L., Grewal, K., Lu, H., Kapral, M. K., Kulkarni, G., & Austin, P. C. (2016). Outcomes among patients discharged from the emergency department with a diagnosis of peripheral vertigo. *Ann Neurol*, 79(1), 32-41. <https://doi.org/10.1002/ana.24521>
- Australasian College for Emergency Medicine. (2022). *Te rautaki manaaki mana: Excellence in emergency care for Māori*. <https://acem.org.au/getmedia/01f5a2ee-6f53-401b-807f-df2dbf4ac418/Te-Rautaki-Manaaki-Mana>
- Barrett, R., & Terry, L. (2018). Patients' and healthcare professionals' experiences and perceptions of physiotherapy services in the emergency department: a qualitative systematic review. *Int J Emerg Med*, 11(1), 42. <https://doi.org/10.1186/s12245-018-0201-z>
- Bashir, K., Alessai, G. S., Salem, W. A., Irfan, F. B., & Cameron, P. A. (2014). Physical maneuvers: effective but underutilized treatment of benign paroxysmal positional vertigo in the ED. *Am J Emerg Med*, 32(1), 95-96. <https://doi.org/10.1016/j.ajem.2013.10.012>
- Bashir, K., Qotb, M. A., Alkahky, S., Fathi, A. M., Mohamed, M. A., & Cameron, P. A. (2015). Are emergency physicians and paramedics providing canalith repositioning manoeuvre for benign paroxysmal positional vertigo? *Emerg Med Australas*, 27(2), 179-180. <https://doi.org/10.1111/1742-6723.12362>
- Benchimol, E. I., Smeeth, L., Guttman, A., Harron, K., Moher, D., Petersen, I., Sorensen, H. T., von Elm, E., Langan, S. M., & Committee, R. W. (2015). The reporting of studies conducted using

- observational routinely-collected health data (RECORD) statement. *PLoS Med*, 12(10), e1001885. <https://doi.org/10.1371/journal.pmed.1001885>
- Benecke, H., Agus, S., Kuessner, D., Goodall, G., & Strupp, M. (2013). The burden and impact of vertigo: Findings from the REVERT patient registry. *Front Neurol*, 4, 136. <https://doi.org/10.3389/fneur.2013.00136>
- Bery, A. K., Hale, D. E., Newman-Toker, D. E., & Saber Tehrani, A. S. (2025). Evaluation of acute dizziness and vertigo [Review]. *Med Clin North Am*, 109(2), 373-388. <https://doi.org/10.1016/j.mcna.2024.09.006>
- Bhat, S., Bir, S., Schreve, F., Bergin, C. J., Jones, P. G., & Waqanivavalagi, S. (2022). Ethnic disparities in CT aortography use for diagnosing acute aortic syndrome. *Radiol Cardiothorac Imaging*, 4(6), e220018. <https://doi.org/10.1148/ryct.220018>
- Bhattacharyya, N., Gubbels, S. P., Schwartz, S. R., Edlow, J. A., El-Kashlan, H., Fife, T., Holmberg, J. M., Mahoney, K., Hollingsworth, D. B., Roberts, R., Seidman, M. D., Steiner, R. W., Do, B. T., Voelker, C. C., Waguespack, R. W., & Corrigan, M. D. (2017). Clinical practice guideline: Benign paroxysmal positional vertigo (update). *Otolaryngol Head Neck Surg*, 156(3\_suppl), S1-S47. <https://doi.org/10.1177/0194599816689667>
- Bierrum, W., Haider, S., Balaratnam, M., Alim-Marvasti, A., Chandratheva, A., Simister, R., Koohi, N., & Kaski, D. (2023). Hyperacute vestibular syndrome: The role of an acute vertigo service. *Front Stroke*, 2, 1265009. <https://doi.org/10.3389/fstro.2023.1265009>
- Bisdorff, A. R., Staab, J. P., & Newman-Toker, D. E. (2015). Overview of the international classification of vestibular disorders. *Neurol Clin*, 33(3), 541-550, vii. <https://doi.org/10.1016/j.ncl.2015.04.010>
- Bladin, C. F., & Cadilhac, D. A. (2014). Effect of telestroke on emergent stroke care and stroke outcomes. *Stroke*, 45(6), 1876-1880. <https://doi.org/10.1161/STROKEAHA.114.003825>
- Bourke, J. A., Owen, H. E., Derrett, S., & Wyeth, E. H. (2023). Disrupted mana and systemic abdication: Maori qualitative experiences accessing healthcare in the 12 years post-injury. *BMC Health Serv Res*, 23(1), 130. <https://doi.org/10.1186/s12913-023-09124-0>
- Bradshaw, S., Graco, M., & Holland, A. (2023). Barriers and facilitators to guideline-recommended care of benign paroxysmal positional vertigo in the ED: A qualitative study using the theoretical domains framework. *Emerg Med J*, 40(5), 335-340. <https://doi.org/10.1136/emered-2022-212585>
- Brown, M. D. (2011). Evidence-based emergency medicine. Is the canalith repositioning maneuver effective in the acute management of benign positional vertigo? *Ann Emerg Med*, 58(3), 286-287. <https://doi.org/10.1016/j.annemergmed.2011.02.024>
- Burbules, N. C. (2000). *Postpositivism and educational research*. Bloomsbury Publishing PLC.
- Came, H. (2013). Doing research in Aotearoa: A Pākehā exemplar of applying Te Ara Tika ethical framework. *Kotuitui: New Zealand Journal of Social Sciences Online*, 8(1-2), 64-73.
- Caplan, L. R. (2007). Dizziness: How do patients describe dizziness and how do emergency physicians use these descriptions for diagnosis? Mayo Clinic Proceedings,
- Celik, E. K., Oner, F., & Akay, H. G. (2024). Do single-session Epley maneuvers treat benign paroxysmal positional vertigo? *Ann Saudi Med*, 44(3), 161-166. <https://doi.org/10.5144/0256-4947.2024.161>
- Chari, D. A., Wu, M. J., Crowson, M. G., Kozin, E. D., & Rauch, S. D. (2020). Telemedicine algorithm for the management of dizzy patients. *Otolaryngol Head Neck Surg*, 163(5), 857-859. <https://doi.org/10.1177/0194599820935859>
- Clark, A. M. (1998). The qualitative-quantitative debate: Moving from positivism and confrontation to post-positivism and reconciliation. *J Adv Nurs*, 27(6), 1242-1249. <https://doi.org/10.1046/j.1365-2648.1998.00651.x>
- Collewijn, H., & Smeets, J. B. (2000). Early components of the human vestibulo-ocular response to head rotation: Latency and gain. *J Neurophysiol*, 84(1), 376-389. <https://doi.org/10.1152/jn.2000.84.1.376>

- Comolli, L., Korda, A., Zamaro, E., Wagner, F., Sauter, T. C., Caversaccio, M. D., Nikles, F., Jung, S., & Mantokoudis, G. (2023). Vestibular syndromes, diagnosis and diagnostic errors in patients with dizziness presenting to the emergency department: a cross-sectional study. *BMJ Open*, 13(3), e064057. <https://doi.org/10.1136/bmjopen-2022-064057>
- Cristiano, E., Marcelli, V., Giannone, A., De Luca, S., Oliva, F., Varriale, R., Motta, G., Paladino, F., Benincasa, M., Perrella, M., & Ricciardiello, F. (2020). Diagnosis of benign paroxysmal positional vertigo in emergency department: Our experience. *Audiol Res*, 10(1), 232. <https://doi.org/10.4081/audiores.2020.232>
- Curley, D., & Gozman, D. (2026). Maintaining emergency department operational efficiency and capacity management in the era of emergency department overcrowding and inpatient boarding. . In: *Medical Research Archives*, 14 (4).
- Curtis, E. (2016). Indigenous positioning in health research: The importance of kaupapa Māori theory-informed practice. *AlterNative: An International Journal of Indigenous Peoples*, 12(4), 396-410. <https://doi.org/https://doi.org/10.1111/1742-6723.13876>
- Curtis, E., Paine, S.-J., Jiang, Y., Jones, P., Raumati, I., Tomash, I., Healey, O., & Reid, P. (2020). Examining emergency department inequities between Māori and non-Māori: Do they exist? *European Journal of Public Health*.
- Curtis, E., Paine, S. J., Jiang, Y., Jones, P., Tomash, I., Raumati, I., & Reid, P. (2019). Examining emergency department inequities: Do they exist? *Emergency Medicine Australasia*, 31(3), 444-450.
- Daocai, W., Qing, W., Ximing, W., Jingzhen, H., Cheng, L., & Xiangxing, M. (2014). Size of the semicircular canals measured by multidetector computed tomography in different age groups. *J Comput Assist Tomogr*, 38(2), 196-199. <https://doi.org/10.1097/RCT.0b013e3182aaf21c>
- De Benedictis, A., Rossi-Espagnet, M. C., de Palma, L., Carai, A., & Marras, C. E. (2022). Networking of the human cerebellum: From anatomo-functional development to neurosurgical implications. *Front Neurol*, 13, 806298. <https://doi.org/10.3389/fneur.2022.806298>
- de Gruchy, A., Granger, C., & Gorelik, A. (2015). Physical therapists as primary practitioners in the emergency department: Six-month prospective practice analysis. *Physical therapy*, 95(9), 1207-1216. <https://doi.org/https://doi.org/10.2522/ptj.20140505>
- Della Santina, C. C., Potyagaylo, V., Migliaccio, A. A., Minor, L. B., & Carey, J. P. (2005). Orientation of human semicircular canals measured by three-dimensional multiplanar CT reconstruction. *J Assoc Res Otolaryngol*, 6(3), 191-206. <https://doi.org/10.1007/s10162-005-0003-x>
- Dieterich, M., & Brandt, T. (2015). The bilateral central vestibular system: its pathways, functions, and disorders. *Ann N Y Acad Sci*, 1343(1), 10-26. <https://doi.org/10.1111/nyas.12585>
- Dmitriew, C., Regis, A., Bodunde, O., Lepage, R., Turgeon, Z., McIsaac, S., & Ohle, R. (2021). Diagnostic accuracy of the HINTS exam in an emergency department: A retrospective chart review. *Acad Emerg Med*, 28(4), 387-393. <https://doi.org/10.1111/acem.14171>
- Drachman, D. A., & Hart, C. W. (1972). An approach to the dizzy patient. *Neurology*, 22(4), 323-334. <https://doi.org/10.1212/wnl.22.4.323>
- Drennan, V. M., Halter, M., Taylor, F., Gabe, J., & Jarman, H. (2023). Non-medical practitioners in the staffing of emergency departments and urgent treatment centres in England: A mixed qualitative methods study of policy implementation. *BMC Health Serv Res*, 23(1), 1221. <https://doi.org/10.1186/s12913-023-10220-4>
- Dubey, P., Saxena, A., Jordan, J. E., Xian, Z., Javed, Z., Jindal, G., Vahidy, F., Sostman, D. H., & Nasir, K. (2022). Contemporary national trends and disparities for head CT use in emergency department settings: Insights from national hospital ambulatory medical care survey (NHAMCS) 2007-2017. *J Natl Med Assoc*, 114(1), 69-77. <https://doi.org/10.1016/j.jnma.2021.12.001>
- Durey, A., & Thompson, S. C. (2012). Reducing the health disparities of Indigenous Australians: Time to change focus. *BMC Health Serv Res*, 12, 151. <https://doi.org/10.1186/1472-6963-12-151>

- Durie, M. H. (1985). A Maori perspective of health. *Soc Sci Med*, 20(5), 483-486.  
[https://doi.org/10.1016/0277-9536\(85\)90363-6](https://doi.org/10.1016/0277-9536(85)90363-6)
- Dutch, M. J., Taylor, D. M., & Dent, A. W. (2008). Triage presenting complaint descriptions bias emergency department waiting times. *Acad Emerg Med*, 15(8), 731-735.  
<https://doi.org/10.1111/j.1553-2712.2008.00177.x>
- Dyhrfjeld-Johnsen, J., & Attali, P. (2019). Management of peripheral vertigo with antihistamines: New options on the horizon. *Br J Clin Pharmacol*, 85(10), 2255-2263.  
<https://doi.org/10.1111/bcp.14046>
- Eagles, D., Stiell, I. G., Clement, C. M., Brehaut, J., Kelly, A. M., Mason, S., Kellermann, A., & Perry, J. J. (2008). International survey of emergency physicians' priorities for clinical decision rules. *Acad Emerg Med*, 15(2), 177-182. <https://doi.org/10.1111/j.1553-2712.2008.00035.x>
- Edlow, J. A. (2019). The timing-and-triggers approach to the patient with acute dizziness. *Emerg Med Pract*, 21(12), 1-24. <https://www.ncbi.nlm.nih.gov/pubmed/31765116>
- Edlow, J. A., Carpenter, C., Akhter, M., Khoujah, D., Marcolini, E., Meurer, W. J., Morrill, D., Naples, J. G., Ohle, R., Omron, R., Sharif, S., Siket, M., Upadhye, S., LOJ, E. S., Sundberg, E., Tartt, K., Vanni, S., Newman-Toker, D. E., & Bellolio, F. (2023). Guidelines for reasonable and appropriate care in the emergency department 3 (GRACE-3): Acute dizziness and vertigo in the emergency department. *Acad Emerg Med*, 30(5), 442-486.  
<https://doi.org/10.1111/acem.14728>
- Edlow, J. A., Gurley, K. L., & Newman-Toker, D. E. (2018). A new diagnostic approach to the adult patient with acute dizziness. *J Emerg Med*, 54(4), 469-483.  
<https://doi.org/10.1016/j.jemermed.2017.12.024>
- Edlow, J. A., & Kerber, K. (2023). Benign paroxysmal positional vertigo: A practical approach for emergency physicians. *Acad Emerg Med*, 30(5), 579-588.  
<https://doi.org/10.1111/acem.14558>
- Edlow, J. A., & Newman-Toker, D. (2016). Using the physical examination to diagnose patients with acute dizziness and vertigo. *J Emerg Med*, 50(4), 617-628.  
<https://doi.org/10.1016/j.jemermed.2015.10.040>
- Edmonds, M., Shankar, S., Elia, T. I., Campos, C. F., Lyndon, M., & Weller, J. M. (2024). Māori experiences and perspectives of hospital treatment in the context of acute care. *N Z Med J*, 137(1601), 63-73. <https://doi.org/10.26635/6965.6397>
- Epley, J. M. (1992). The canalith repositioning procedure: For treatment of benign paroxysmal positional vertigo. *Otolaryngol Head Neck Surg*, 107(3), 399-404.  
<https://doi.org/10.1177/019459989210700310>
- Espiner, E., Paine, S. J., Weston, M., & Curtis, E. (2021). Barriers and facilitators for Māori in accessing hospital services in Aotearoa New Zealand. *N Z Med J*, 134(1546), 47-58.  
<https://www.ncbi.nlm.nih.gov/pubmed/34855733>
- Evans, A., Frost, K., Wood, E., & Herdman, D. (2024). Management of recurrent benign paroxysmal positional vertigo. *J Laryngol Otol*, 138(S2), S18-S21.  
<https://doi.org/10.1017/S0022215123002244>
- Evans, J. G. (1990). Transient neurological dysfunction and risk of stroke in an elderly English population: The different significance of vertigo and non-rotatory dizziness. *Age Ageing*, 19(1), 43-49. <https://doi.org/10.1093/ageing/19.1.43>
- Ezzelregal, A. (2016). *Audio-vestibular findings in pregnancy* [Master's thesis Cairo University].
- Ferguson, L. (2004). External validity, generalizability, and knowledge utilization. *J Nurs Scholarsh*, 36(1), 16-22. <https://doi.org/10.1111/j.1547-5069.2004.04006.x>
- Ferreira, G. E., Traeger, A. C., & Maher, C. G. (2019). Review article: A scoping review of physiotherapists in the adult emergency department. *Emerg Med Australas*, 31(1), 43-57.  
<https://doi.org/10.1111/1742-6723.12987>

- Fife, T. D., & von Brevern, M. (2018). Benign paroxysmal positional vertigo in the acute care setting. *D.C. Tracts*, 30(3), 10-10. <https://research.ebsco.com/linkprocessor/plink?id=f44fe7d1-8075-357c-86d8-47b6124292a1>
- Filippopoulos, F. M., Strobl, R., Belanovic, B., Dunker, K., Grill, E., Brandt, T., Zwergal, A., & Huppert, D. (2022). Validation of a comprehensive diagnostic algorithm for patients with acute vertigo and dizziness. *Eur J Neurol*, 29(10), 3092-3101. <https://doi.org/10.1111/ene.15448>
- Fox, N. J. (2008). Post-positivism. *The SAGE encyclopedia of qualitative research methods*, 2(1), 659-664.
- Gabrielsen, E., Lindstrom, U. A., & Naden, D. (2009). Acute--an ambiguous concept in healthcare. *Scand J Caring Sci*, 23(3), 589-597. <https://doi.org/10.1111/j.1471-6712.2008.00646.x>
- Gagnon, R., Guertin, J. R., Perreault, K., LaRue, S., Berthelot, S., Gatovo, K. E., Lafrance, S., & Hebert, L. J. (2026). Could primary contact physical therapy improve emergency department care while being efficient? A 3-month cost-utility analysis. *J Orthop Sports Phys Ther*, 56(2), 109-118. <https://doi.org/10.2519/jospt.2025.13429>
- Gagnon, R., Perreault, K., Berthelot, S., Matifat, E., Desmeules, F., Achou, B., Laroche, M. C., Van Neste, C., Tremblay, S., Leblond, J., & Hebert, L. J. (2021). Direct-access physiotherapy to help manage patients with musculoskeletal disorders in an emergency department: Results of a randomized controlled trial [Article]. *Acad Emerg Med*, 28(8), 848-858. <https://doi.org/10.1111/acem.14237>
- Gagnon, R., Perreault, K., Matifat, E., Desmeules, F., Berthelot, S., & Hébert, L. J. (2024). Diagnostic concordance between physiotherapist and emergency physicians for patients with a musculoskeletal disorder in the emergency department. *Musculoskeletal Care*, 22.
- Gerlier, C., Fels, A., Vitaux, H., Mousset, C., Perugini, A., Chatellier, G., & Ganansia, O. (2023). Effectiveness and reliability of the four-step STANDING algorithm performed by interns and senior emergency physicians for predicting central causes of vertigo. *Acad Emerg Med*, 30(5), 487-500. <https://doi.org/10.1111/acem.14659>
- Gerlier, C., Hoarau, M., Fels, A., Vitaux, H., Mousset, C., Farhat, W., Firmin, M., Pouyet, V., Paoli, A., Chatellier, G., & Ganansia, O. (2021). Differentiating central from peripheral causes of acute vertigo in an emergency setting with the HINTS, STANDING, and ABCD2 tests: A diagnostic cohort study. *Acad Emerg Med*, 28(12), 1368-1378. <https://doi.org/10.1111/acem.14337>
- Giardino, D., Musazzi, M., Perez Akly, M., Cherchi, M., & Yacovino, D. A. (2021). A comparative study of two methods for treatment of benign paroxysmal positional vertigo in the emergency department. *J Otol*, 16(4), 231-236. <https://doi.org/10.1016/j.joto.2021.04.002>
- Gilbert, E. H., Lowenstein, S. R., Koziol-McLain, J., Barta, D. C., & Steiner, J. (1996). Chart reviews in emergency medicine research: Where are the methods? *Ann Emerg Med*, 27(3), 305-308. [https://doi.org/10.1016/s0196-0644\(96\)70264-0](https://doi.org/10.1016/s0196-0644(96)70264-0)
- Goeldlin, M., Gaschen, J., Kammer, C., Comolli, L., Bernasconi, C. A., Spiegel, R., Bassetti, C. L., Exadaktylos, A. K., Lehmann, B., Mantokoudis, G., Kalla, R., & Fischer, U. (2019). Frequency, aetiology, and impact of vestibular symptoms in the emergency department: a neglected red flag. *J Neurol*, 266(12), 3076-3086. <https://doi.org/10.1007/s00415-019-09525-4>
- Goldberg, E. M., Marks, S. J., Resnik, L. J., Long, S., Mellott, H., & Merchant, R. C. (2020). Can an emergency department-initiated intervention prevent subsequent falls and health care use in older adults? A randomized controlled trial. *Ann Emerg Med*, 76(6), 739-750. <https://doi.org/10.1016/j.annemergmed.2020.07.025>
- Gopinath, B., Tang, D., Burlutsky, G., & Mitchell, P. (2024). Ten-year incidence, predictors and impact of dizziness and vertigo in community-dwelling adults. *Maturitas*, 180, 107890. <https://doi.org/10.1016/j.maturitas.2023.107890>
- Gottlieb, M., Peksa, G. D., & Carlson, J. N. (2023). Head impulse, nystagmus, and test of skew examination for diagnosing central causes of acute vestibular syndrome. *Cochrane Database Syst Rev*, 11(11), CD015089. <https://doi.org/10.1002/14651858.CD015089.pub2>

- Gracey, M., & King, M. (2009). Indigenous health part 1: Determinants and disease patterns. *Lancet*, 374(9683), 65-75. [https://doi.org/10.1016/S0140-6736\(09\)60914-4](https://doi.org/10.1016/S0140-6736(09)60914-4)
- Graham, R., & Masters-Awatere, B. (2020). Experiences of Maori of Aotearoa New Zealand's public health system: A systematic review of two decades of published qualitative research. *Aust N Z J Public Health*, 44(3), 193-200. <https://doi.org/10.1111/1753-6405.12971>
- Grant, B. M., & Giddings, L. S. (2002). Making sense of methodologies: A paradigm framework for the novice researcher. *Contemp Nurse*, 13(1), 10-28. <https://doi.org/10.5172/conu.13.1.10>
- Grant, M. J., & Booth, A. (2009). A typology of reviews: An analysis of 14 review types and associated methodologies. *Health Info Libr J*, 26(2), 91-108. <https://doi.org/10.1111/j.1471-1842.2009.00848.x>
- Grewal, K., Austin, P. C., Kapral, M. K., Lu, H., & Atzema, C. L. (2015). Missed strokes using computed tomography imaging in patients with vertigo: Population-based cohort study. *Stroke*, 46(1), 108-113. <https://doi.org/10.1161/STROKEAHA.114.007087>
- Grill, E., Heuberger, M., Strobl, R., Saglam, M., Holle, R., Linkohr, B., Ladwig, K. H., Peters, A., Schneider, E., Jahn, K., & Lehnen, N. (2018). Prevalence, determinants, and consequences of vestibular hypofunction. Results from the KORA-FF4 survey. *Front Neurol*, 9, 1076. <https://doi.org/10.3389/fneur.2018.01076>
- Gurley, K. L., & Edlow, J. A. (2019). Avoiding misdiagnosis in patients with posterior circulation ischemia: A narrative review. *Acad Emerg Med*, 26(11), 1273-1284. <https://doi.org/10.1111/acem.13830>
- Hall, C. D., Herdman, S. J., Whitney, S. L., Anson, E. R., Carender, W. J., Hoppes, C. W., Cass, S. P., Christy, J. B., Cohen, H. S., Fife, T. D., Furman, J. M., Shepard, N. T., Clendaniel, R. A., Dishman, J. D., Goebel, J. A., Meldrum, D., Ryan, C., Wallace, R. L., & Woodward, N. J. (2022). Vestibular Rehabilitation for Peripheral Vestibular Hypofunction: An Updated Clinical Practice Guideline From the Academy of Neurologic Physical Therapy of the American Physical Therapy Association. *J Neurol Phys Ther*, 46(2), 118-177. <https://doi.org/10.1097/NPT.0000000000000382>
- Hanley, K., & O' Dowd, T. (2002). Symptoms of vertigo in general practice: a prospective study of diagnosis. *Br J Gen Pract*, 52(483), 809-812. <https://www.ncbi.nlm.nih.gov/pubmed/12392120>
- Harris, P. A., Taylor, R., Minor, B. L., Elliott, V., Fernandez, M., O'Neal, L., McLeod, L., Delacqua, G., Delacqua, F., Kirby, J., Duda, S. N., & Consortium, R. E. (2019). The REDCap consortium: Building an international community of software platform partners. *J Biomed Inform*, 95, 103208. <https://doi.org/10.1016/j.jbi.2019.103208>
- Harris, P. A., Taylor, R., Thielke, R., Payne, J., Gonzalez, N., & Conde, J. G. (2009). Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *Journal of biomedical informatics*, 42(2), 377-381.
- Harris, R., Tobias, M., Jeffreys, M., Waldegrave, K., Karlsen, S., & Nazroo, J. (2006). Racism and health: the relationship between experience of racial discrimination and health in New Zealand. *Soc Sci Med*, 63(6), 1428-1441. <https://doi.org/10.1016/j.socscimed.2006.04.009>
- Health Quality, & Safety Commission. (2019). A window on the quality of Aotearoa New Zealand's health care 2019—a view on Māori health equity. In: Health Quality & Safety Commission Wellington.
- Herdman, D. (2024). Advances in the diagnosis and management of acute vertigo. *J Laryngol Otol*, 138(S2), S8-S13. <https://doi.org/10.1017/S0022215123002232>
- Herdman, D., Ahmad, H., Antoniadis, G., Bailur, G., Pajaniappane, A., & Moss, P. (2023). Developing an implementation intervention for managing acute vertigo in the emergency department. *Emerg Med J*, 40(12), 840-846. <https://doi.org/10.1136/emermed-2023-213344>
- Herr, R. D., Zun, L., & Mathews, J. J. (1989). A directed approach to the dizzy patient. *Ann Emerg Med*, 18(6), 664-672. [https://doi.org/10.1016/s0196-0644\(89\)80524-4](https://doi.org/10.1016/s0196-0644(89)80524-4)

- Hillier, S. L., & Hollohan, V. (2007). Vestibular rehabilitation for unilateral peripheral vestibular dysfunction. *Cochrane Database Syst Rev*(4), CD005397. <https://doi.org/10.1002/14651858.CD005397.pub2>
- Hudson, M., Milne, M., Reynolds, P., Russell, K., & Smith, B. (2010). Te Ara Tika: Guidelines for Māori research ethics: A framework for researchers and ethics committee members. *Health Research Council of New Zealand*.
- Hunt, W. T., Zimmermann, E. F., & Hilton, M. P. (2012). Modifications of the Epley (canalith repositioning) manoeuvre for posterior canal benign paroxysmal positional vertigo (BPPV). *Cochrane Database Syst Rev*, 2012(4), CD008675. <https://doi.org/10.1002/14651858.CD008675.pub2>
- Hunter, B. R., Wang, A. Z., Bucca, A. W., Musey, P. I., Jr., Strachan, C. C., Roupf, S. K., Propst, S. L., Croft, A., Menard, L. M., & Kirschner, J. M. (2022). Efficacy of benzodiazepines or antihistamines for patients with acute vertigo: A systematic review and meta-analysis. *JAMA Neurol*, 79(9), 846-855. <https://doi.org/10.1001/jamaneurol.2022.1858>
- Imam, Y. Z., Chandra, P., Singh, R., Hakeem, I., Al Sirhan, S., Kotob, M., Akhtar, N., Kamran, S., Al Jerdi, S., Muhammad, A., Haroon, K. H., Hussain, S., Perkins, J. D., Elalamy, O., Alhatou, M., Ali, L., Abdelmoneim, M. S., Joseph, S., Morgan, D., . . . Deleu, D. (2024). Incidence, clinical features, and outcomes of posterior circulation ischemic stroke: Insights from a large multiethnic stroke database. *Front Neurol*, 15, 1302298. <https://doi.org/10.3389/fneur.2024.1302298>
- Ip, K., Lloyd, M., Luscombe, A., & Hitch, D. (2022). Implementing specialised vestibular physiotherapy in an emergency department: A process evaluation. *Implement Sci Commun*, 3(1), 63. <https://doi.org/10.1186/s43058-022-00313-2>
- Jaeger, D. (2022). Cerebellar nuclei and cerebellar learning. In M. U. Manto, D. L. Gruol, J. D. Schmahmann, N. Koibuchi, & R. V. Sillitoe (Eds.), *Handbook of the Cerebellum and Cerebellar Disorders* (pp. 1251-1274). Springer International Publishing. [https://doi.org/10.1007/978-3-030-23810-0\\_47](https://doi.org/10.1007/978-3-030-23810-0_47)
- Johnston, S. C., Rothwell, P. M., Nguyen-Huynh, M. N., Giles, M. F., Elkins, J. S., Bernstein, A. L., & Sidney, S. (2007). Validation and refinement of scores to predict very early stroke risk after transient ischaemic attack. *The Lancet*, 369(9558), 283-292.
- Jones, P., Le Fevre, J., Harper, A., Wells, S., Stewart, J., Curtis, E., Reid, P., & Ameratunga, S. (2017). Effect of the shorter stays in emergency departments time target policy on key indicators of quality of care. *N Z Med J*, 130(1455), 35-44. <https://www.ncbi.nlm.nih.gov/pubmed/28494476>
- Kaji, A. H., Schriger, D., & Green, S. (2014). Looking through the retrospectroscope: Reducing bias in emergency medicine chart review studies. *Annals of Emergency Medicine*, 64(3), 292-298.
- Kattah, J. C. (2018). Use of HINTS in the acute vestibular syndrome. An overview. *Stroke Vasc Neurol*, 3(4), 190-196. <https://doi.org/10.1136/svn-2018-000160>
- Kattah, J. C., Talkad, A. V., Wang, D., Hsieh, Y.-H., & Newman-Toker, D. E. (2009). Hints to diagnose stroke in the acute vestibular syndrome: Three-step bedside oculomotor examination more sensitive than early mri diffusion-weighted imaging. *Stroke*, 40, 3504-3510.
- Kavitha, Y., Joish, U. K., Sachin, K. S., & Gund, S. (2023). Estimation of normal semi-circular canal dimensions on computed tomography. *Indian J Otolaryngol Head Neck Surg*, 75(Suppl 1), 176-180. <https://doi.org/10.1007/s12070-022-03331-7>
- Kerber, K. A., Brown, D. L., Lisabeth, L. D., Smith, M. A., & Morgenstern, L. B. (2006). Stroke among patients with dizziness, vertigo, and imbalance in the emergency department: A population-based study. *Stroke*, 37(10), 2484-2487.
- Kerber, K. A., Burke, J. F., Skolarus, L. E., Meurer, W. J., Callaghan, B. C., Brown, D. L., Lisabeth, L. D., McLaughlin, T. J., Fendrick, A. M., & Morgenstern, L. B. (2013). Use of BPPV processes in emergency department dizziness presentations: A population-based study. *Otolaryngol Head Neck Surg*, 148(3), 425-430. <https://doi.org/10.1177/0194599812471633>

- Kerber, K. A., Damschroder, L., McLaughlin, T., Brown, D. L., Burke, J. F., Telian, S. A., Tsodikov, A., Fagerlin, A., An, L. C., Morgenstern, L. B., Forman, J., Vijan, S., Rowell, B., & Meurer, W. J. (2020). Implementation of evidence-based practice for benign paroxysmal positional vertigo in the emergency department: A stepped-wedge randomized trial. *Ann Emerg Med*, 75(4), 459-470. <https://doi.org/10.1016/j.annemergmed.2019.09.017>
- Kerber, K. A., Meurer, W. J., West, B. T., & Fendrick, A. M. (2008). Dizziness presentations in U.S. emergency departments, 1995-2004. *Acad Emerg Med*, 15(8), 744-750. <https://doi.org/10.1111/j.1553-2712.2008.00189.x>
- Kerber, K. A., Morgenstern, L. B., Meurer, W. J., McLaughlin, T., Hall, P. A., Forman, J., Fendrick, A. M., & Newman-Toker, D. E. (2011). Nystagmus assessments documented by emergency physicians in acute dizziness presentations: A target for decision support? *Acad Emerg Med*, 18(6), 619-626. <https://doi.org/10.1111/j.1553-2712.2011.01093.x>
- Kerber, K. A., & Newman-Toker, D. E. (2015). Misdiagnosing dizzy patients: Common pitfalls in clinical practice. *Neurol Clin*, 33(3), 565-575, viii. <https://doi.org/10.1016/j.ncl.2015.04.009>
- Khan, S., & Chang, R. (2013). Anatomy of the vestibular system: A review [Review]. *NeuroRehabilitation*, 32(3), 437-443. <https://doi.org/10.3233/NRE-130866>
- Khoujah, D., Naples, J. G., Silva, L., Edlow, J. A., Gerberi, D. J., Carpenter, C. R., & Bellolio, F. (2023). Epley maneuver for benign paroxysmal positional vertigo: Evidence synthesis for guidelines for reasonable and appropriate care in the emergency department. *Acad Emerg Med*, 30(5), 501-516. <https://doi.org/10.1111/acem.14739>
- Kim, H.-J., Lee, J.-R., Lee, H., & Kim, J.-S. (2024). Healthcare costs due to dizziness/vertigo in Korea: Analyses using the public data of health insurance review & assessment service. *Journal of Korean Medical Science*, 39.
- Kim, H. S., Schauer, J. M., Kan, A. K., Alinger, J. B., Strickland, K. J., Garreau, A., McCarthy, D. M., Taylor, Z. B., Fishman, I. L., Muschong, K. M., & Roth, H. R. (2025). Emergency department vestibular rehabilitation therapy for dizziness and vertigo: A nonrandomized clinical trial. *JAMA Netw Open*, 8(2), e2459567. <https://doi.org/10.1001/jamanetworkopen.2024.59567>
- Kim, J.-S., & Zee, D. S. (2014). Benign paroxysmal positional vertigo. *New England Journal of Medicine*, 370(12), 1138-1147.
- Kingma, H., & van de Berg, R. (2016). Chapter 1 - Anatomy, physiology, and physics of the peripheral vestibular system. In J. M. Furman & T. Lempert (Eds.), *Handbook of clinical neurology* (Vol. 137, pp. 1-16). Elsevier. <https://doi.org/10.1016/B978-0-444-63437-5.00001-7>
- Komene, E., Pene, B., Gerard, D., Parr, J., Aspinall, C., & Wilson, D. (2024). Whakawhanaungatanga-Building trust and connections: A qualitative study indigenous Maori patients and whanau (extended family network) hospital experiences. *J Adv Nurs*, 80(4), 1545-1558. <https://doi.org/10.1111/jan.15912>
- Lammers, K., Kumble, S., Sperle, C., McCarty, J. B., & Steinhorn, G. (2020). Influence of vestibular diagnosis and management on recommended discharge environment for hospitalized inpatients. *Journal of Acute Care Physical Therapy*, 11(3), 151-161. <https://doi.org/10.1097/jat.0000000000000128>
- Landis, J. R., & Koch, G. G. (1977). An application of hierarchical kappa-type statistics in the assessment of majority agreement among multiple observers. *Biometrics*, 363-374.
- Lateef, F., Yeong, Y. Q., Galwankar, S., Soxman, A., & Kamm, S. (2025). Emergency physicians: Creating ripples, expanding domains, and negotiating VUCA situations. *J Emerg Trauma Shock*, 18(2), 69-73. [https://doi.org/10.4103/jets.jets\\_112\\_24](https://doi.org/10.4103/jets.jets_112_24)
- Lee, G. T., Agbelie, C. E., & Lee, T. H. (2025). Use of physical therapists in the emergency department for benign paroxysmal positional vertigo (BPPV): A statewide retrospective analysis. *Acad Emerg Med*, 32(12), 1363-1366. <https://doi.org/10.1111/acem.70116>

- Lee, J. Y., Shin, K. J., Kim, J. N., Yoo, J. Y., Song, W. C., & Koh, K. S. (2013). A morphometric study of the semicircular canals using micro-CT images in three-dimensional reconstruction. *Anat Rec (Hoboken)*, 296(5), 834-839. <https://doi.org/10.1002/ar.22664>
- Lee, S.-H., & Kim, J. S. (2010). Benign paroxysmal positional vertigo. *Journal of Clinical Neurology*, 6(2), 51-63.
- Lee, S. U., Edlow, J. A., & Tarnutzer, A. A. (2025). Acute vertigo, dizziness and imbalance in the emergency department-beyond stroke and acute unilateral vestibulopathy-A narrative review. *Brain Sci*, 15(9). <https://doi.org/10.3390/brainsci15090995>
- Lefmann, S. A., & Crane, J. L. (2016). Establishing the diverse value of the emergency department physiotherapist [Editorial]. *J Physiother*, 62(1), 1-3. <https://doi.org/10.1016/j.jphys.2015.11.001>
- Lilford, R., Edwards, A., Girling, A., Hofer, T., Di Tanna, G. L., Petty, J., & Nicholl, J. (2007). Inter-rater reliability of case-note audit: A systematic review. *J Health Serv Res Policy*, 12(3), 173-180. <https://doi.org/10.1258/135581907781543012>
- Lloyd, M., Luscombe, A., Grant, C., Karunajeewa, H., Klim, S., Wijeratne, T., & Kelly, A. M. (2020). Specialised vestibular physiotherapy in the emergency department: A pilot safety and feasibility study. *Emerg Med Australas*, 32(5), 860-863. <https://doi.org/10.1111/1742-6723.13569>
- Lloyd, M., Mackintosh, A., Grant, C., McManus, F., Kelly, A. M., Karunajeewa, H., & Tang, C. Y. (2020). Evidence-based management of patients with vertigo, dizziness, and imbalance at an Australian metropolitan health service: An observational study of clinical practice. *Physiother Theory Pract*, 36(7), 818-825. <https://doi.org/10.1080/09593985.2018.1511020>
- Lopez-Escamez, J. A., Gamiz, M. J., Fernandez-Perez, A., & Gomez-Finana, M. (2005). Long-term outcome and health-related quality of life in benign paroxysmal positional vertigo. *Eur Arch Otorhinolaryngol*, 262(6), 507-511. <https://doi.org/10.1007/s00405-004-0841-x>
- Lopez, C., & Blanke, O. (2011). The thalamocortical vestibular system in animals and humans. *Brain Res Rev*, 67(1-2), 119-146. <https://doi.org/10.1016/j.brainresrev.2010.12.002>
- Lowenstein, S. R. (2005). Medical record reviews in emergency medicine: The blessing and the curse. *Ann Emerg Med*, 45(4), 452-455. <https://doi.org/10.1016/j.annemergmed.2005.01.032>
- Madrigal, J., Zuma, E. M. F., Cal, R., Faria Ramos, B., & Castillo-Bustamante, M. (2024). Addressing the overlapping challenges of benign paroxysmal positional vertigo (BPPV) and persistent postural-perceptual dizziness (PPPD): Impacts and integrated management. *Cureus*, 16(10), e72019. <https://doi.org/10.7759/cureus.72019>
- Mahato, P. K. (2024). Post-positivism and its application in health research. *Chaturbhujeshwar Academic Journal*, 2(1), 148-158. <https://doi.org/10.3126/caj.v2i1.72223>
- Maka, K., Alkhouri, H., Wong, L., George, L., Walton, A., & McCarthy, S. (2022). Identifying the activities of physiotherapy practitioners through primary and secondary models of care provided in New South Wales emergency departments. *Australas Emerg Care*, 25(1), 30-36. <https://doi.org/10.1016/j.auec.2021.04.005>
- Mandge, V., Palaiodimos, L., Lai, Q., Papanastasiou, C. A., Wang, Y., Santos, D., Grau, L., Kodali, A., Ocava, L., & Gutwein, A. H. (2020). Predictors of vertigo in the emergency department: The preved study. *J Stroke Cerebrovasc Dis*, 29(9), 105043. <https://doi.org/10.1016/j.jstrokecerebrovasdis.2020.105043>
- Mao, J. J., Lin, H. C., Lin, S. T., Lin, P. C., Chang, C. H., Chien, W. C., Chung, C. H., Chen, Y. J., & Chen, J. W. (2024). Incidence of subsequent injuries associated with a new diagnosis of benign paroxysmal positional vertigo and effects of treatment: A nationwide cohort study. *J Clin Med*, 13(15). <https://doi.org/10.3390/jcm13154561>
- Martens, C., Goplen, F. K., Aasen, T., Nordfalk, K. F., & Nordahl, S. H. G. (2019). Dizziness handicap and clinical characteristics of posterior and lateral canal BPPV. *Eur Arch Otorhinolaryngol*, 276(8), 2181-2189. <https://doi.org/10.1007/s00405-019-05459-9>

- Masood, A., Alkhaja, O., Alsetrawi, A., Alshaibani, F., Awad, A., Habbash, Z., Alyusuf, Z. Y., Ali, N., Al Mail, S., & Al Taei, T. (2024). The diagnostic value of brain CT scans in evaluating dizziness in the emergency department: A retrospective study. *Cureus*, *16*(1), e52483. <https://doi.org/10.7759/cureus.52483>
- McCall, M., McIntyre-Robinson, A., Toh, E., Green, H., Dunn, J., White, J., & Mark, S. (2025). Utilisation of MRI in newly diagnosed prostate cancer in Aotearoa New Zealand. *ANZ J Surg*, *95*(9), 1896-1905. <https://doi.org/10.1111/ans.70270>
- McCambridge, J., Witton, J., & Elbourne, D. R. (2014). Systematic review of the Hawthorne effect: New concepts are needed to study research participation effects. *J Clin Epidemiol*, *67*(3), 267-277. <https://doi.org/10.1016/j.jclinepi.2013.08.015>
- McDonnell, M. N., & Hillier, S. L. (2015). Vestibular rehabilitation for unilateral peripheral vestibular dysfunction. *Cochrane Database Syst Rev*, *1*(1), CD005397. <https://doi.org/10.1002/14651858.CD005397.pub4>
- McDowell, T., & Moore, F. (2016). The under-utilization of the head impulse test in the emergency department. *Can J Neurol Sci*, *43*(3), 398-401. <https://doi.org/10.1017/cjn.2015.330>
- McGillis, M., Roy, D., Savage, D., McIsaac, S., Nicholls, J., Waltenbury, D., & Ohle, R. (2023). Overuse of pharmacological treatments for patients with benign paroxysmal positional vertigo in the emergency department. *Cjem*, *25*(8), 710-711. <https://doi.org/10.1007/s43678-023-00549-4>
- McMeeking, S., Tarena, E., Williams, M., Anderson, A., & Shorter, L. (2022). *Whiria te muka tangata: Anti-racism systems change. A preliminary model for the Aotearoa New Zealand health system.*
- Miner, D. G., Parcetch, K., & Smith, K. (2022). Troponin elevation following percutaneous coronary intervention in acute coronary syndrome. *Journal of Acute Care Physical Therapy*, *13*(3), 135-144. <https://doi.org/10.1097/jat.0000000000000181>
- Ministry of Health. (2023). *Annual report for the year ended 30 June 2023*. Wellington Retrieved from <https://www.health.govt.nz/publications/manatu-hauora-ministry-of-health-annual-report-for-the-year-ended-30-june-2023>
- Mira, E. (2008). Improving the quality of life in patients with vestibular disorders: The role of medical treatments and physical rehabilitation. *Int J Clin Pract*, *62*(1), 109-114. <https://doi.org/10.1111/j.1742-1241.2006.01091.x>
- Mohwald, K., Hadzhikolev, H., Bardins, S., Becker-Bense, S., Brandt, T., Grill, E., Jahn, K., Dieterich, M., & Zwergal, A. (2020). Health-related quality of life and functional impairment in acute vestibular disorders. *Eur J Neurol*, *27*(10), 2089-2098. <https://doi.org/10.1111/ene.14318>
- Montero-Odasso, M., van der Velde, N., Martin, F. C., Petrovic, M., Tan, M. P., Ryg, J., Aguilar-Navarro, S., Alexander, N. B., Becker, C., Blain, H., Bourke, R., Cameron, I. D., Camicioli, R., Clemson, L., Close, J., Delbaere, K., Duan, L., Duque, G., Dyer, S. M., . . . Masud, T. (2022). World guidelines for falls prevention and management for older adults: A global initiative. *Age Ageing*, *51*(9), afac205. <https://doi.org/10.1093/ageing/afac205>
- Moon, K., & Blackman, D. (2014). A guide to understanding social science research for natural scientists. *Conserv Biol*, *28*(5), 1167-1177. <https://doi.org/10.1111/cobi.12326>
- Morrow, S., Koohi, N., & Kaski, D. (2023). Hyperacute assessment of vertigo in suspected stroke. *Front Stroke*, *2*, 1267251. <https://doi.org/10.3389/fstro.2023.1267251>
- Moulin, T., Sablot, D., Vidry, E., Belahsen, F., Berger, E., Lemounaud, P., Tatu, L., Vuillier, F., Cosson, A., Revenco, E., Capellier, G., & Rumbach, L. (2003). Impact of emergency room neurologists on patient management and outcome. *Eur Neurol*, *50*(4), 207-214. <https://doi.org/10.1159/000073861>
- Munn, Z., Peters, M. D. J., Stern, C., Tufanaru, C., McArthur, A., & Aromataris, E. (2018). Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC Medical Research Methodology*, *18*.

- Nagdee, N., de Andrade, V. M., & Banoo, M. (2024). The dizzying cycle: A qualitative study showing the effects of vestibular disorders and stress on work experience. *Int J Audiol*, 63(6), 431-438. <https://doi.org/10.1080/14992027.2023.2199444>
- Nakatsuka, M., & Molloy, E. E. (2022). The HINTS examination and STANDING algorithm in acute vestibular syndrome: A systematic review and meta-analysis involving frontline point-of-care emergency physicians. *PloS One*, 17(5), e0266252. <https://doi.org/10.1371/journal.pone.0266252>
- Navi, B. B., Kamel, H., Shah, M. P., Grossman, A. W., Wong, C., Poisson, S. N., Whetstone, W. D., Josephson, S. A., Johnston, S. C., & Kim, A. S. (2012). Application of the ABCD2 score to identify cerebrovascular causes of dizziness in the emergency department. *Stroke*, 43(6), 1484-1489. <https://doi.org/10.1161/STROKEAHA.111.646414>
- Naylor, J., Killingback, C., & Green, A. (2025). The experiences of patients attending the emergency department who were managed by physiotherapists: A person-centred perspective. *Disabil Rehabil*, 47(7), 1741-1753. <https://doi.org/10.1080/09638288.2024.2382311>
- Neely, P., Patel, H., McTaggart, J., Bright, S., & Wellings, T. (2023). EVESTA: Emergency VESTibular Algorithm and its impact on the acute management of benign paroxysmal positional vertigo. *Emerg Med Australas*, 35(2), 312-318. <https://doi.org/10.1111/1742-6723.14124>
- Neely, P., Patel, H., & Wellings, T. (2021). Benign paroxysmal positional vertigo in the emergency department: An observational study of an Australian regional hospital's acute clinical practice. *Emerg Med Australas*, 33(6), 1082-1087. <https://doi.org/10.1111/1742-6723.13810>
- Neuhauser, H. K., Radtke, A., von Brevern, M., Lezius, F., Feldmann, M., & Lempert, T. (2008). Burden of dizziness and vertigo in the community. *Arch Intern Med*, 168(19), 2118-2124. <https://doi.org/10.1001/archinte.168.19.2118>
- Newman-Toker, D. E. (2007). Charted records of dizzy patients suggest emergency physicians emphasize symptom quality in diagnostic assessment. *Ann Emerg Med*, 50(2), 204-205. <https://doi.org/10.1016/j.annemergmed.2007.03.037>
- Newman-Toker, D. E. (2016). Missed stroke in acute vertigo and dizziness: It is time for action, not debate. *Annals of Neurology*, 79(1), 27.
- Newman-Toker, D. E., Camargo, C. A., Jr., Hsieh, Y. H., Pelletier, A. J., & Edlow, J. A. (2009). Disconnect between charted vestibular diagnoses and emergency department management decisions: A cross-sectional analysis from a nationally representative sample. *Acad Emerg Med*, 16(10), 970-977. <https://doi.org/10.1111/j.1553-2712.2009.00523.x>
- Newman-Toker, D. E., Cannon, L. M., Stofferahn, M. E., Rothman, R. E., Hsieh, Y.-H., & Zee, D. S. (2007). Imprecision in patient reports of dizziness symptom quality: A cross-sectional study conducted in an acute care setting. *Mayo Clinic Proceedings*,
- Newman-Toker, D. E., Curthoys, I. S., & Halmagyi, G. M. (2015). Diagnosing stroke in acute vertigo: The HINTS family of eye movement tests and the future of the "Eye ECG". *Semin Neurol*, 35(5), 506-521. <https://doi.org/10.1055/s-0035-1564298>
- Newman-Toker, D. E., & Edlow, J. A. (2015). TiTrATE: A novel, evidence-based approach to diagnosing acute dizziness and vertigo. *Neurol Clin*, 33(3), 577-599, viii. <https://doi.org/10.1016/j.ncl.2015.04.011>
- Newman-Toker, D. E., Hsieh, Y.-H., Camargo Jr, C. A., Pelletier, A. J., Butchy, G. T., & Edlow, J. A. (2008). Spectrum of dizziness visits to US emergency departments: Cross-sectional analysis from a nationally representative sample. *Mayo Clinic Proceedings*,
- Newman-Toker, D. E., Kerber, K. A., Hsieh, Y. H., Pula, J. H., Omron, R., Saber Tehrani, A. S., Mantokoudis, G., Hanley, D. F., Zee, D. S., & Kattah, J. C. (2013). HINTS outperforms ABCD2 to screen for stroke in acute continuous vertigo and dizziness. *Acad Emerg Med*, 20(10), 986-996. <https://doi.org/10.1111/acem.12223>
- Newman-Toker, D. E., Moy, E., Valente, E., Coffey, R., & Hines, A. L. (2014). Missed diagnosis of stroke in the emergency department: A cross-sectional analysis of a large population-based sample. *Diagnosis (Berl)*, 1(2), 155-166. <https://doi.org/10.1515/dx-2013-0038>

- Newman-Toker, D. E., Peterson, S. M., Badihian, S., Hassoon, A., Nassery, N., Parizadeh, D., Wilson, L. M., Jia, Y., Omron, R., Tharmarajah, S., Guerin, L., Bastani, P. B., Fracica, E. A., Kotwal, S., & Robinson, K. A. (2022). Diagnostic errors in the emergency department: A systematic review.
- Newman-Toker, D. E., Saber Tehrani, A. S., Mantokoudis, G., Pula, J. H., Guede, C. I., Kerber, K. A., Blitz, A., Ying, S. H., Hsieh, Y. H., Rothman, R. E., Hanley, D. F., Zee, D. S., & Kattah, J. C. (2013). Quantitative video-oculography to help diagnose stroke in acute vertigo and dizziness: Toward an ECG for the eyes. *Stroke*, *44*(4), 1158-1161. <https://doi.org/10.1161/STROKEAHA.111.000033>
- Newman-Toker, D. E., Camargo, J., Carlos A, Hsieh, Y. H., Pelletier, A. J., & Edlow, J. A. (2009). Disconnect between charted vestibular diagnoses and emergency department management decisions: A cross-sectional analysis from a nationally representative sample. *Academic Emergency Medicine*, *16*(10), 970-977.
- Noda, M., Kuroda, T., Nomura, A., Ito, M., Yoshizaki, T., & Fushiki, H. (2023). Smartphone-assisted medical care for vestibular dysfunction as a telehealth strategy for digital therapy beyond COVID-19: Scoping review. *JMIR mHealth and uHealth*, *11*(1), e48638.
- Ogrinc, G., Davies, L., Goodman, D., Batalden, P., Davidoff, F., & Stevens, D. (2015). SQUIRE 2.0 (Standards for QUality Improvement Reporting Excellence): Revised publication guidelines from a detailed consensus process. *The Journal of Continuing Education in Nursing*, *46*(11), 501-507.
- Ohle, R., Montpellier, R.-A., Marchadier, V., Wharton, A., McIsaac, S. M., Anderson, M., & Savage, D. W. (2020). Can emergency physicians accurately rule out a central cause of vertigo using the hints examination? A systematic review and meta-analysis. *Academic Emergency Medicine*, *27*, 887 - 896.
- Ohle, R., Roy, D., Baraku, E., Patel, K., Savage, D. W., McIsaac, S., Singh, R., Lelli, D., Tse, D., Johns, P., Yadav, K., & Perry, J. J. (2026). A prospective multi-center implementation study to improve the diagnosis and treatment of benign paroxysmal positional vertigo. *Acad Emerg Med*, *33*(2), e70177. <https://doi.org/10.1111/acem.70177>
- Oliveira, J. E. S. L., Khoujah, D., Naples, J. G., Edlow, J. A., Gerberi, D. J., Carpenter, C. R., & Bellolio, F. (2023). Corticosteroids for patients with vestibular neuritis: An evidence synthesis for guidelines for reasonable and appropriate care in the emergency department. *Acad Emerg Med*, *30*(5), 531-540. <https://doi.org/10.1111/acem.14583>
- Palmer, S. C., Gray, H., Huria, T., Lacey, C., Beckert, L., & Pitama, S. G. (2019). Reported Māori consumer experiences of health systems and programs in qualitative research: A systematic review with meta-synthesis. *Int J Equity Health*, *18*(1), 163. <https://doi.org/10.1186/s12939-019-1057-4>
- Patu, E., Kruse, K., & Patu, E. (2023). Development of a national human rights survey using equal explanatory power - flipping the picture in the collection of national survey quantitative data honouring indigenous populations [journal article]. *Population Medicine*, *5*(Supplement). <https://doi.org/10.18332/popmed/164628>
- Pavlovic, T., Milosevic, M., Trtica, S., & Budincevic, H. (2018). Value of head CT scan in the emergency department in patients with vertigo without focal neurological abnormalities. *Open Access Maced J Med Sci*, *6*(9), 1664-1667. <https://doi.org/10.3889/oamjms.2018.340>
- Pellegrino, N., Di Stefano, V., Rotondo, E., Graziosi, A., Rispoli, M. G., Torrente, A., Lupica, A., Brighina, F., Raucci, U., & Parisi, P. (2022). Neurological vertigo in the emergency room in pediatric and adult age: Systematic literature review and proposal for a diagnostic algorithm. *Ital J Pediatr*, *48*(1), 125. <https://doi.org/10.1186/s13052-022-01313-7>
- Perez-Vazquez, P., Franco-Gutierrez, V., Soto-Varela, A., Amor-Dorado, J. C., Martin-Sanz, E., Oliva-Dominguez, M., & Lopez-Escamez, J. A. (2018). Practice guidelines for the diagnosis and management of benign paroxysmal positional vertigo otoneurology committee of spanish otorhinolaryngology and head and neck surgery consensus document [Practice Guidelines for the Diagnosis and Management of Benign Paroxysmal Positional Vertigo]. *Acta*

- Otorrinolaringol Esp (Engl Ed)*, 69(6), 345-366. <https://doi.org/10.1016/j.otorri.2017.05.001> (Guía de Practica Clinica Para el Diagnostico y Tratamiento del Vertigo Posicional Paroxistico Benigno. Documento de Consenso de la Comision de Otoneurologia Sociedad Espanola de Otorrinolaringologia y Cirugia de Cabeza y Cuello.)
- Perloff, M. D., Patel, N. S., Kase, C. S., Oza, A. U., Voetsch, B., & Romero, J. R. (2017). Cerebellar stroke presenting with isolated dizziness: Brain MRI in 136 patients. *Am J Emerg Med*, 35(11), 1724-1729. <https://doi.org/10.1016/j.ajem.2017.06.034>
- Peters, M. D. J., Marnie, C., Tricco, A. C., Pollock, D., Munn, Z., Alexander, L., McInerney, P., Godfrey, C. M., & Khalil, H. (2020). Updated methodological guidance for the conduct of scoping reviews. *JBI Evid Synth*, 18(10), 2119-2126. <https://doi.org/10.11124/JBIES-20-00167>
- Pitama, S., Huria, T., & Lacey, C. (2014). Improving Māori health through clinical assessment: Waikare o te Waka o Meihana. *New Zealand Medical Journal*, 127(1393), 107-119.
- Pitama, S., Robertson, P., Cram, F., Gillies, M., Huria, T., & Dallas-Katoa, W. (2007). Meihana model: A clinical assessment framework. *New Zealand Journal of Psychology*, 36(3).
- Polensek, S. H., Sterk, C. E., & Tusa, R. J. (2008). Screening for vestibular disorders: A study of clinicians' compliance with recommended practices. *Med Sci Monit*, 14(5), CR238-242. <https://www.ncbi.nlm.nih.gov/pubmed/18443546>
- Popper, K. R. (1972). Objective knowledge: An evolutionary approach.
- Prisk, D., Godfrey, A. J., & Lawrence, A. (2016). Emergency department Length of stay for Māori and European patients in New Zealand. *West J Emerg Med*, 17(4), 438-448. <https://doi.org/10.5811/westjem.2016.5.29957>
- Puissant, M. M., Giampalmo, S., Wira III, C. R., Goldstein, J. N., & Newman-Toker, D. E. (2024). Approach to acute dizziness/vertigo in the emergency department: Selected controversies regarding specialty consultation. *Stroke*, 55(10), 2584-2588.
- Quimby, A. E., Kwok, E. S. H., Lelli, D., Johns, P., & Tse, D. (2018). Usage of the HINTS exam and neuroimaging in the assessment of peripheral vertigo in the emergency department. *J Otolaryngol Head Neck Surg*, 47(1), 54. <https://doi.org/10.1186/s40463-018-0305-8>
- Rafael, J. O., Zoe Chavez Valderrama, I., Chakravarthi, S. S., Paternò, G., Ascenzi, B. M., & Monroy-Sosa, A. (2025). The vestibular system. In B. M. Ascenzi (Ed.), *From Anatomy to Function of the Central Nervous System* (pp. 543-566). Academic Press. <https://doi.org/10.1016/b978-0-12-822404-5.00005-x>
- Renga, V. (2019). Clinical evaluation of patients with vestibular dysfunction. *Neurol Res Int*, 2019, 3931548. <https://doi.org/10.1155/2019/3931548>
- Richoz, B., Hugli, O., Dami, F., Carron, P. N., Faouzi, M., & Michel, P. (2015). Acute stroke chameleons in a university hospital: Risk factors, circumstances, and outcomes. *Neurology*, 85(6), 505-511. <https://doi.org/10.1212/WNL.0000000000001830>
- Robson, B. (2002). *Mana whakamārama - equal explanatory power: Māori and non-Māori sample size in national health surveys*.
- Rochford, T. (2004). Whare Tapa Wha: A Māori model of a unified theory of health. *Journal of primary prevention*, 25(1), 41-57.
- Ronchetti, M., Bartalucci, P., Pepe, G., Canaroli, G., Magazzini, S., De Curtis, E., Di Sacco, F., Bartolucci, M., Pecci, R., Casula, C., Pelagatti, L., Fabiani, G., Pavellini, A., Caviglioli, C., Nazerian, P., Vannucchi, P., Vanni, S., National, S., & Research Center of Simeu, S. I. d. M. d. E. U. (2025). Diagnostic accuracy of the STANDING algorithm in patients with isolated vertigo: A multicentre prospective study (STANDING-M). *Emerg Med J*, 42(12), 791-797. <https://doi.org/10.1136/emermed-2025-214902>
- Rosen, P. (1979). The biology of emergency medicine. *JACEP*, 8(7), 280-283. [https://doi.org/10.1016/s0361-1124\(79\)80226-9](https://doi.org/10.1016/s0361-1124(79)80226-9)
- Royle, G., Ploner, C. J., & Leithner, C. (2011). Dizziness in the emergency room: Diagnoses and misdiagnoses. *Eur Neurol*, 66(5), 256-263. <https://doi.org/10.1159/000331046>

- Ryan, A. B. (2006). Post-positivist approaches to research. *Researching and Writing your Thesis: a guide for postgraduate students*, 12-26.
- Saber Tehrani, A. S., Coughlan, D., Hsieh, Y. H., Mantokoudis, G., Korley, F. K., Kerber, K. A., Frick, K. D., & Newman-Toker, D. E. (2013). Rising annual costs of dizziness presentations to U.S. emergency departments. *Acad Emerg Med*, 20(7), 689-696.  
<https://doi.org/10.1111/acem.12168>
- Saber Tehrani, A. S., Kattah, J. C., Kerber, K. A., Gold, D. R., Zee, D. S., Urrutia, V. C., & Newman-Toker, D. E. (2018). Diagnosing stroke in acute dizziness and vertigo: Pitfalls and pearls. *Stroke*, 49(3), 788-795. <https://doi.org/10.1161/STROKEAHA.117.016979>
- Sacco, R. R., Burmeister, D. B., Rupp, V. A., & Greenberg, M. R. (2014). Management of benign paroxysmal positional vertigo: A randomized controlled trial. *J Emerg Med*, 46(4), 575-581.  
<https://doi.org/10.1016/j.jemermed.2013.08.116>
- Sandlund, M. G., Diamant, A., Granasen, G., & Salzer, J. (2019). Effectiveness of care in acute dizziness presentations. *Eur Arch Otorhinolaryngol*, 276(9), 2389-2396.  
<https://doi.org/10.1007/s00405-019-05470-0>
- Savioli, G., Ceresa, I. F., Gri, N., Bavestrello Piccini, G., Longhitano, Y., Zanza, C., Piccioni, A., Esposito, C., Ricevuti, G., & Bressan, M. A. (2022). Emergency department overcrowding: Understanding the factors to find corresponding solutions. *J Pers Med*, 12(2).  
<https://doi.org/10.3390/jpm12020279>
- Savitz, S. I., Caplan, L. R., & Edlow, J. A. (2007). Pitfalls in the diagnosis of cerebellar infarction. *Acad Emerg Med*, 14(1), 63-68. <https://doi.org/10.1197/j.aem.2006.06.060>
- Selak, V., Crengle, S., Elley, C. R., Wadham, A., Harwood, M., Rafter, N., Bullen, C., Pillai, A., Arroll, B., & Rodgers, A. (2013). Recruiting equal numbers of indigenous and non-indigenous participants to a 'polypill' randomized trial. *Int J Equity Health*, 12(1), 44.  
<https://doi.org/10.1186/1475-9276-12-44>
- Shah, V., Oliveira, J., Farah, W., Seisa, M., Kara Balla, A., Christensen, A., Farah, M., Hasan, B., Bellolio, F., & Murad, M. H. (2023). Diagnostic accuracy of neuroimaging in emergency department patients with acute vertigo or dizziness: A systematic review and meta-analysis for the guidelines for reasonable and appropriate care in the emergency department. *Acad Emerg Med*, 30(5), 517-530. <https://doi.org/10.1111/acem.14561>
- Shah, V., Oliveira, J. E. S. L., Farah, W., Seisa, M. O., Balla, A. K., Christensen, A., Farah, M., Hasan, B., Bellolio, F., & Murad, M. H. (2023). Diagnostic accuracy of the physical examination in emergency department patients with acute vertigo or dizziness: A systematic review and meta-analysis for GRACE-3. *Acad Emerg Med*, 30(5), 552-578.  
<https://doi.org/10.1111/acem.14630>
- Sharif, S., Khoujah, D., Greer, A., Naples, J. G., Upadhye, S., & Edlow, J. A. (2023). Vestibular suppressants for benign paroxysmal positional vertigo: A systematic review and meta-analysis of randomized controlled trials. *Acad Emerg Med*, 30(5), 541-551.  
<https://doi.org/10.1111/acem.14608>
- Shikino, K., & Ikusaka, M. (2021). Alexander's law in vestibular neuritis. *BMJ Case Rep*, 14(1).  
<https://doi.org/10.1136/bcr-2020-239705>
- Smith-Bindman, R., Miglioretti, D. L., & Larson, E. B. (2008). Rising use of diagnostic medical imaging in a large integrated health system. *Health Aff (Millwood)*, 27(6), 1491-1502.  
<https://doi.org/10.1377/hlthaff.27.6.1491>
- Smith, L. J., Pyke, W., Fowler, R., Matthes, B., de Goederen, E., & Surenthiran, S. (2024). Impact and experiences of vestibular disorders and psychological distress: Qualitative findings from patients, family members and healthcare professionals. *Health Expect*, 27(1), e13906.  
<https://doi.org/10.1111/hex.13906>
- Solie, T. (2024). Reflexivity in research: Addressing power dynamics in researching Syrian refugees in the UK. *Language and Intercultural Communication*, 24(5), 511-526.  
<https://doi.org/10.1080/14708477.2024.2392264>

- Soto, E., & Vega, R. (2010). Neuropharmacology of vestibular system disorders. *Curr Neuroparmacol*, 8(1), 26-40. <https://doi.org/10.2174/157015910790909511>
- Sousa, F. A., Alves, C. S., Pinto, A. N., Meireles, L., & Rego, A. R. (2024). Pharmacological treatment of acute unilateral vestibulopathy: A review. *J Audiol Otol*, 28(1), 18-28. <https://doi.org/10.7874/jao.2023.00066>
- Spiegel, R., Kirsch, M., Rosin, C., Rust, H., Baumann, T., Sutter, R., Friedrich, H., Goldlin, M., Muri, R., Kalla, R., Bingisser, R., & Mantokoudis, G. (2017). Dizziness in the emergency department: An update on diagnosis. *Swiss Med Wkly*, 147, w14565. <https://doi.org/10.4414/smw.2017.14565>
- Srinivasan, V., & Tirschwell, D. (2023). Give us some GRACE, we can't take the HINT: There is still a role for imaging in dizzy patients! *Acad Emerg Med*, 30(10), 1078-1079. <https://doi.org/10.1111/acem.14779>
- Stanton, V. A., Hsieh, Y.-H., Camargo Jr, C. A., Edlow, J. A., Lovett, P., Goldstein, J. N., Abbuhl, S., Lin, M., Chanmugam, A., & Rothman, R. E. (2007). Overreliance on symptom quality in diagnosing dizziness: Results of a multicenter survey of emergency physicians. *Mayo Clinic Proceedings*,
- Stephens, C., Nettleton, C., Porter, J., Willis, R., & Clark, S. (2005). Indigenous peoples' health—why are they behind everyone, everywhere? *The Lancet*, 366(9479), 10-13.
- Stewart, V., Mendis, M., & Low Choy, N. (2019). Clinical effectiveness of a physiotherapy-led, hospital-based vestibular service. *Otorinolaringologia*, 69(1), 1-8.
- Stewart, V., Rosbergen, I., Tsang, B., Hoffman, A., Kwan, S., & Grimley, R. (2022). Do vestibular physiotherapy and a clinical pathway in the emergency department improve management of vertigo? *OTO Open*, 6(3), 2473974X221119163. <https://doi.org/10.1177/2473974X221119163>
- Stewart, V. M., Mendis, M. D., & Low Choy, N. (2018). A systematic review of patient-reported measures associated with vestibular dysfunction. *Laryngoscope*, 128(4), 971-981. <https://doi.org/10.1002/lary.26641>
- Strupp, M., Arbusow, V., Maag, K. P., Gall, C., & Brandt, T. (1998). Vestibular exercises improve central vestibulospinal compensation after vestibular neuritis. *Neurology*, 51(3), 838-844. <https://doi.org/10.1212/wnl.51.3.838>
- Strupp, M., & Brandt, T. (2009). Vestibular neuritis. *Semin Neurol*, 29(5), 509-519. <https://doi.org/10.1055/s-0029-1241040>
- Takeda, N., Matsuda, K., Fukuda, J., Sato, G., Uno, A., & Kitahara, T. (2024). Vestibular compensation: Neural mechanisms and clinical implications for the treatment of vertigo. *Auris Nasus Larynx*, 51(2), 328-336. <https://doi.org/10.1016/j.anl.2023.11.009>
- Tarnutzer, A. A., Berkowitz, A. L., Robinson, K. A., Hsieh, Y.-H., & Newman-Toker, D. E. (2011). Does my dizzy patient have a stroke? A systematic review of bedside diagnosis in acute vestibular syndrome. *CMAJ*, 183(9), E571-E592.
- Tarnutzer, A. A., & Edlow, J. A. (2023). Bedside testing in acute vestibular syndrome-evaluating HINTS plus and beyond-A critical review. *Audiol Res*, 13(5), 670-685. <https://doi.org/10.3390/audiolres13050059>
- Tarnutzer, A. A., Koohi, N., Lee, S. U., & Kaski, D. (2025). Diagnostic errors in the acutely dizzy patient-lessons learned. *Brain Sci*, 15(1), 55. <https://doi.org/10.3390/brainsci15010055>
- Tarnutzer, A. A., Lee, S. H., Robinson, K. A., Wang, Z., Edlow, J. A., & Newman-Toker, D. E. (2017). ED misdiagnosis of cerebrovascular events in the era of modern neuroimaging: A meta-analysis. *Neurology*, 88(15), 1468-1477. <https://doi.org/10.1212/WNL.0000000000003814>
- Tenbensel, T., Chalmers, L., Jones, P., Appleton-Dyer, S., Walton, L., & Ameratunga, S. (2017). New Zealand's emergency department target—did it reduce ED length of stay, and if so, how and when? *BMC Health Services Research*, 17(1), 678.
- Tenbensel, T., Jones, P., Chalmers, L. M., Ameratunga, S., & Carswell, P. (2020). Gaming New Zealand's emergency department target: How and why did it vary over time and between

- organisations? *Int J Health Policy Manag*, 9(4), 152-162.  
<https://doi.org/10.15171/ijhpm.2019.98>
- Thomas, D. P., & Anderson, I. P. (2006). Use of emergency departments by Aboriginal and Torres Strait Islander people. *Emerg Med Australas*, 18(1), 68-76. <https://doi.org/10.1111/j.1742-6723.2006.00804.x>
- Tomas, I. (2018). Equity for Indigenous peoples in the emergency department: A Maori perspective. *Emerg Med Australas*, 30(6), 859-861. <https://doi.org/10.1111/1742-6723.13196>
- Treaty of Waitangi Tribunal. (2019). *Haurora report on stage 1 of the health services and outcomes kaupapa inquiry*. <https://www.waitangitribunal.govt.nz/en/inquiries/kaupapa-inquiries/health-services-and-outcomes>
- Tricco, A. C., Langlois, E. V., Straus, S. E., Alliance for Health, P., Systems, R., & World Health, O. (2017). *Rapid reviews to strengthen health policy and systems: A practical guide*. World Health Organization. <https://iris.who.int/handle/10665/258698>
- Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., Moher, D., Peters, M. D. J., Horsley, T., Weeks, L., Hempel, S., Akl, E. A., Chang, C., McGowan, J., Stewart, L., Hartling, L., Aldcroft, A., Wilson, M. G., Garritty, C., . . . Straus, S. E. (2018). PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. *Ann Intern Med*, 169(7), 467-473. <https://doi.org/10.7326/M18-0850>
- Tsang, B. K. T., Chen, A. S. K., & Paine, M. (2017). Acute evaluation of the acute vestibular syndrome: Differentiating posterior circulation stroke from acute peripheral vestibulopathies. *Intern Med J*, 47(12), 1352-1360. <https://doi.org/10.1111/imj.13552>
- Vanni, S., Pecci, R., Casati, C., Moroni, F., Risso, M., Ottaviani, M., Nazerian, P., Grifoni, S., & Vannucchi, P. (2014). STANDING, a four-step bedside algorithm for differential diagnosis of acute vertigo in the emergency department. *Acta Otorhinolaryngol Ital*, 34(6), 419-426. <https://www.ncbi.nlm.nih.gov/pubmed/25762835>
- Vanni, S., Pecci, R., Edlow, J. A., Nazerian, P., Santimone, R., Pepe, G., Moretti, M., Pavellini, A., Caviglioli, C., Casula, C., Bigiarini, S., Vannucchi, P., & Grifoni, S. (2017). Differential diagnosis of vertigo in the emergency department: A prospective validation study of the STANDING algorithm. *Front Neurol*, 8, 590. <https://doi.org/10.3389/fneur.2017.00590>
- Vanni, S., Vannucchi, P., Pecci, R., Pepe, G., Paciaroni, M., Pavellini, A., Ronchetti, M., Pelagatti, L., Bartolucci, M., Konze, A., Castellucci, A., Manfrin, M., Fabbri, A., de Iaco, F., Casani, A. P., & Societa Italiana di Medicina d'Emergenza Urgenza, S. I. d. V. (2024). Consensus paper on the management of acute isolated vertigo in the emergency department. *Intern Emerg Med*, 19(5), 1181-1202. <https://doi.org/10.1007/s11739-024-03664-x>
- Varner, C. (2023). Emergency departments are in crisis now and for the foreseeable future. *Cmaj*, 195(24), E851-E852. <https://doi.org/10.1503/cmaj.230719>
- Veritas Health Innovation. (2025). *Covidence systematic review software*. In [Computer software]. Veritas Health Innovation. <https://www.covidence.org>
- Voetsch, B., & Sehgal, S. (2021). Acute dizziness, vertigo, and unsteadiness. *Neurol Clin*, 39(2), 373-389. <https://doi.org/10.1016/j.ncl.2021.01.008>
- von Brevern, M., Bertholon, P., Brandt, T., Fife, T., Imai, T., Nuti, D., & Newman-Toker, D. (2017). Benign paroxysmal positional vertigo: Diagnostic criteria consensus document of the committee for the classification of vestibular disorders of the Barany Society [Benign Paroxysmal Positional Vertigo: Diagnostic Criteria]. *Acta Otorrinolaringol Esp (Engl Ed)*, 68(6), 349-360. <https://doi.org/10.1016/j.otorri.2017.02.007> (Vertigo posicional paroxístico benigno: criterios diagnosticos. Documento de consenso del Comité para la Clasificación de los Trastornos Vestibulares de la Barany Society.)
- Wang, W., Zhang, Y., Pan, Q., Liu, J., Zhu, Y., Tan, G., Zhan, Q., & Zhou, J. (2021). Central nystagmus plus ABCD(2) identifying stroke in acute dizziness presentations. *Acad Emerg Med*, 28(10), 1118-1123. <https://doi.org/10.1111/acem.14295>

- Wilson, D., Moloney, E., Parr, J. M., Aspinall, C., & Slark, J. (2021). Creating an Indigenous Māori-centred model of relational health: A literature review of Maori models of health. *J Clin Nurs*, 30(23-24), 3539-3555. <https://doi.org/10.1111/jocn.15859>
- Wipperman, J. (2014). Dizziness and vertigo. *Prim Care*, 41(1), 115-131. <https://doi.org/10.1016/j.pop.2013.10.004>
- Worster, A., Bledsoe, R. D., Cleve, P., Fernandes, C. M., Upadhye, S., & Eva, K. (2005). Reassessing the methods of medical record review studies in emergency medicine research. *Ann Emerg Med*, 45(4), 448-451. <https://doi.org/10.1016/j.annemergmed.2004.11.021>
- Yates, K. M. (2020). Examining emergency department inequities: Are outcomes in your emergency department equitable? *Emerg Med Australas*, 32(6), 912-913. <https://doi.org/10.1111/1742-6723.13647>

## Appendices

### Appendix A

#### Summary Matrix of Clinical Quality Indicators and Associated Evidence-Based Support

**Table A1**

*Summary Matrix of Clinical Quality Indicators and Associated Evidence-Based Support*

| Metrics                     | Studies Supporting                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | (n =) |
|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| Neurological Screening      | Aroor et al., 2017, von Brevern et al., 2015, Pérez-Vázquez et al., 2018, Bhattacharyya et al., 2017, Bierrum et al., 2023, Nakatsuka and Molloy, 2022, Sandlund et al., 2019, Ammar et al., 2017, Cristiano et al., 2020, Gerber et al., 2023, Filippopoulos et al., 2022, Vanni et al., 2014 (Pilot), Shah et al., 2023 (Physical Exam), Masood et al., 2022, Ljunggren et al., 2018, Gottlieb et al., 2023, Herdman et al., 2021, Sacco et al., 2014, Vanni et al., 2015, Kerber et al., 2015, Gaudino et al., 2021, Bradshaw et al., 2023, Ipsat et al., 2022, Stewart et al., 2022, Sharif et al., 2023, Kerber et al., 2011, Hall et al., 2021, Machner et al., 2020, Gerber et al., 2022, Kim et al., 2012, Mandge et al., 2020, Ahsan et al., 2013, Lloyd et al., 2018, Pellegrino et al., 2022, Tu et al., 2024, Neely et al., 2021, Shah et al., 2023, Edlow et al., 2023,                                                     | 38    |
| Nystagmus Assessment        | Aroor et al., 2017 von Brevern et al., 2015 Pérez-Vázquez et al., 2018 Bhattacharyya et al., 2017 Hunter et al., 2022 Bierrum et al., 2023 Nakatsuka and Molloy, 2022 Sandlund et al., 2019 Ammar et al., 2017 Vanni et al., 2017 (Validation) Cristiano et al., 2020 Tarnutzer & Edlow, 2023 Gerber et al., 2023 Filippopoulos et al., 2022 Vanni et al., 2014 (Pilot) Shah et al., 2023 (Physical Exam) Ljunggren et al., 2018 Gottlieb et al., 2023 Herdman et al., 2021 Sacco et al., 2014 Vanni et al., 2015 Gaudino et al., 2021 Bradshaw et al., 2023 Ipsat et al., 2022 Stewart et al., 2022 Vanni et al., 2024 Hall et al., 2021 Machner et al., 2020 Gerber et al., 2022 Mandge et al., 2020 Ahsan et al., 2013 Lloyd et al., 2018 Khoujah et al., 2023 Kerber et al., 2020 Oliveira J. e Silva et al., 2023 Pellegrino et al., 2022 Vanni et al., 2023 (Timing) Neely et al., 2021 Edlow et al., 2023 Dumitrascu et al., 2017 | 40    |
| Gait / Balance Assessment   | Aroor et al., 2017 Bierrum et al., 2023 Nakatsuka and Molloy, 2022 Ammar et al., 2017 Vanni et al., 2017 (Validation) Tarnutzer & Edlow, 2023 Gerber et al., 2023 Filippopoulos et al., 2022 Vanni et al., 2014 (Pilot) Shah et al., 2023 (Physical Exam) Ljunggren et al., 2018 Gottlieb et al., 2023 Herdman et al., 2023 Bradshaw et al., 2023 Ip et al., 2022 Stewart et al., 2022 Vanni et al., 2024 Hall et al., 2021 Machner et al., 2020 Gerber et al., 2021 Lloyd et al., 2020 Mandge et al., 2020 Ahsan et al., 2013 Lloyd et al., 2018 Oliveira J. e Silva et al., 2023 Pellegrino et al., 2022 Vanni et al., 2023 (Timing) Edlow et al., 2023                                                                                                                                                                                                                                                                                | 28    |
| Vestibulo-ocular Assessment | Aroor et al., 2017 Stewart et al., 2022 Vanni et al., 2024 Hall et al., 2021 Lloyd et al., 2020 Edlow et al., 2023                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 6     |

|                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |    |
|---------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Co-ordination                                                                                     | Aroor et al., 2017 Ammar et al., 2017 Shah et al., 2023 (Physical Exam) Ljunggren et al., 2018                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 4  |
| Timing and Triggers<br>Subjective<br>Symptoms                                                     | Brown, 2011 von Brevern et al., 2015 Pérez-Vázquez et al., 2018 Hunter et al., 2022 Bierrum et al., 2023 Nakatsuka and Molloy, 2022 Sandlund et al., 2019 Ammar et al., 2017 Vanni et al., 2017 (Validation) Cristiano et al., 2020 Tarnutzer & Edlow, 2023 Gerber et al., 2023 Filippopoulos et al., 2022 Vanni et al., 2014 (Pilot) Ashiq et al., 2024 Masood et al., 2024 Ljunggren et al., 2018 Gottlieb et al., 2023 Herdman et al., 2023 Vanni et al., 2015 Giardino et al., 2021 Bradshaw et al., 2023 Ip et al., 2022 Stewart et al., 2022 Vanni et al., 2024 Kerber et al., 2003 Machner et al., 2020 Gerber et al., 2021 Newman-Toker et al., 2009 Lloyd et al., 2020 Mandge et al., 2020 Lloyd et al., 2018 Khoujah et al., 2023 Kerber et al., 2020 Oliveira J. e Silva et al., 2023 Pellegrino et al., 2022 Tu et al., 2024 Vanni et al., 2023 (Timing) Neely et al., 2023 Shah et al., 2023 Edlow et al., 2023 | 41 |
| Positional Testing<br>(in general)                                                                | von Brevern et al., 2015 Pérez-Vázquez et al., 2018 Sandlund et al., 2019 Vanni et al., 2017 (Validation) Gerber et al., 2023 Vanni et al., 2014 (Pilot) Ljunggren et al., 2018 Sacco et al., 2014 Vanni et al., 2015 Bradshaw et al., 2023 Ip et al., 2022 Sharif et al., 2023 Vanni et al., 2024 Kerber et al., 2011 Machner et al., 2020 Gerber et al., 2021 Newman-Toker et al., 2009 Lloyd et al., 2020 Lloyd et al., 2018 Khoujah et al., 2023 Pellegrino et al., 2022 Vanni et al., 2023 (Timing) Neely et al., 2021 Neely et al., 2023 Polensek et al., 2008                                                                                                                                                                                                                                                                                                                                                         | 24 |
| Dix-Hallpike Test                                                                                 | von Brevern et al., 2015 Pérez-Vázquez et al., 2018 Bhattacharyya et al., 2017 Bierrum et al., 2023 Sandlund et al., 2019 Vanni et al., 2017 (Validation) Cristiano et al., 2020 Gerber et al., 2023 Vanni et al., 2014 (Pilot) Shah et al., 2023 (Physical Exam) Ljunggren et al., 2018                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 29 |
| Supine Roll /<br>Pagnini-McClure                                                                  | Gottlieb et al., 2023 Sacco et al., 2014 Vanni et al., 2015 Bradshaw et al., 2023 Ip et al., 2022 Sharif et al., 2023 Kerber et al., 2011 Gerber et al., 2021 Lloyd et al., 2020 Ahsan et al., 2013 Lloyd et al., 2018 Khoujah et al., 2023 Kerber et al., 2020 Pellegrino et al., 2022 Neely et al., 2021 Neely et al., 2023 Edlow et al., 2023 Polensek et al., 2008                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 13 |
| Nystagmus<br>Recording                                                                            | von Brevern et al., 2015 Pérez-Vázquez et al., 2018 Bhattacharyya et al., 2017 Vanni et al., 2017 (Validation) Cristiano et al., 2020 Gerber et al., 2023 Vanni et al., 2014 (Pilot) Vanni et al., 2015 Ip et al., 2022 Sharif et al., 2023 Gerber et al., 2021 Lloyd et al., 2020 Polensek et al., 2008                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 9  |
| Bow and Lean,<br>Seated<br>Pseudonystagmus<br>Observation,<br>Cephalic<br>Hyperextension<br>Test, | Pérez-Vázquez et al., 2018 Bierrum et al., 2023 Vanni et al., 2017 (Validation) Cristiano et al., 2020 Gerber et al., 2023 Vanni et al., 2015 Stewart et al., 2022 Gerber et al., 2021 Edlow et al., 2023                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 1  |

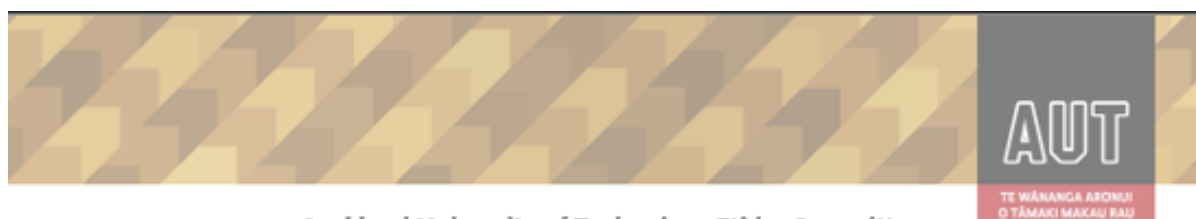
|                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |    |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| HINTS/HINTS+                   | Bierrum et al., 2023 Nakatsuka and Molloy, 2022 Tarnutzer & Edlow, 2023 Gerber et al., 2023 Filippopoulos et al., 2022 Ashiq et al., 2024 Shah et al., 2023 (Physical Exam) Ljunggren et al., 2018 Gottlieb et al., 2023 Herdman et al., 2023 Vanni et al., 2015 Grewal et al., 2015                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 22 |
| Head Impulse Test              | Stewart et al., 2022 Vanni et al., 2024 Machner et al., 2020 Gerber et al., 2021 Mandge et al., 2020 Pellegrino et al., 2022 Tu et al., 2024 Vanni et al., 2023 (Timing) Edlow et al., 2023 Dumitrascu et al., 2017                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 23 |
| Test of Skew                   | Bierrum et al., 2023 Nakatsuka and Molloy, 2022 Vanni et al., 2017 (Validation) Tarnutzer & Edlow, 2023 Gerber et al., 2023 Filippopoulos et al., 2022 Vanni et al., 2014 (Pilot) Shah et al., 2023 (Physical Exam) Gottlieb et al., 2023 Herdman et al., 2023 Vanni et al., 2015 Bradshaw et al., 2023 Stewart et al., 2022 Vanni et al., 2024 Hall et al., 2021 Machner et al., 2020 Gerber et al., 2021 Ahsan et al., 2013 Oliveira J. e Silva et al., 2023 Vanni et al., 2023 (Timing) Edlow et al., 2023 Polensek et al., 2008 Dumitrascu et al., 2017                                                                                                                                                                                                                                                    | 18 |
| Finger Rub Hearing Screen      | Bierrum et al., 2023 Nakatsuka and Molloy, 2022 Tarnutzer & Edlow, 2023 Gottlieb et al., 2023 Herdman et al., 2023 Edlow et al., 2023 Dumitrascu et al., 2017                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 7  |
| Video Head Impulse Test        | Bierrum et al., 2023 Gottlieb et al., 2023                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 2  |
| Vestibular Referral            | von Brevern et al., 2015 Pérez-Vázquez et al., 2018 Bhattacharyya et al., 2017 Bierrum et al., 2023 Sandlund et al., 2019 Ammar et al., 2017 Tarnutzer & Edlow, 2023 Gerber et al., 2023 Ashiq et al., 2024 Shah et al., 2023 (Physical Exam) Ljunggren et al., 2018 Gottlieb et al., 2023 Herdman et al., 2023 Sacco et al., 2014 Vanni et al., 2015 Giardino et al., 2021 Bradshaw et al., 2023 Ip et al., 2022 Stewart et al., 2022 Vanni et al., 2024 Kerber et al., 2011 Hall et al., 2021 Machner et al., 2020 Gerber et al., 2021 Newman-Toker et al., 2009 Mandge et al., 2020 Lloyd et al., 2018 Khoujah et al., 2023 Kerber et al., 2020 Oliveira J. e Silva et al., 2023 Pellegrino et al., 2022 Neely et al., 2021 Neely et al., 2023 Shah et al., 2023 Edlow et al., 2023 Dumitrascu et al., 2017 | 36 |
| Canal Repositioning Manoeuvres | Brown, 2011 Pérez-Vázquez et al., 2018 Hunter et al., 2022 Bierrum et al., 2023 Sandlund et al., 2019 Cristiano et al., 2020 Filippopoulos et al., 2022 Gottlieb et al., 2023 Herdman et al., 2023 Sacco et al., 2014 Giardino et al., 2021 Bradshaw et al., 2023 Ip et al., 2022 Sharif et al., 2023 Vanni et al., 2024 Kerber et al., 2011 Machner et al., 2020 Gerber et al., 2021 Newman-Toker et al., 2009 Lloyd et al., 2020 Lloyd et al., 2018 Khoujah et al.,                                                                                                                                                                                                                                                                                                                                          | 27 |

|                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |    |
|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
|                            | 2023 Kerber et al., 2020 Neely et al., 2021 Neely et al., 2023 Edlow et al., 2023 Polensek et al., 2008                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |    |
| Epley                      | Pérez-Vázquez et al., 2018 Bhattacharyya et al., 2017 Gerlier et al., 2023 Giardino et al., 2021 Ip et al., 2022 Sharif et al., 2023 Vanni et al., 2024 Gerlier et al., 2021 Khoujah et al., 2023 Edlow et al., 2023, Neely et al. 2021 Polensek et al., 2008                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 12 |
| Habituation Exercises      | Bhattacharyya et al., 2017: Hall et al., 2021: Lloyd et al., 2020                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 3  |
| Education                  | Bhattacharyya et al., 2017 Bierrum et al., 2023 Sandlund et al., 2019 Gottlieb et al., 2023 Herdman et al., 2023 Stewart et al., 2022 Hall et al., 2021 Lloyd et al., 2018 Khoujah et al., 2023 Kerber et al., 2020                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 11 |
| Vestibular Suppressants    | Sacco et al., 2014 Newman-Toker et al., 2009 Edlow et al., 2023                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 3  |
| Balance and Mobility       | Bradshaw et al., 2023: Ip et al., 2022: Hall et al., 2021:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 3  |
| Steroids                   | Kerber et al., 2011: Oliveira J. e Silva et al., 2023:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2  |
| CT Imaging Not Recommended | Bhattacharyya et al., 2017 Nakatsuka and Molloy, 2022 Sandlund et al., 2019 Ammar et al., 2017 Tarnutzer & Edlow, 2023 Gerlier et al., 2023 Filippopoulos et al., 2022 Ashiq et al., 2024 Shah et al., 2023 (Physical Exam) Masood et al., 2024 Gottlieb et al., 2023 Herdman et al., 2023 Grewal et al., 2015 Stewart et al., 2022 Vanni et al., 2024 Kerber et al., 2011 Machner et al., 2020 Gerlier et al., 2021 Newman-Toker et al., 2009 Lloyd et al., 2020 Ahsan et al., 2013 Lloyd et al., 2018 Khoujah et al., 2023 Imam et al., 2024 Dumitrascu et al., 2017                                                                                                                                                                             | 25 |
| MRI Recommended            | Bierrum et al., 2023 Nakatsuka and Molloy, 2022 Sandlund et al., 2019 Ammar et al., 2017 Tarnutzer & Edlow, 2023 Gerlier et al., 2023 Filippopoulos et al., 2022 Vanni et al., 2014 (Pilot) Ashiq et al., 2024 Shah et al., 2023 (Physical Exam) Ljunggren et al., 2018 Gottlieb et al., 2023 Vanni et al., 2015 Grewal et al., 2015 Vanni et al., 2024 Machner et al., 2020 Gerlier et al., 2021 Newman-Toker et al., 2009 Oliveira J. e Silva et al., 2023 Pellegrino et al., 2022 Tu et al., 2024 Vanni et al., 2023 (Timing) Shah et al., 2023 Bhattacharyya et al., 2017 Cristiano et al., 2020 Herdman et al., 2023 Dumitrascu et al., 2017 Lloyd et al., 2020 Lloyd et al., 2018 Khoujah et al., 2023 Neely et al., 2021 Neely et al., 2023 | 23 |
| MRI Not Recommended        | Hunter et al., 2022 Bierrum et al., 2023 Nakatsuka and Molloy, 2022 Ammar et al., 2017 Vanni et al., 2017 (Validation) Tarnutzer & Edlow, 2023 Filippopoulos et al., 2022 Ashiq et al., 2024 Shah et al., 2023 Ljunggren et al., 2018 Gottlieb et al., 2023 Grewal et al., 2015 Stewart et al., 2022 Vanni et al., 2024 Machner et al., 2020 Gerlier et al., 2021 Mandge et al., 2020 Pellegrino et al., 2022 Tu et al., 2024 Vanni et al., 2023 (Timing) Edlow et al., 2023                                                                                                                                                                                                                                                                       | 9  |
| HINTS / + Algorithm        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 22 |

|                                 |                                                                                                                                                                                                                                                                                                                                                                               |    |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| STANDING Algorithm              | Hunter et al., 2022 Bierrum et al., 2023 Nakatsuka and Molloy, 2022 Vanni et al., 2017 (Validation) Tarnutzer & Edlow, 2023 Gerlier et al., 2023 Filippopulos et al., 2022 Vanni et al., 2014 (Pilot) Ljunggren et al., 2018 Gottlieb et al., 2023 Herdman et al., 2023 Vanni et al., 2015 Vanni et al., 2024 Gerlier et al., 2021 Pellegrino et al., 2022 Edlow et al., 2023 | 23 |
| Titrate                         | Hunter et al., 2022 Bierrum et al., 2023 Nakatsuka and Molloy, 2022 Filippopulos et al., 2022 Herdman et al., 2023 Vanni et al., 2024 Machner et al., 2020 Tu et al., 2024 Neely et al., 2021 Neely et al., 2023 Shah et al., 2023 Edlow et al., 2023                                                                                                                         | 12 |
| ABCD <sup>2</sup>               | Vanni et al., 2017 (Validation) Tarnutzer & Edlow, 2023 Filippopulos et al., 2022 Ljunggren et al., 2018 Gottlieb et al., 2023 Grewal et al., 2015 Machner et al., 2020 Gerlier et al., 2021 Pellegrino et al., 2022 Edlow et al., 2023 Vanni et al., 2024                                                                                                                    | 11 |
| Physiotherapy Inclusion         | Bhattacharyya et al., 2017 Herdman et al., 2023 Sacco et al., 2014 Bradshaw et al., 2023 Ip et al., 2022 Stewart et al., 2022 Hall et al., 2021 Lloyd et al., 2020 Lloyd et al., 2018 Khoujah et al., 2023 Kerber et al., 2020 Neely et al., 2021 Neely et al., 2023 Edlow et al., 2023                                                                                       | 14 |
| GRACE 3                         | Bierrum et al., 2023 Gerlier et al., 2023 Filippopulos et al., 2022 Shah et al., 2023 (Physical Exam) Herdman et al., 2023 Sharif et al., 2023 Vanni et al., 2024 Khoujah et al., 2023 Oliveira J. e Silva et al., 2023 Tu et al., 2024 Shah et al., 2023 Edlow et al., 2023                                                                                                  | 12 |
| BPPV Bhattacharyya 2017         | Bhattacharyya et al., 2017 Hunter et al., 2022 Giardino et al., 2021 Lloyd et al., 2020 Lloyd et al., 2018 Khoujah et al., 2023 Neely et al., 2021 Neely et al., 2023                                                                                                                                                                                                         | 8  |
| Against Symptom quality History | von Brevern et al., 2015 Ammar et al., 2017 Shah et al., 2023 (Physical Exam) Gottlieb et al., 2023 Vanni et al., 2024 Kerber et al., 2011 Kerber et al., 2020 Tu et al., 2024 Edlow et al., 2023                                                                                                                                                                             | 9  |
| Against ABCD <sup>2</sup>       | Vanni et al., 2017 (Validation) Tarnutzer & Edlow, 2023 Machner et al., 2020 Gerlier et al., 2021 Pellegrino et al., 2022 Dumitrascu et al., 2017                                                                                                                                                                                                                             | 6  |
| Against Vestibular Suppressants | Hunter et al., 2022 Bhattacharyya et al., 2017 Ip et al., 2022 Sharif et al., 2023 Hall et al., 2021 Newman-Toker et al., 2009 Khoujah et al., 2023 Neely et al., 2021 Neely et al., 2023 Edlow et al., 2023                                                                                                                                                                  | 10 |

## Appendix B

### Auckland University of Technology Ethics Committee Approval Letter



#### Auckland University of Technology Ethics Committee (AUTEC)

11 September 2025

Denise Taylor  
Faculty of Health and Environmental Sciences

Dear Denise

Re Ethics Application: **25/259 A retrospective audit of emergency department management of acute dizziness and vertigo in New Zealand: Evaluating alignment to evidence-based guidelines and the impact of physiotherapist involvement.**

Thank you for your responses to AUTEC's conditions.

Your ethics application has been approved for three years until 11 September 2028.

#### Standard Conditions of Approval

1. The research is to be undertaken in accordance with the [Auckland University of Technology Code of Conduct for Research](#) and as approved by AUTEC.
2. All public facing documents must have the AUTEC approval number and be of a high standard of spelling and grammar. Dates on the Information Sheet(s) and Consent Form(s) must be consistent.
3. Any amendments to the project must be approved by AUTEC prior to being implemented.
4. A progress report is due annually on the anniversary of the approval date.
5. A final report is due at the expiration of the approval period, or, upon completion of project.
6. Any serious or adverse events must be reported to AUTEC, this includes unforeseen issues that might affect continued ethical acceptability of the project.
7. AUTEC grants ethical approval only. You are responsible for obtaining management permission for access from any institution or organisation at which your research is being conducted and you need to meet all ethical, legal, public health, and locality obligations or requirements for the jurisdictions in which the research is being undertaken.

The application number and title need to be referenced on all correspondence related to this project.

All forms are available online <http://www.aut.ac.nz/research/researchethics>

For any enquiries, please contact the Secretariat at [ethics@aut.ac.nz](mailto:ethics@aut.ac.nz)  
(This is a computer-generated letter for which no signature is required)

The AUTEC Secretariat  
Auckland University of Technology Ethics Committee

Cc: [Kane.nickles@gmail.com](mailto:Kane.nickles@gmail.com)

## Appendix C

### REDCap Data Extraction Tool and Supplementary Document

Confidential

ED Dizziness  
Page 1

#### Data Extraction Tool

Record ID

Study ID number

Are the records appropriate for data extraction?

- ☐ Yes  
☐ No, not assessed in ED / no emergency medicine assessment  
☐ No, no clear indication for vestibular assessment  
☐ No, self d/c prior to assessment/treatment

Data extraction from which care providers notes

- ☐ Emergency Medicine Doctor  
☐ Physiotherapist

#### Emergency Medicine Notes Audit

Is the timing of vertigo clearly established

- ☐ yes established as continuous  
☐ yes established as episodic  
☐ not clearly established

Are vertigo symptoms established as having a trigger or as spontaneous

- ☐ trigger noted  
☐ noted spontaneous nil triggering event  
☐ none recorded

Nystagmus assessment recorded

- ☐ Yes  
☐ No

Nystagmus characteristics recorded adequately

- ☐ Yes  
☐ No  
(Select yes - if documents nil nystagmus or describes characteristics)

Head Impulse Test assessed

- ☐ Yes  
☐ No

Head impulse test findings adequately described

- ☐ Yes  
☐ No  
(described side tested and if +/- )

Test of skew assessment recorded

- ☐ Yes  
☐ No

Test of skew findings adequately recorded

- ☐ Yes  
☐ No

Finger rub or similar acute hearing loss screen recorded

- ☐ Yes  
☐ No

HINTS or HINTS+ documented

- ☐ Yes  
☐ No

HINTS or HINTS+ results analysed accurately

- ☐ Yes  
☐ No

|                                                           |                                                                                                                                                                                                                                                                                 |
|-----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Degree of gait unsteadiness assessed                      | <input type="radio"/> Yes<br><input type="radio"/> No                                                                                                                                                                                                                           |
| BPPV Positional Tests recorded                            | <input type="radio"/> Yes<br><input type="radio"/> No                                                                                                                                                                                                                           |
| Positional test used                                      | <input type="checkbox"/> Dix-Hallpike<br><input type="checkbox"/> Supine Roll test<br><input type="checkbox"/> Other                                                                                                                                                            |
| Name of 'other' positional test                           | _____                                                                                                                                                                                                                                                                           |
| BPPV assessment description/interpretation                | <input type="checkbox"/> Adequately described and reported<br><input type="checkbox"/> Not adequately described or correctly reported (symptoms and nystagmus are detailed, there is correlation to canal tested)                                                               |
| CT Head                                                   | <input type="radio"/> Yes<br><input type="radio"/> No                                                                                                                                                                                                                           |
| MRI ordered or considered by Emergency Medicine clinician | <input type="radio"/> Yes<br><input type="radio"/> No                                                                                                                                                                                                                           |
| Medication for vertigo symptoms documented                | <input type="checkbox"/> Ondansetron<br><input type="checkbox"/> Cyclizine<br><input type="checkbox"/> Prochlorperazine<br><input type="checkbox"/> Droperidol<br><input type="checkbox"/> Metoclopramide<br><input type="checkbox"/> Steroid<br><input type="checkbox"/> Other |
| If other medication is used, please list.                 | _____                                                                                                                                                                                                                                                                           |
| Canal repositioning manoeuvre (CRM) used in treatment     | <input type="radio"/> Yes<br><input type="radio"/> No                                                                                                                                                                                                                           |
| CRM documented correlates to previous assessment          | <input type="radio"/> Yes<br><input type="radio"/> No<br>(eg DHT --> Epley)                                                                                                                                                                                                     |
| Referral to vestibular follow-up mentioned                | <input type="radio"/> Yes<br><input type="radio"/> No                                                                                                                                                                                                                           |

### Physiotherapy Notes Audit

|                                                                        |                                                                                                                                                           |
|------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Is the timing of vertigo clearly established                           | <input type="radio"/> yes established as continuous<br><input type="radio"/> yes established as episodic<br><input type="radio"/> not clearly established |
| Are vertigo symptoms established as having a trigger or as spontaneous | <input type="radio"/> trigger noted<br><input type="radio"/> noted spontaneous nil triggering event<br><input type="radio"/> none recorded                |
| Nystagmus assessment recorded                                          | <input type="radio"/> Yes<br><input type="radio"/> No                                                                                                     |

## **Data Extraction Tool Supplementary Document:**

*Explanation and rationale for the specific elements of the bespoke data extraction tool created in REDCap.*

Edlow et al in 2023 in published clinical guidelines for acute dizziness and vertigo in the emergency department following very comprehensive reviews of the evidence base to this point. The paper produced 10 specific recommendations, seven of which were taken as the basis of forming a bespoke data extraction tool. The three recommendations not included were related to training of emergency department clinicians, a method to assess for TIA and to consider steroid prescription, while still important they were outside of this study's particular area of interest, which is the application of specific bedside assessments and interventions employed and were also much less feasible to examine with my proposed methodology. Additionally, Bhattacharya 2017 guidelines for BPPV management were used to clarify specifics around what would be expected to be recorded in particular assessments and treatments of the BPPV condition.

The tool was developed within REDCap by the primary researcher and was piloted with iterative refinements made following three one-hour trial extractions. The draft tool was then socialised with an emergency medicine specialist and further refinement from feedback was invited to be included in the final version.

Question description and guidance:

### **Study ID number**

Record the unique study ID number for all emergency medicine clinical notes. If extracting data from physiotherapy clinical notes record the study ID number and letter 'p'. For example "513p".

### **Are the records appropriate for data extraction?**

Not appropriate if there are no emergency medicine clinical notes. Acceptable to extract data from emergency medicine admission notes, discharge notes and any electronic clinical notes.

At times there may be medical doctor notes from other specialty areas such as general medicine, this is outside the area of interest to the study and no further data extraction is required.

Upon reviewing the clinical notes it may become clear there is no clear indication for a vestibular assessment this is recorded as such and no further data extraction is required.

At times the patient may have self-discharged and not have had usual access to assessments and treatments. This will be recorded and no further data extraction is required. Any data already extracted from this record will be excluded from the study.

#### **Data extraction from which care providers notes**

All participants require data extraction from emergency medicine clinical notes (admission notes, discharge notes and any electronic clinical notes). Additionally using the filter notes feature, apply changes of service to 'Allied Health' and role to 'Physiotherapy' to establish if there was any physiotherapy input while the participant was in ED/ADU, if so the first section collects data from emergency medicine and the second half repeats most of the items for physiotherapy notes. Physiotherapy student notes (including student notes that are countersigned) will not be included in data extraction, (data from emergency medicine will still be recorded).

#### **Section 1 Emergency Medicine Notes Audit**

##### **Is the timing of vertigo clearly established**

This refers to the documentation of the timing characteristic of vertigo symptoms. This may include description of onset and duration of the vertigo noted. Of interest to the study is establishing the vertigo symptoms as 'continuous' or 'episodic' or not established.

This subjective assessment may include the terms continuous or episodic or use other descriptions consistent with the definitions below;

**Continuous:** acute-onset continuous dizziness lasting days to weeks and generally including features suggestive of new, ongoing vestibular system dysfunction (e.g., nausea and vomiting, nystagmus, and postural instability). In the ED, patients are symptomatic even at rest, and exacerbation from head movement or position change is typical. Often continuous vertigo conditions are defined as symptoms greater than 24hours, however in an ED context this is not a useful delineator, therefore continuous is defined as persisting from onset up until ED assessment, this may be a number of hours.

**Episodic:** discrete episode of vertiginous symptoms (nausea, vomiting nystagmus and postural instability) lasting seconds to hours, at rest between episodes the patient will have no vertigo.

##### **Are vertigo symptoms established as having a trigger or as spontaneous onset**

This question applies only to responses from the previous question in which the timing of vertigo was selected as 'yes established as episodic'. If episodic are vertigo symptoms established as having a trigger or as spontaneous onset.

A trigger will include onset of symptoms triggered by specific action, often duration seconds to minutes. Noting a difference between aggravation of milder ongoing enduring symptoms at rest (which should be recorded as continuous in previous question) and those asymptomatic at rest, with a episode of symptoms triggered by a discrete action.

Spontaneous will include notation of no triggering action being identified, or if specified as spontaneous (often minutes to hours).

If there is no comment referring to the nature of symptoms onset, such as a triggering action or description of spontaneous onset 'none recorded' will be selected.

**BPPV assessment description/interpretation**

BPPV assessment findings are adequately recorded;

- noting elicitation of nystagmus and symptoms,
- notation of nystagmus direction, and/or comment of this being consistent with tested canal,
- comment on duration of nystagmus,

May include other characteristics such as onset/latency and description of crescendo/decrecendo.

**CT Head**

CT head ordered by emergency medicine, inclusive of all variants of CT protocols.

**MRI ordered or considered by Emergency Medicine clinician**

MRI ordered or suggested in plan by emergency medicine doctor.

**Medication for vertigo symptoms documented**

Was there pharmacological treatment provided for management of acute dizziness and vertigo symptoms, if so, what was used or prescribed?

**If other medication is used, please list.**

Provide medication used to manage acute dizziness and vertigo if was not one included as an option in previous item.

**Canal repositioning manoeuvre (CRM) used in treatment**

Documentation of treatment given using a Canal repositioning manoeuvre (CRM).

**CRM documented correlates to previous assessment**

If a CRM was used, is there correlation from assessment findings and working diagnosis through to choice of CRM? e.g. positive Dix-Hallpike on right --> Right posterior canal BPPV → right Epley CRM.

E.g. would not be considered correlated to prescribe/perform Epley treatment without appropriate assessment (such as Dix-Hallpike) to diagnosis PC BPPV.

**Referral to vestibular follow-up mentioned**

Documentation of referral or plan for referral to ongoing vestibular rehabilitation, this may include referral to any appropriate provider including, outpatient physiotherapy, inpatient physiotherapy, ORL, concussion clinic, private physiotherapy provider or specialist clinic.

**Section 2 Physiotherapy Notes Audit**

Continue to Physiotherapy Notes Audit if physiotherapy notes were identified within ED/ADU environment. See above descriptions.

## Appendix D

### Evidence Synthesis Informing Data Extraction Tool for the Retrospective Clinical Notes Audit

**Table D1**

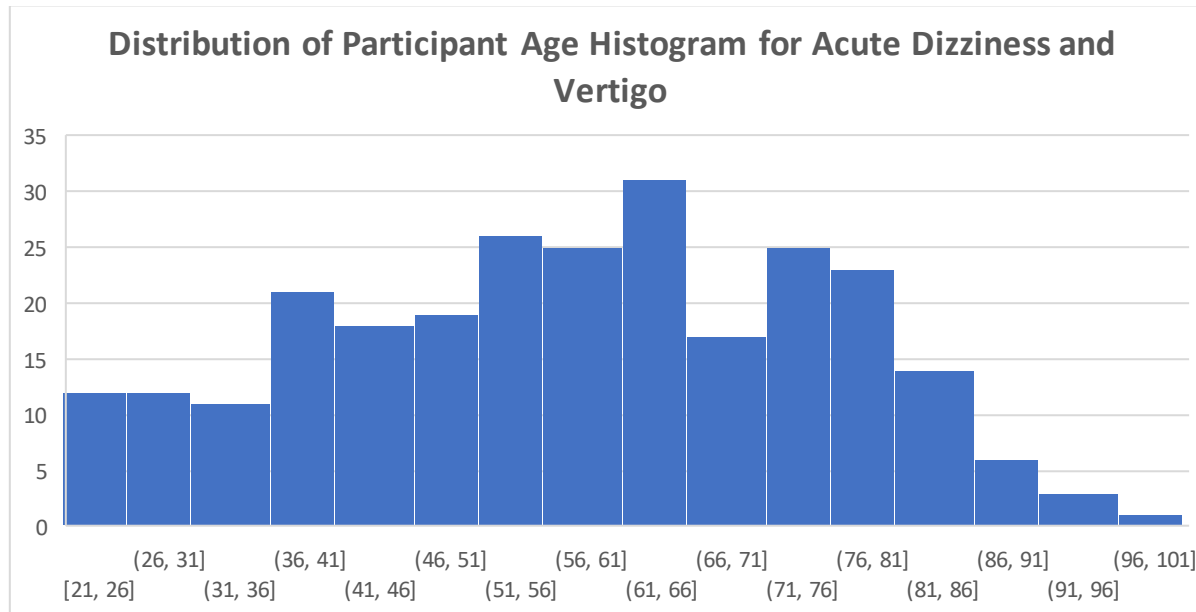
*Evidence Synthesis Informing Data Extraction Tool for the Retrospective Clinical Notes Audit*

| Clinical Metric                  | GRACE-3 (Edlow et al., 2023) | Scoping Review Consensus ( $\geq 10$ of total 51 studies) | BPPV Guidelines (Bhattacharyya et al., 2017) | Final Tool Inclusion           |
|----------------------------------|------------------------------|-----------------------------------------------------------|----------------------------------------------|--------------------------------|
| Timing of Symptoms               | Recommended (Strong)         | Supported (n=41)                                          | Recommended (Strong)                         | <b>Yes</b>                     |
| HINTS / HINTS+                   | Recommended (Strong)         | Supported (n=21)                                          | N/A                                          | <b>Yes</b>                     |
| Gait Instability                 | Clinical Indicator           | Supported (n=28)                                          | Recommended (Strong)                         | <b>Yes</b>                     |
| Dix-Hallpike Test                | Recommended (Strong)         | Supported (n=28)                                          | Recommended (Strong)                         | <b>Yes</b>                     |
| Supine Roll Test                 | Excluded (Nuance)            | Supported (n=12)                                          | Recommended (Strong)                         | <b>Yes</b>                     |
| Canal Repositioning Manoeuvres   | Recommended (Strong)         | Supported (n=26)                                          | Recommended (Strong)                         | <b>Yes</b>                     |
| Epley Manoeuvre                  | Recommended (Strong)         | Supported (n=11)                                          | Recommended (Strong)                         | <b>Yes</b>                     |
| Vestibular Suppressants          | Discouraged                  | Supported (Against n=7)                                   | Discouraged                                  | <b>Yes (Audit for Misuse)</b>  |
| CT / MRI Imaging                 | Discouraged (for BPPV)       | Supported (Against n=23)                                  | Discouraged                                  | <b>Yes (Audit for Utility)</b> |
| Referral to Vestibular Follow-up | Recommended (Strong)         | Supported (n=35)                                          | Recommended (Strong)                         | <b>Yes</b>                     |

**Appendix E**  
**Histogram of Sample Age Data**  
**to Inform Visual Inspection of Non-Normally Distributed Data**

**Figure E1**

*Histogram of Sample Age Data to Inform Visual Inspection of Non-Normally Distributed Data*



## Appendix F

### Paired Sample 2x2 Tables for Agreement and Discordance Calculation

| Nystagmus                            | Physiotherapy<br>(positive) | Physiotherapy<br>(negative) | Total        |
|--------------------------------------|-----------------------------|-----------------------------|--------------|
| Emergency Medicine (Positive)        | 31                          | 2                           | Total EM (+) |
| Emergency Medicine (Negative)        | 16                          | 0                           | Total EM (-) |
| Total                                | Total PT (+)                | Total PT (-)                | N            |
|                                      |                             |                             |              |
| Head Impulse Test                    | Physiotherapy<br>(positive) | Physiotherapy<br>(negative) | Total        |
| Emergency Medicine (Positive)        | 4                           | 0                           | n = 49       |
| Emergency Medicine (Negative)        | 42                          | 3                           |              |
| Total                                |                             |                             |              |
|                                      |                             |                             |              |
| Test of Skew                         | Physiotherapy<br>(positive) | Physiotherapy<br>(negative) | Total        |
| Emergency Medicine (Positive)        | 10                          | 0                           | Total EM (+) |
| Emergency Medicine (Negative)        | 36                          | 3                           | Total EM (-) |
| Total                                | Total PT (+)                | Total PT (-)                | N            |
|                                      |                             |                             |              |
| Finger Rub Hearing Screen            | Physiotherapy<br>(positive) | Physiotherapy<br>(negative) | Total        |
| Emergency Medicine (Positive)        | 3                           | 7                           | Total EM (+) |
| Emergency Medicine (Negative)        | 8                           | 31                          | Total EM (-) |
| Total                                | Total PT (+)                | Total PT (-)                | N            |
|                                      |                             |                             |              |
| Adequately Completed<br>HINTS/HINTS+ | Physiotherapy<br>(positive) | Physiotherapy<br>(negative) | Total        |
| Emergency Medicine (Positive)        | 2                           | 0                           | Total EM (+) |

|                                              |                                     |                                     |              |
|----------------------------------------------|-------------------------------------|-------------------------------------|--------------|
| Emergency Medicine (Negative)                | 18                                  | 29                                  | Total EM (-) |
| Total                                        | Total PT (+)                        | Total PT (-)                        | N            |
|                                              |                                     |                                     |              |
| <b>Gait Unsteadiness</b>                     | <b>Physiotherapy<br/>(positive)</b> | <b>Physiotherapy<br/>(negative)</b> | <b>Total</b> |
| Emergency Medicine (Positive)                | 23                                  | 4                                   | Total EM (+) |
| Emergency Medicine (Negative)                | 22                                  | 0                                   | Total EM (-) |
| Total                                        | Total PT (+)                        | Total PT (-)                        | N            |
|                                              |                                     |                                     |              |
| <b>Positional Assessment for BPPV</b>        | <b>Physiotherapy<br/>(positive)</b> | <b>Physiotherapy<br/>(negative)</b> | <b>Total</b> |
| Emergency Medicine (Positive)                | 8                                   | 0                                   | Total EM (+) |
| Emergency Medicine (Negative)                | 35                                  | 6                                   | Total EM (-) |
| Total                                        | Total PT (+)                        | Total PT (-)                        | N            |
|                                              |                                     |                                     |              |
| <b>Dix-Hallpike Test</b>                     | <b>Physiotherapy<br/>(positive)</b> | <b>Physiotherapy<br/>(negative)</b> | <b>Total</b> |
| Emergency Medicine (Positive)                | 8                                   | 0                                   | Total EM (+) |
| Emergency Medicine (Negative)                | 32                                  | 9                                   | Total EM (-) |
| Total                                        | Total PT (+)                        | Total PT (-)                        | N            |
|                                              |                                     |                                     |              |
| <b>Supine Roll Test</b>                      | <b>Physiotherapy<br/>(positive)</b> | <b>Physiotherapy<br/>(negative)</b> | <b>Total</b> |
| Emergency Medicine (Positive)                | 0                                   | 0                                   | Total EM (+) |
| Emergency Medicine (Negative)                | 42                                  | 7                                   | Total EM (-) |
| Total                                        | Total PT (+)                        | Total PT (-)                        | N            |
|                                              |                                     |                                     |              |
| <b>BPPV Assessment Adequately Documented</b> | <b>Physiotherapy<br/>(positive)</b> | <b>Physiotherapy<br/>(negative)</b> | <b>Total</b> |
| Emergency Medicine (Positive)                | 4                                   | 0                                   | Total EM (+) |

|                                      |                                     |                                     |              |
|--------------------------------------|-------------------------------------|-------------------------------------|--------------|
| Emergency Medicine (Negative)        | 39                                  | 6                                   | Total EM (-) |
| Total                                | Total PT (+)                        | Total PT (-)                        | N            |
|                                      |                                     |                                     |              |
| <b>CRM Performed</b>                 | <b>Physiotherapy<br/>(positive)</b> | <b>Physiotherapy<br/>(negative)</b> | <b>Total</b> |
| Emergency Medicine (Positive)        | 1                                   | 1                                   | Total EM (+) |
| Emergency Medicine (Negative)        | 15                                  | 32                                  | Total EM (-) |
| Total                                | Total PT (+)                        | Total PT (-)                        | N            |
|                                      |                                     |                                     |              |
| <b>CRM Performed Adequately</b>      | <b>Physiotherapy<br/>(positive)</b> | <b>Physiotherapy<br/>(negative)</b> | <b>Total</b> |
| Emergency Medicine (Positive)        | 1                                   | 0                                   | Total EM (+) |
| Emergency Medicine (Negative)        | 15                                  | 33                                  | Total EM (-) |
| Total                                | Total PT (+)                        | Total PT (-)                        | N            |
|                                      |                                     |                                     |              |
| <b>Referral Vestibular Follow Up</b> | <b>Physiotherapy<br/>(positive)</b> | <b>Physiotherapy<br/>(negative)</b> | <b>Total</b> |
| Emergency Medicine (Positive)        | 3                                   | 3                                   | Total EM (+) |
| Emergency Medicine (Negative)        | 23                                  | 20                                  | Total EM (-) |
| Total                                | Total PT (+)                        | Total PT (-)                        | N            |

## Appendix G

### Comparative Analysis with Established Studies

#### Table G1

*Comparative Analysis of Clinical Characteristics in Acute Dizziness and Vertigo*

|                                     | Keber et al., 2013 | Neely et. al., 2021 | Neely et al. 2023 | Lloyd et al., 2020 |         | Lloyd et al., 2020 (pilot) |           | Stewart et al., 2022 |          | This Study  |           |
|-------------------------------------|--------------------|---------------------|-------------------|--------------------|---------|----------------------------|-----------|----------------------|----------|-------------|-----------|
| Geographic Location                 | USA                | Australia           | Australia         | Australia          |         | Australia                  |           | Australia            |          | New Zealand |           |
| Sample Population                   | 3522               | BPPV 101            | BPPV 75           | 96                 |         | 52                         |           | 543                  |          | 264         |           |
| Clinician                           | –                  | –                   | –                 | EM n=96            | PT n=22 | EM n=20                    | PT n=32   | EM n=393             | PT n=150 | EM n=264    | PT n=49   |
| Median Age                          | 52.2               | 79(mean)            | 60(mean)          | 67                 |         | 57                         | 56        | 58(mean)             | 62(mean) | 60          | –         |
| Females (%)                         | 64.8               | 58                  | 68                | 67                 |         | 5                          | 56.3      | 250 (64)             | 84 (56)  | 160 (60.6)  | –         |
| ED Length of stay- median (minutes) | –                  | 228(mean)           | 258(mean)         |                    |         | 546                        | 546       | 204                  | 216      | 299         |           |
| Rate of Admission to ward (%)       | –                  | 25 (24)             | (100)             | 16 (17)            |         | 3 (15.0)                   | 2 (6.3)   | 194 (49)             | 119 (79) | 7.9         | 16.3      |
| Referral to vestibular follow-up    | –                  | 6 (6)               | 13 (17)           | 1 (4)              |         | –                          | –         | 22 (6)               | 88 (59)  | 16 (6.1)    | 26 (53.0) |
| BPPV Positional Tests (General)     | –                  | –                   | –                 | –                  | –       | –                          | –         | 107 (27)             | 120 (80) | 69 (26.1)   | 43 (87.8) |
| Dix-Hallpike Test (%)               | 137 (3.9)          | 46 (45)             | 65 (87)           | 25(26)             | 3(14)   | 1 (5)                      | 32 (100)  | –                    | –        | 69 (26.1)   | 40 (81.6) |
| Supine Roll Test                    | –                  | –                   | –                 | 0(0)               | 1(5)    | –                          | 21 (65.6) | –                    | –        | 0 (0.0)     | 42 (85.7) |

|                                                  |             |         |         |           |        |           |           |          |            |            |           |
|--------------------------------------------------|-------------|---------|---------|-----------|--------|-----------|-----------|----------|------------|------------|-----------|
| Canal Repositioning Manoeuvre                    | 8 (0.2)     | 32 (31) | 18 (24) | 3/26 (12) |        | 0         | 13 (92.9) | 17 (4)   | 49 (33)    | 15 (19.2)  | 16(100)   |
| Vestibular Suppressant Use (%)                   | —           | 59 (58) | 22 (29) | 25 (96%)  |        | 14 (70.0) | 25 (78.1) | 303 (77) | 114 (76)   | 66 (84.6)  | —         |
| Advanced Imaging CT (%)                          | 1162 (33)   | 37 (36) | 27 (64) | 35(36)    | —      | 11 (55)   | 11 (34)   | —        | —          | 127 (48.1) | —         |
| Advanced Imaging MRI (%)                         | —           | —       | —       | —         | —      | —         | —         | —        | —          | 13 (4.9)   | —         |
| Subjectively Determined Pattern of dizziness (%) | 1484 (40.9) | —       | —       | 52(54)    | 8(36)  | —         | —         | —        | —          | 129 (48.9) | 35 (71.4) |
| Gait / Postural Stability (%)                    | 882 (25)    | —       | —       | 54(56)    | 21(95) | —         | 30 (93.8) | 64 (16)  | 59 (39)    | 164 (62.1) | 45 (91.8) |
| Nystagmus (%)                                    | —           | —       | —       | 49(51)    | 2(9)   | —         | 31 (96.9) | 122 (31) | 121 (81)   | 170 (64.4) | 47 (95.9) |
| Head Thrust Test (%)                             | —           | —       | —       | —         | —      | —         | —         | 18 (5)   | 135 (90)   | 21 (8.0)   | 47 (95.9) |
| Test of Skew (%)                                 | —           | —       | —       | —         | —      | —         | —         | 17 (4)   | 122 (81)   | 37 (14.0)  | 46 (93.9) |
| Hearing screen (%)                               | —           | —       | —       | 24(25)    | 3(14)  | —         | —         | —        | —          | 8 (3.0)    | 11 (22.5) |
| HINTS                                            | —           | —       | —       | —         | —      | —         | —         | 11 (3)   | 105 (70.0) | 7 (2.7)    | 20 (40.8) |

