An integrative review of the FAST, MASS and CPSS when used in a prehospital setting.

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Table of Contents

List of Figures

List of Tables

List of Appendices

Abstract

Well-structured prehospital management is vital in acute stroke management to identify stroke quickly and accurately, and to administer the time-critical thrombolytic therapy. Utilisation of stroke screening tools is one of the important steps in prehospital acute stroke management to optimise health outcomes. There is a large volume of literature exploring the application, sensitivity and specificity of the prehospital stroke screening tools. Fast Arm Speech Test (FAST), Melbourne Ambulance Stroke Screening (MASS) and Cincinnati Prehospital Stroke Screen (CPSS) are three of the most commonly used screening tools in the United States, the United Kingdom, New Zealand and Australia. These are chosen for this integrative review because they have similar assessing components, but there is no integrative review comparing these three tools.

This research follows the integrative literature review methodology to conduct research that focuses on the FAST, MASS and CPSS systematically. There is no literature solely focusing on the FAST, MASS and CPSS. Hence, these three prehospital stroke screening tools are chosen for this dissertation with the aim to review, update and reconceptualise the knowledge. The chosen literature is reviewed using the Joanna Briggs Institution (JBI) critical appraisal checklist to critically analyse research rigor and to see if there are any potential bias in research design, method and conduct. Through the thematic analysis, two themes are identified. Firstly, it is evident that EMD (emergency medical dispatcher) and EMS (emergency medical service) are the predominant users of the prehospital stroke screening tools. Secondly, the prehospital stroke screening is used for the purpose of triaging patients prior to hospital transfer, leading to either over or under-triage.

This integrative review recommends increasing the awareness of stroke symptoms. This can be achieved by educating practitioners. Also, the need for more robust data on the prehospital stroke screening tool sensitivity and specificity is highlighted to aid prehospital practitioners to maintain evidence-based practice and be prepared for detecting stroke even when a patient displays atypical stroke symptoms.

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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 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.

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Chapter 1 Introduction

1.1 Beginning Position

This integrative review focuses on utilisation of the Fast Arm Speech Time (FAST), Melbourne Ambulance Stroke Screening (MASS) and Cincinnati Prehospital Stroke Screen (CPSS) in prehospital settings in the United States of America (USA), the United Kingdom (UK), New Zealand (NZ) and Australia. FAST, MASS and CPSS are known to have similar components for assessing patients. There is no published literature focusing solely on these three tools.

Definition of prehospital healthcare settings can vary depending on the context. Within this dissertation, the prehospital setting refers to any clinics and medical services that are not part of a secondary or tertiary hospital where a patient is seen by specialists and receives diagnostic tests and necessary treatments. All of the countries' current stroke guidelines recommend patients or members of public call for an ambulance to initiate acute stroke care, and for paramedics to assess patients with validated stroke screening tools (Intercollegiate Stroke Working Party, 2016; Powers et al., 2018; Stroke Foundation, 2017; Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010). Each country's guideline recommends the use of a particular prehospital stroke screening tool. Thus, it is reasonable to compare use of these three prehospital stroke screening tools.

1.2 Background

The worldwide burden of stroke is increasing (Feigin et al., 2015). Stroke is the second highest cause of death and a common cause of disability internationally (Krishnamurthi et al., 2014). It is the third most frequent cause of mortality in New Zealand (Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010). There has been a reduction in age-standardised stroke mortality rates (Feigin et al., 2014); however, the overall burden of stroke and its economic impact is increasing due to growing and aging populations (Feigin et al., 2015; Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010; Wang, Ding, & Fu, 2018).

Stroke research should be continuous so healthcare professionals can comprehend the risk factors, prevention strategies, early recognition of stroke, the gold-standard treatment, epidemiological trends, impact of stroke, and the nature of this disease (Thrift et al., 2017). This is in an effort to reduce disparities in health outcomes between ethnic groups, and between

countries with contrasting income levels (Feigin et al., 2014). Also, this will enable healthcare professionals to maintain an evidence-based approach in their practice.

Ischaemic stroke is the most common type of stroke and is caused by thrombi, which are made up of fibrin as well as other biochemical products (Walker, Yip, Zhelev, & Henschke, 2014). Intravenous tissue plasminogen activator (IV-tPA) is the only approved treatment for acute ischaemic stroke. It is strictly a time-dependent treatment that dissolves the thrombus (Walker et al., 2014). In an attempt to administer the time-critical thrombolytic treatment to more eligible patients, a number of prehospital stroke screening tools were created for quick and accurate assessment (Walker et al., 2014). The history of each screening tool will be explored further in the literature review chapter.

In 1996, New Zealand published a guideline for acute stroke management and a rehabilitation plans for after stroke care with the primary goal of assisting healthcare professionals to enhance the standard of the care they provide (Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010). The previous NZ stroke guideline was created in 2010 with assistance from the Australian Stroke Foundation. Currently, the NZ stroke guideline has been replaced by the 2017 Australian Clinical Guidelines for stroke management (Intercollegiate Stroke Working Party, 2016). In New Zealand, the current recommendation is to follow the latest Australian stroke guideline excluding care framework for ethnic and cultural aspects of the care (Mahawish, Barber, McRae, Slark, & Ranta, 2018; Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010).

1.3 Research Significance

The FAST, MASS and CPSS screening tools are examined to build knowledge in current prehospital stroke management in USA, UK, NZ, and Australia. This integrative review is not intended to select a superior prehospital stroke screening tool and ask clinicians to change their practice. It is true that modern medicine and technology enable stroke to be a treatable disease and to be classified as a medical emergency (Sibson, 2017). The prehospital stroke screening tool attributed to this evolvement because it is able to rapidly and accurately detect stroke in a prehospital setting (Drenck et al., 2019). However, none of the prehospital stroke screening tools are flawless enough to satisfy every scenario in the real world.

Prehospital stroke management is constantly emphasised in the acute stroke care chain (Hasegawa et al., 2013; Sibson, 2017; Wang et al., 2018). Researchers and practitioners continuously attempt to identify the gold-standard practice that enables patients to have the best health outcome and minimise public health expenditure. Conversely, evolving technology, confusing research findings, and the capacity of different healthcare practices can cause misunderstandings for many practitioners working in the real world. Therefore, this integrative review is significant in the current prehospital management research field as the methodology allows the author to update the knowledge using multiple sources and types of information, then produce feasible recommendations (Whittemore & Knafl, 2005).

The integrative review methodology allows researchers to include a mixture of quantitative and qualitative studies to gain the most comprehensive information to produce new knowledge on a specific phenomenon or healthcare issue (Noble & Smith, 2018; Whittemore & Knafl, 2005). Although modern evidence-based practice (EBP) demands various types of literature when suggesting recommendations, there have been no integrative reviews focusing on prehospital stroke recognition tools. This is another reason why the integrative review methodology fits well with this research.

This integrative review offers unique perspectives on examining both quantitative and qualitative data to update knowledge in USA, UK, NZ and Australia prehospital stroke management, particularly use of prehospital stroke recognition tools. The initial research revealed that the most of the studies examined the stroke screening tool when the tools were used by paramedics or healthcare professionals working in emergency department. However, this integrative review has broader inclusion criteria in an attempt to review how effective the tools were used in the less-known prehospital environment such as urgent care clinics.

Urgent care speciality plays a significant role in New Zealand's healthcare system (Royal New Zealand College of Urgent Care, 2019). According to the Royal New Zealand College of Urgent Care (2019), this speciality is the second largest in providing face-to-face consultations. However, it was extremely difficult to identify literature focusing on urgent care clinics in New Zealand or in other developed countries such as Australia, the United Kingdom and the United States. Since there is little to no literature including urgent care clinicians, the flexibility of this methodology and an extensive literature review would be valuable for urgent care physicians in an effort to develop recommendations for current and future prehospital stroke assessment and guidelines.

Urgent care plays a significant role in the modern healthcare system in NZ; however, there is little to no attention paid to this speciality. This dissertation does not set out to change current NZ guidelines or individual healthcare professionals' practice. Instead, the purpose of this research is to educate healthcare professionals working in urgent care clinics. Through this integrative review, the healthcare professionals can connect the new knowledge from the latest research and the interpretation of the research findings into clinical practice (Bourgault, 2018).

Accordingly, this integrative review aims to review, update and reconceptualise the data from published literature on prehospital stroke screening tools, precisely the FAST, MASS and CPSS tools. Integrative review methodology used in this dissertation is described as a collection of detailed and extensive data of a research topic, in this case use of prehospital stroke screening tools, through diligent and systematic research.. To achieve this, the following two research questions will be examined in detail in the discussion chapter.

1. **How did the utilisation of FAST, MASS and CPSS by the assessor in a prehospital setting impact on hospital admissions?**
2. **What are the gaps when using the stroke screening tools in a prehospital setting?**

1.4 Research Structure

Chapter one introduces the dissertation by defining the important concepts within the topic. The outline of the FAST, MASS and CPSS in the prehospital setting provides a deeper insight and updates the knowledge of prehospital stroke management. This dissertation uses an integrative review which is a methodology that stems from evidence-based practice. The integrative review aims to summarise pertinent studies and produces recommendations for practice (de Souza, de Silva, & de Carvalho, 2010; Whittemore & Knafl, 2005). This integrative review utilises thematic analysis which is a method to review and analysis data, and then to detect common themes across dataset (Braun & Clarke, 2006). The aim of this dissertation is revealed along with the two research questions.

Chapter two explains the pathophysiology of stroke, acute stroke treatment, current prehospital management, and prehospital stroke screening tools. There are many prehospital stroke screening tools; however, for the purpose of this dissertation, only the FAST, MASS and CPSS tools will be discussed.

Chapter three details how this research has been conducted and the chapter follows the integrative review guideline for robustness (Whittemore & Knafl, 2005). The PRISMA flowchart is used to track numbers of literature after screening and elimination, and is attached as an appendix A (Moher, Liberati, Tetzlaff, Altman, & The PRISMA Group, 2009).

Chapter four is dedicated to the findings of this research. It starts with a summary of the data evaluation using a JBI critical appraisal checklist (Joanna Briggs Institute, 2019), which is included as an appendix B and then explores the findings. The thematic analysis map has three boxes, the top box, indicates title and fundamental concept of this integrative review. The two lower boxes are the common themes based on thematic analysis, which are the predominant users Emergency Medicine Dispatcher (EMD) and Emergency Medicine Service (EMS), and over and under-triage.

Chapter five answers the two research questions to critically analyse the findings. The second portion of the chapter concludes this integrative review by unpacking future research and limitations.

1.5 Summary

The burden of stroke is continuously increasing due to growing and aging populations. Continuous stroke research is needed to support healthcare professionals to provide evidence-based practice. This integrative review focuses on the FAST, MASS and CPSS tools when used in the prehospital setting in USA, UK, NZ and Australia. Prehospital stroke management is a vital step in acute stroke care to improve patient's health outcomes and to administer thrombolytic therapy to patients with acute ischaemic stroke.

The following chapter will concentrate on the literature review of pathophysiology of stroke, acute stroke treatment, prehospital management, and prehospital stroke screening tools. The updated knowledge will contribute to a better understanding of the literature concerning this research field.

Chapter 2 Literature Review

2.1 Introduction

Stroke is a sudden interruption of blood circulation to the brain, which results from either an acute ischaemic or haemorrhagic event (Chan & Radomski, 2005; Tutwiler et al., 2017). The stroke or 'brain attack' illness is a major health concern in the elderly population (Tan & Christensen, 2012). The current literature shows that stroke is increasingly becoming a burden across all age groups because the stroke incidence rate has increased even in people aged under 65 years (Alebeek et al., 2018).

This chapter will focus on a literature review concerning the fatal and costly illness, stroke. Firstly, it will explain the pathophysiological perspectives of stroke. Then, the latter part of this chapter will concentrate on acute stroke treatment, prehospital management, and early stroke recognition tools.

2.2 Pathophysiology of Stroke

There are two main physiological processes that lead to stroke. Acute stroke is classified as either ischaemic or haemorrhagic. These two types of stroke have different causes and cellular sequelae, but the end result is the same; normal blood flow to the brain tissue is disrupted, leading to cellular damage (Sibson, 2017; Tutwiler et al., 2017). Many steps that lead to cell damage in stroke are yet to be clearly explained (Deb, Sharma, & Hassan, 2010; Tutwiler et al., 2017).

Ischaemic strokes are caused by a thrombus in a blood vessel reducing blood flow to the brain tissue (Manners, Steinberg, & Shutter, 2017). Ischaemic stroke accounts for 80% of all stroke cases (Kloska, Wintermark, Engelhorn, & Fiebach, 2009). Cardiac embolism, atherosclerosis and microvascular diseases are known to be the common causes of ischaemic stroke (Mohr et al., 1997).

In ischaemic stroke, a thrombotic event is caused by local formation of a thrombus, leading to blockage of blood vessels. An embolic event occurs when a thrombus in the systemic circulation degrades, causing emboli to travel into the vasculature of the brain, resulting in an ischaemic event (Boss & Huether, 2014). Regardless of the degree of blockage, it decreases blood flow in the brain meaning less oxygen supply to the brain. The tissue is therefore starved of oxygen and glucose, leading to cell damage and death (Tutwiler et al., 2017). Classification of

ischaemic stroke depends on its source and the aid of computed tomography (CT) image findings in conjunction with patient presentation (Boss & Huether, 2014; Collins, 2007). CT perfusion images can assist the stroke specialist to measure the blood-brain barrier permeability, which results from ischaemia (Horsch et al., 2016).

Haemorrhagic stroke may have a similar presentation to ischaemic stroke; however, pathophysiology and treatment are different to ischaemic stroke (Collins, 2007). Haemorrhagic stroke is caused by bleeding in the cerebral tissue from the ruptured intracerebral vessels, which have multiple origins. Haemorrhagic stroke can start from 1) the simple rupture of small vessels from long-term hypertension or cerebral amyloid angiopathy, 2) broken intracranial aneurysms, 3) broken tumours that are attached to many blood vessels, 4) ruptured arteriovenous malformations, 5) decreased coagulation, or 6) trauma (Peck et al., 2008).

Haemorrhagic stroke only accounts for approximately 15% of all stroke, but its death rate is four times higher than ischaemic stroke (Collins, 2007; Peck et al., 2008; Wu et al., 2017). It has received more attention from researchers due to its high mortality and morbidity rates (Chen, Zeng, & Hu, 2014). Ironically, haemorrhagic stroke has a better long-term outcome than ischaemic stroke when it comes to recovery, and results in lower morbidity and disability in haemorrhagic stroke survivors (Collins, 2007).

2.3 Acute Stroke Treatment

Acute stroke treatment, particularly thrombolytic therapy, receives vast attention because of its proven effect on acute ischaemic stroke patients. Acute stroke treatment varies greatly depending on the type of stroke, whether it is ischaemic or haemorrhagic. For this reason, accurately and rapidly diagnosing stroke and determining the type of stroke is fundamental in stroke management (Glober et al., 2016).

Appropriately diagnosed stroke patients can be transported to a stroke management capable hospital (SMCH) where timely stroke treatment such as tissue plasminogen activator (tPA) or intra-arterial therapy is available (Manners et al., 2017). Within this dissertation, SMCH constitutes the tertiary hospitals where patients would be referred to after EMS and urgent care clinicians suspect stroke based on the screening result, and then confirm patients' diagnosis and administer thrombolytic treatments if needed. The life-saving treatment, namely intravenous (IV) or intra-arterial (IA) thrombolysis for stroke, is available for acute ischaemic stroke patients

(Intercollegiate Stroke Working Party, 2016; Powers et al., 2018; Stroke Foundation, 2017; Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010). IV tPA, such as Alteplase, is known to dissolve the thrombus or clot in acute ischaemic stroke, and has risks of developing bleeding (D. Miller, Simpson, & Silver, 2011). It is extremely important to select IV tPA candidates carefully and it must be administered within the first three hours of stroke onset (Intercollegiate Stroke Working Party, 2016; Powers et al., 2018; Stroke Foundation, 2017; Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010). There is some evidence that IV tPA is still effective when it is given more than three hours after the symptoms start; however, for the best outcome, it should be administered within three hours of the onset as approved by the US Food and Drug Administration (FDA) and the Australian Therapeutic Goods Administration (Chapman et al., 2014; Stroke Foundation, 2017; von Kummer, 2010). Besides time as an inclusion and exclusion criteria for IV tPA, the patient's age, medical history, allergies, underlying comorbidities, level of SMCH staffing and their skills and experience in thrombolytic therapy as well as easy and immediate access to imaging facility must be considered (Intercollegiate Stroke Working Party, 2016; Powers et al., 2018; Stroke Foundation, 2017; Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010).

'Time is tissue' is a well-described mantra here, as the time elapsed from symptom onset to treatment administration has a direct correlation with brain tissue damage, and long-lasting detrimental health effects (Sibson, 2017). Hence, delayed recognition of symptoms and administration of thrombolytic treatments are associated with poorer outcomes in acute ischaemic stroke patients (Fassbender et al., 2013; Padma et al., 2007; Simonsen et al., 2014). Stroke patients have the highest chance of getting positive outcomes as long as they present in hospital within first few hours of the development of stroke symptoms (Intercollegiate Stroke Working Party, 2016; Powers et al., 2018; Stroke Foundation, 2017; Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010; Venturelli, Appleton, Anderson, & Bath, 2018). In ischaemic stroke, neuron survival is heavily influenced by the length of the occlusion (Tan & Christensen, 2012). Hence, 'golden hour' and 'door-to-needle time' are key terms in prehospital stroke care literature regarding the view of frequency and success rate for thrombolytic treatments. Golden hour is often used in trauma literature meaning the highest effect is expected if the time of symptom onset to treatment is within the first 60 minutes (Ebinger et al., 2015). Door-to-needle time refers to the time from arrival at SMCH to initiation of thrombolytic therapy (Ebinger et al., 2015).

According to recent data, only up to 3% of patients with acute ischaemic stroke received IV tPA in Australia and New Zealand (Mosley, Morphet, Innes, & Braitberg, 2013; Stroke

Foundation, 2017; Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010). While this may be partly due to multiple contraindications, the narrow three-hour time window for IV tPA, means many eligible acute ischaemic stroke patients are unable to receive thrombolysis treatment (Lakhan, Walther, Morganstein, & Nguyen, 2017; T. Miller, Levitt, & Brook, 2013). Furthermore, the poor administration is due to prehospital delay, usually time taken to ring an ambulance for medical help (Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010). This indicates that a lack of public awareness of stroke symptoms and prehospital delays are the main barriers to timely intervention (Hasegawa et al., 2013; Swartz et al., 2017).

Intra-arterial therapy (IAT) refers to mechanical removal or retrieval of the clot. It is also available with less haemorrhaging risks than IV tPA; however, this therapy is less accessible due to the necessity for highly trained specialists and related high costs (T. Miller et al., 2013; Powers et al., 2018; Stroke Foundation, 2017; Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010). IAT is available for confirmed ischaemic stroke patients who are not eligible for IV tPA, or it can be used adjacent to IV tPA (T. Miller et al., 2013). Fortunately, it has a wider therapeutic time window, which varies depending on local policies and protocol. A general rule of thumb is that IAT can be done within 5 to 6 hours of symptom onset and with selected patients (Intercollegiate Stroke Working Party, 2016; Powers et al., 2018; Stroke Foundation, 2017; Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010). Evidence suggests that IAT is more suitable for large arterial occlusion (Intercollegiate Stroke Working Party, 2016; T. Miller et al., 2013).

2.4 Prehospital Management

Prehospital recognition and management of acute stroke feature significantly in the stroke care cascade. Many regions and countries have different referral systems between primary, secondary and tertiary care centres, which can make universal recommendations troublesome. The prehospital management includes any care that is offered by Emergency Medicine Service (EMS) including ambulance personnel, ambulance technicians, Emergency Medicine Dispatcher (EMD), telemedicine, prehospital clinicians or paramedics at the scene (MacFarlane, 2003). EMS is usually the first responder for those who have medical or traumatic emergencies and are in need of treatment (Hunter, Porter, & Williams, 2019). Whereas, the role of an EMD is to receive and evaluate emergency calls and identify stroke by asking callers a set of scripted questions (Caceres

et al., 2013; Mould-Millman et al., 2018; Puolakka, Strbian, Harve, Kuisma, & Lindsberg, 2016; Ramanujam et al., 2008).

The definition of EMS is a medical provider who identifies stroke, transports patients to the nearest SMCH, and activates the stroke team at the receiving SMCH (Asimos et al., 2014; Bray, Coughlan, Barger, & Bladin, 2010; Studnek, Asimos, Dodds, & Swanson, 2013). Typically, paramedics are the major player in the EMS sector. It is not uncommon for studies to classify EMS and EMD separately in a prehospital setting. It is evident that EMS is an important contributor in prehospital stroke management because they are often the initial medical contact for stroke patients (Studnek et al., 2013). If EMD categorises the call as a potential stroke case, then the EMD dispatches an ambulance immediately and provides prearrival instructions to callers simultaneously (Caceres et al., 2013; Mould-Millman et al., 2018; Puolakka et al., 2016). Prehospital stroke identification starts when the EMD receives the emergency call and evaluates the phone conversation (Mould-Millman et al., 2018).

Urgent care physicians are included in this dissertation because they also offer care to people who casually present in urgent care clinics. If a case cannot be safely and effectively treated in an urgent care clinic, then the patient must be referred to a local emergency department or appropriate department directly if possible (Royal New Zealand College of Urgent Care, 2019). Collaborative practice between prehospital physicians, EMS, emergency department (ED) clinicians and stroke specialists are vital (Intercollegiate Stroke Working Party, 2016; Powers et al., 2018; Stroke Foundation, 2017; Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010). Prehospital clinicians and EMS are trained to recognise stroke symptoms quickly, have clear communication and more interaction with ED departments and/or stroke specialists to increase the effectiveness of care and provide high quality care consistently (Govindarajan, de Souza, Pierog, Ghilarducci, & Johnston, 2011; MacFarlane, 2003). This implies that prehospital management should include prenotifying the receiving SMCH so the stroke team can be ready for diagnostic examination and intervention (Intercollegiate Stroke Working Party, 2016; Powers et al., 2018; Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010). Without a multidisciplinary approach, prehospital management of acute stroke cannot succeed.

Stroke is one of the most common causes of mortality and disability in the developed world, despite the proven effectiveness of thrombolytic treatment for acute ischaemic stroke (Mosley et al., 2013). This includes younger adults as well as older adults who are 65 years old and above. According to Ekker et al. (2018), the incidence of ischemic stroke in younger adults has increased

up to 40% internationally during the last decade. This confirms that the younger adults should receive as equal screening opportunities as the older population. Only a small proportion of stroke patients receive intravenous thrombolysis treatment. Poor awareness of stroke symptoms is directly linked to late arrival at hospital (Jin et al., 2012). Hence, national and international guidelines for stroke recognition and management have been developed and researchers are constantly reviewing the existing data to enhance the guidelines and clinical outcomes (Mosley et al., 2012).

In New Zealand, prehospital management for stroke highlights the necessity of increased awareness of critical characteristics of stroke and signs and symptoms of stroke (Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010). Several attempts have been made to emphasise the fact that prehospital stroke recognition tools are a significant component of prehospital management. A large randomised control trial (RCT), involving 4,895 suspected stroke patients was conducted in Italy to evaluate the efficacy of prehospital care pathway for stroke (de Luca et al., 2009). The study found that well-structured and well-planned pathways allowed higher numbers of eligible patients to receive thrombolysis treatment, resulting in higher quality of care for stroke patients (de Luca et al., 2009). This finding is consistent with why New Zealand prehospital stroke guideline promotes being conscious of the stroke signs and symptoms, and utilising the tools to place an appropriate candidate onto a correct pathway. Ultimately, these small actions will optimise patient's health outcome as found in the recent study (Ebinger et al., 2015; Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010).

2.5 Prehospital Stroke Screening Tools

Neurological illnesses have many symptoms, such as migraine, seizure, sepsis, abnormal blood glucose levels and syncope (Glober et al., 2016). The aforementioned list is broad, making it challenging for prehospital clinicians to make the correct decisions regarding stroke diagnosis. It is recommended that prehospital clinicians use prehospital stroke screening tools as a checklist (Intercollegiate Stroke Working Party, 2016; Powers et al., 2018; Stroke Foundation, 2017; Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010; Zhelev, Walker, Henschke, Fridhandler, & Yip, 2019). Bray et al. (2010) concluded that using a prehospital stroke screening tool led to faster hospital transfer and improved EMS diagnosis, thus increased thrombolytic therapy frequency for more patients. Prehospital stroke screening tools not only function as a checklist, they are also used to rule out stroke mimics. Therefore, it is important to

have a well-structured pathway or protocols for the assessor to identify stroke correctly and quickly (de Luca et al., 2009).

There are many different types of stroke screening tools for prehospital stroke recognition. These include the Los Angeles Prehospital Stroke Screen (LAPSS), the Face Arm Speech Test (FAST), the Cincinnati Prehospital Stroke Scale (CPSS), Ontario Prehospital Stroke Screening tool (OPSS), Recognition Of Stroke in the Emergency Room (ROSIER), the Medic Prehospital Assessment for Code Stroke (Med PACS) and the Melbourne Ambulance Stroke Screen (MASS) (Bray et al., 2010; Purrucker et al., 2015; Walker et al., 2014). These tools are designed to identify stroke rather than measure the severity of stroke (Purrucker et al., 2015). Stroke screening tools are valuable in prehospital management as they enable the ambulance dispatcher to recognise possible stroke cases over the phone, even if the patient them self is not aware they may be suffering from a stroke (Oostema, Carle, Talia, & Reeves, 2016).

Each country, region and stroke management capable hospital has their own policies and guidelines based on local stroke service availability and related costs (Harrington, 2019). The local policies and guidelines are in place to assist clinicians to make clinical decisions and perform evidence-based practice. One of the main evidence-based practice for stroke management is to utilise the prehospital stroke screening tools. It is notable that these prehospital screening tools have similar assessing components. Many studies have evaluated paramedic diagnostic skills using the prehospital stroke screening tools and stress how important it is to initiate the intervention as soon as possible (Drenck et al., 2019; Ebinger et al., 2015; Fassbender et al., 2013). The exact accuracy and applicability of the prehospital stroke screening tools in the real world is still not known (Zhelev et al., 2019). For example, the UK, NZ and Australian guidelines recommend the FAST for prehospital assessment (Intercollegiate Stroke Working Party, 2016; Stroke Foundation, 2017; Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010). The UK guidelines suggest that other stroke screening tools, such as National Institutes of Health Stroke Scale (NIHSS) and ROSIER, can be considered if there is more robust data available for assessing the symptoms that are not inherent in the FAST tool (Intercollegiate Stroke Working Party, 2016). The US guidelines endorse the FAST, LAPSS, or CPSS for prehospital stroke identification (Powers et al., 2018). All of the current guidelines advocate educating clinicians on the prehospital stroke screening tools and the critical characteristics of stroke (Intercollegiate Stroke Working Party, 2016; Powers et al., 2018; Stroke Foundation, 2017; Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010).

2.6 Face Arm Speech Time Stroke Screening Tool History and Assessment Technique

The FAST tool is the preferred prehospital stroke screening tool in UK and New Zealand (Rudd, Buck, Ford, & Price, 2016; Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010). The FAST tool was developed in late 1990s by stroke specialists, emergency medicine specialists, and EMS as part of a paramedic education bundle (Harbison et al., 2003; Kleindorfer et al., 2007). The FAST screening tool was derived from CPSS and LAPSS (Los Angeles Prehospital Stroke Screen) tools, which were the most validated screening tools at the time the FAST tool was developed (Harbison et al., 2003).

The FAST tool originators emphasised the importance of developing a simple screening tool that contains the components that are already in the paramedic assessment to avoid repetition (Harbison et al., 2003). The FAST tool contains three items that were derived from the CPSS screening tool: speech changes, arm weakness and facial droop (Harbison et al., 2003; Kleindorfer et al., 2007). The FAST tool does not test lower limb weakness because the screening tool is designed to be used when the patient is sitting down; other symptoms, such as visual disturbance, coordination and balance, are not included in the screening tool because these symptoms do not contribute significantly in the screening tool sensitivity (Harbison et al., 2003).

Facial symmetry can be assessed by asking the patient to smile and show all of their teeth (Harbison et al., 2003; Pickham et al., 2019). The speech changes refers to slurred speech or any other new changes to the speech, ability to have a conversation, and ability to verbally label the objects (Harbison et al., 2003). Arm weakness can be assessed by asking patient to shut their eyes and raise their arms to 90° if sitting upright, or 45° if lying down in supine position, then looking for any weakness on one side (Harbison et al., 2003; Pickham et al., 2019). Abnormalities in any of these assessments can be classified a positive FAST. Subsequently, the patient should be transferred to SMCH for further investigation and treatment if required. While the FAST is proven to be effective, quick and simple to use, it may give the public the wrong impression that other neurological symptoms and leg weakness are not as important as other stroke symptoms (Kleindorfer et al., 2007; Robinson, Reid, Haunton, Wilson, & Naylor, 2012).

2.7 Cincinnati Prehospital Stroke Screening Tool History and Assessment Technique

The Cincinnati Prehospital Stroke Scale is a shorter version of the National Institutes of Health Stroke Scales (NIHSS). The former scale consists of three items, whereas the latter scale has 15 items to assess (Kothari, Hall, Brott, & Broderick, 1997; Malekzadeh, Shafaee, Behnam, & Mirhaghi, 2015). It was designed to recognise stroke in the prehospital environment (Rudd et al., 2016). A prospective, observational and cohort study was conducted in Cincinnati, US to examine the accuracy of the modified NIHSS, now known as the CPSS, for prehospital stroke recognition (Kothari et al., 1997).

The majority of stroke patients displayed facial palsy, motor arm and speech disturbance when assessed with NIHSS (Kothari et al., 1997). The CPSS relies on physical findings to recognise stroke, which is same as the FAST screening tool (Maddali, Razack, Cattamanchi, & Ramakrishnan, 2018). Therefore, the CPSS encompasses upper limb drift, facial droop and speech changes (Oostema et al., 2016). The assessment technique is similar to the FAST. The assessor should observe a patient's ability to smile or show their teeth, ability to raise both upper limbs above their head while their eyes are closed, and ability to repeat 'The sky is blue in Cincinnati' articulately (Govindarajan et al., 2011; Kothari, Pancioli, Liu, Brott, & Broderick, 1999). Even though dysarthria and aphasia are separate symptoms, they are often difficult to distinguish by the in-field clinicians, so both symptoms are combined as speech abnormality (Kothari et al., 1997). Furthermore, those three items (facial palsy, abnormal speech and arm drift) showed 100% sensitivity with 88% specificity in stroke detection (Kothari et al., 1997).

The high sensitivity and reproducibility of the CPSS, particularly between prehospital clinicians and hospital physicians, has been demonstrated when it is applied in various settings (Kothari et al., 1999). The CPSS tool has been used by developed countries' EMD but there had been limited documentation from developing countries (Malekzadeh et al., 2015). A quasi-empirical study carried out in Iran found out that the CPSS tool assisted Iranian nurses in reducing phone triage errors, and potentially, it could reduce healthcare expenditure by decreasing over-triage errors (Malekzadeh et al., 2015).

2.8 Melbourne Ambulance Stroke Screening Tool History and Assessment Technique

The MASS has been utilised continuously by the Melbourne EMS since 2005 (Bray et al., 2010). The MASS is a combination of the CPSS tool's sensitivity and the LAPSS tool's specificity, which aims for better accuracy than using either tool alone (Bray et al., 2005). It has the components from the CPSS, which are facial droop, upper limb drift, grip strength and speech changes, to maintain accuracy aspects of the stroke recognition tool (Bray et al., 2010; Bray et al., 2005). The MASS also contains "nonmotor" components, such as considering the patient's age (over 45 years), history of previous or acute seizure or epileptic activities, baseline mobility (wheelchair bound or bedridden), and blood glucose level between 2.8 to 22.2 mmol/l. These patient history components were included in the LAPSS and MASS to rule out stroke mimics (Bray et al., 2010). The patient history items are the same as the LAPSS, and the physical assessment items are a combination of the LAPSS and CPSS.

A study was conducted to analyse and compare the sensitivity and specificity of the LAPSS, MASS and CPSS (Bray et al., 2005). In their findings, the MASS and CPSS had the same sensitivity, and the MASS and LAPSS had identical specificity; the MASS had the highest overall accuracy of 86% whereas the CPSS had 84% and the LAPSS had 80% (Bray et al., 2005).

The FAST, MASS and CPSS are not identical but all of them contain similar key features and the main three testing items. The key commonality of all of the selected studies for this integrative review is that the FAST, MASS and CPSS were designed by and for prehospital clinicians. The FAST has been classified as the favoured prehospital stroke recognition tool in NZ (Rudd et al., 2016; Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010). However, the key problem with this explanation is that both literature overlooked whether the FAST is appropriate enough for the urgent care physicians to adapt, given that the urgent care is critical in modern NZ health care system. Bray et al. (2010) does not take account of other prehospital clinicians besides EMS and EMD using the MASS nor does they examine whether the MASS is appropriate for other prehospital clinicians such as urgent care physicians. These kinds of interpretations underpin the rationale of this integrative review. Table 1 compares each tool.

Table 1 Comparison of the FAST, CPSS and MASS

Components	Face	Upper limb	Speech	History items
FAST	Either smiles or shows teeth. **Normal**: symmetrical movement of the face. **Abnormal**: asymmetrical movement of the face.	Lift both arms together to 90° if sitting upright or 45° if lying down flat. Hold for five seconds. **Normal**: able to hold arms equally for five seconds. **Abnormal**: one arm drifts down.	Have a conversation and ask the patient to label everyday objects that are nearby. **Normal**: coherent and articulate speech. Ask companions to compare how she/he usually speaks, if he/she is speaking the same as usual. **Abnormal**: New disturbance of speech, slurred speech, difficulties finding words.	
CPSS	Either smiles or shows teeth. **Normal**: symmetrical movement of the face. **Abnormal**: asymmetrical movement of the face.	Extend both arms for ten seconds with eyes closed. **Normal**: both arms either can or cannot move. **Abnormal**: only one arm moves or one arm drifts down.	Repeat "The sky is blue in Cincinnati". **Normal**: able to repeat with correct words; no slurred speech. **Abnormal**: Slurred speech, incorrect words, or unable to speak.	
MASS	Either smiles or show teeth. **Normal:** symmetrical movement of the face.	Extend both arms for ten seconds with eyes closed. **Normal:** both arms either can or cannot move.	Repeat a sentence. **Normal:** able to repeat with correct words. **Abnormal**:	• **Age >45 years old** • **No history of seizure or epilepsy.**

	Abnormal: asymmetrical movement of the face.	**Abnormal**: only one arm moves or one arm drifts down. Ask patient to squeeze assessor's hand with both hands. **Normal:** equal grip strength or both have no grip strength. **Abnormal:** unequal grip strength.	Slurred speech, incorrect words, or unable to speak.	• **Baseline mobility - either wheelchair bound or bed bound.** • **Blood sugar level between 2.2-22.2 mmol/l.**

(Bray et al., 2005; Harbison et al., 2003; Kothari et al., 1999; Purrucker et al., 2015; Rudd et al., 2016)

2.9 Summary

This background chapter was comprised of pathophysiology, acute stroke treatment, prehospital management, and early stroke recognition tools, specifically the FAST, CPSS and MASS tools. Stroke is a fatal and costly illness. Mortality and stroke-related disability can be either reduced or avoided if a stroke is diagnosed promptly and the acute ischaemic stroke patients receive thrombolytic therapies within the first few hours of developing symptoms. This suggests that early recognition is the key to stroke prehospital management. It has been proven that early stroke recognition tools are effective in prehospital management. This dissertation intends to discover how the FAST, CPSS and MASS tools are used in the prehospital environments, which includes urgent care physicians, in Australia, USA, UK and New Zealand in an attempt to draw out recommendations for clinicians practicing in the prehospital setting. The next chapter will introduce methodology and methods for this dissertation.

Chapter 3 Methodology

3.1 Introduction

The practice of conducting a literature review in healthcare started in the 1970s as a way to synthesise evidence and to expand knowledge of a phenomenon (Whittemore & Knafl, 2005). Subsequently, there have been significant increases in the quantity and complexity of information in the modern health science research field (de Souza et al., 2010). Hence, an integrative review was formulated to improve applicability of primary research findings and assist healthcare professionals to perform EBP (de Souza et al., 2010; Torraco, 2016). EBP is extracted from scientific research and rigorous appraisal (Curtis, Fry, Shaban, & Considine, 2016). Research method, applicability, strength and weakness should evaluated constantly with the object of disseminating research findings, interpreting results and maintaining high quality EBP in modern nursing, (Braun & Clarke, 2006; Curtis et al., 2016; Whittemore & Knafl, 2005).

This chapter provides an overview of this research methodology and methods, and the rationale for selecting integrative review for this dissertation. The term methodology refers to philosophy of research, whereas the term method in research refers to how data are collected and how the research is carried out to answer the research question (McGregor & Murnane, 2010). Cautiously, methodology and methods are different but are often used interchangeably. Although their meanings are not the same, the methodology should be reflected in the methods (Hyett, Kenny, & Dickson-Swift, 2014). Understanding the definition of methodology and method enables the author to establish a firm base for this research and maximise transparency and credibility of the research.

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3.2 Methodology

This dissertation's primary aim is to review, update, and reconceptualise the published literature findings of the prehospital stroke screening tools, FAST, MASS and CPSS. An integrative review was chosen as it allows the researcher to use both qualitative and quantitative studies in an effort to synthesise all the relevant data to review and draw up recommendations on a specified topic (Whittemore & Knafl, 2005). Also, there are no previous integrative reviews specifically comparing prehospital stroke recognition tools, and the impact of their use in prehopspital recognition and management of stroke.

This integrative review applies the philosophical perspectives of constructionism and interpretivism in its research design to combine quantitative and qualitative data collection and analysis. Constructionism treats knowledge as a resource that is deliberately created, becomes institutionalised, and adopted as customary practice (Thomas, Menon, Boruff, Rodriguez, &

Ahmed, 2014). The principles of constructionism were used to generate the thematic analysis map which will be explained further in Chapter 4. In contrast, constructivism is a mixture of hermeneutics and phenomenology that aims to describe how we view the world and social interactions (Houghton, Hunter, & Meskell, 2012; Mackenzie & Knipe, 2006) and is applied here to build knowledge from the practice use of prehospital stroke screening tools. Although an interpretivist approach is usually used for qualitative data, quantitative data can also be used to expand and support qualitative data (Mackenzie & Knipe, 2006). In epistemology, interpretivism complements constructionism because interpretivism declares that objective data and subjective experience are different (Gray, 2014), yet both approaches to data collection and analysis will help assess the role of prehospital stroke assessment tools. Further, Welford, Murphy, and Casey (2011) state that the combination of theory and knowledge creates meaning of social interaction, so interpretivism endorses nursing researchers to look at how to create objective knowledge from subjective matters.

This integrative review includes a mixture of quantitative and qualitative articles as it aims to update subjective and objective knowledge of the stroke screening tools used in the prehospital setting. Quantitative measures are used for evaluating the efficacy and accuracy of prehospital stroke screening tools, however qualitative approaches may be advantageous when seeking to understand how the prehospital stroke screening tools were used, and the perceived benefits and drawbacks of using the tools from frontline workers. This dissertation interprets subjective data in how FAST, CPSS and MASS are utilised in detecting hyperacute stroke in the prehospital environments in UK, USA, NZ and Australia. Simultaneously, quantitative data are used to assess the accuracy of the FAST, CPSS and MAS tools to detect hyperacute stroke and stroke-mimics.

Various methodologies could be used to fully review the prehospital stroke recognition tools. During the preliminary research stage, the author noted that various studies have been undertaken on similar topics using different methodologies (Rudd et al., 2016). However, the author felt the integrative review fits well to meet this research aim and to increase applicability of empirical and theoretical knowledge to everyday practice. Integrative review methodology has benefits of allowing scholars to reconceptualise the reviewed topic, revise and update knowledge, critique the literature, and find solutions for specific questions pertaining to the topic within the reviewed literature (Torraco, 2016). Sometimes, ‘research’ disconnects theoretical and practical aspects in clinical practice. Therefore, applicability of the findings from research should not be neglected (Dean, 2009). Even if the majority of data support one particular stroke screening tool, the author should consider its applicability when it comes to making recommendations.

Some researchers tend to label an integrative review as a synonym to meta-analysis, literature review, and systematic review. Integrative review is distinctive because it requires deep, detailed and comprehensive knowledge from exhaustive research to produce a critical summary

of the research topic (Crossetti, 2012). Moreover, the integrative review is different from other methodologies because the data evaluation and analysis stages enable researchers to organise diverse data to produce new recommendations prior to applying them in practice and policy making (Whittemore & Knafl, 2005). This can result in a collection of extensive and diverse data to find the root of the phenomenon that is chosen to be examined (Crossetti, 2012; Whittemore & Knafl, 2005).

While having diverse data is appreciated, it can also create a challenge when it comes to sorting the data into well-organised categories. After discussing this potential obstacle with the supervisors, the author was recommended to adopt the thematic analysis method for this integrative review data analysis stage. Thematic analysis involves categorising, scrutinising, and describing themes within a topic (Braun & Clarke, 2006).

During the data analysis stage in the integrative review, it is recommended to compare the data repeatedly to find data patterns and concepts (Glaser, 1978; Miles, Huberman, & Saldana, 2014; Patton, 2002). Thus, thematic analysis enables the author to yield common themes across the entire sample, in this case reflecting on the seven articles (Braun & Clarke, 2006).

In this dissertation, the research was prepared according to the integrative review methodology framework (Whittemore & Knafl, 2005). The type of research method is an important factor to consider because the research method can affect the outcome and adherence to the true aims of the study. The framework encourages the researcher or the author to use five steps for a successful integrative review, which are problem identification, literature search, data evaluation, data analysis and presentation (Braun & Clarke, 2006; Whittemore & Knafl, 2005). The details of these steps are explained below

3.3 Problem Identification

The first step, problem identification, required the author to plan this dissertation. This includes, for instance, planning the aim, purpose and method of this review as well as selecting a research question. This step is beneficial for setting up the review purpose and scope (Whittemore & Knafl, 2005).

An integrative review offers extensive knowledge of a phenomenon or healthcare issue by summarising practical or theoretical documents (Whittemore & Knafl, 2005). The focus of this integrative review is to review the data concentrated on the FAST, MASS and CPSS tools to discover how these tools were used and which health professional used them prior to transporting the suspected stroke patients to tertiary care. There are systematic reviews that review early stroke recognition tools but there are no integrative reviews that focus on prehospital stroke screening tools, including urgent care clinics (Brandler et al., 2014; Rudd et al., 2016; Walker et al., 2014;

Zhelev et al., 2019). This integrative review will be useful to identify and collect relevant data to resolve the research question through a nonexperimental design yet a systematic approach (Noble & Smith, 2018). Although stroke is a well-researched topic, this integrative review has summarised the latest literature about prehospital stroke screening tools.

The author works in an urgent care clinic in an urban area in New Zealand. Patients present at an urgent care clinic with various complaints from simple viral colds to major life threatening illness such as stroke and trauma. Urgent care clinics are equipped to provide simple episodic care and have an x-ray facility on site, but they are not resourced to intervene for major emergencies; for instance, CT scanning to diagnose stroke and provide thrombolytic treatments (Medical Council of New Zealand, n.d.; Royal New Zealand College of Urgent Care, 2019). In stroke, CT scan is used to diagnose the disease and determine brain-blood barrier permeability, stroke severity and length of ischaemia (Horsch et al., 2016). CT scanners are easily accessible in secondary hospitals in New Zealand, particularly in metropolitan areas (Nixon et al., 2014). Thrombolytic treatment, particularly thrombectomy, is an advanced treatment and is available only at certain hospitals in New Zealand due to its risks of bleeding (Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010). Hence, a suspected stroke has to be referred to SMCH urgently as per NZ stroke guidelines.

In doing an initial review of the literature, the author noticed a gap in the current stroke prehospital management guidelines. Despite many stroke awareness campaigns encouraging people to ring for an ambulance if they develop slurred speech, facial and arm weakness, there are people who still choose to go to urgent care clinics for diagnosis of stroke because of the ease of accessibility to a doctor (Robinson et al., 2012; Swartz et al., 2017). It is impossible to diagnose stroke and distinguish different types of stroke by using the stroke early recognition tools only. However, the screening tool can assist practitioners to decide quickly following the local stroke pathway and management plan. For instance, if the screening result is positive, then the patient can be transferred to the nearest stroke management capable hospital for diagnostic tests and life-saving thrombolytic treatment (Figueroa, Zhao, & Aiyagari, 2015).

Urgent care specialists provide care to enhance one's health outcomes, but their scope of care is narrow due to limited resources available in urgent care clinics (Royal New Zealand College of Urgent Care, 2019). Thus, having a management plan derived from a rigorous literature review will provide guidelines that may assist patients and urgent care practitioners in reducing unnecessary delays. It has been proven that the screening tools are beneficial to use prior to referring patients to the stroke specialist team (Oostema et al., 2016). This adds further to the importance of this dissertation, to review the use of FAST, MASS and CPSS tools in the prehospital setting.

There are ambiguous opinions on comparing and selecting prehospital stroke screening tools. As individual clinicians are supposed to follow the local guidelines, it is important to provide clear and up to date information on the evidence regarding the prehospital stroke screening tools. Furthermore, the top available evidence is more important than professional viewpoints alone for clinicians to provide high quality and safe care (Bourgault, 2018). and Purrucker et al. (2015) recommend using the prehospital stroke screening tools, whereas Rudd et al. (2016) disagree on selecting one superior tool in their systematic review because 'who' uses the tool, 'why' they use it and 'how' they use it would vary the screening test outcome. It is evident that using the stroke screening tools is effective in recognising the stroke as early as possible because clinicians working in prehospital settings usually make the call whether or not a patient should be transferred to SMCH with acute stroke (Oostema et al., 2016; Rudd et al., 2016). As stated in the previous chapter, the precise accuracy and applicability of the prehospital stroke screening tools in the real world are still not clearly identified (Zhelev et al., 2019). This suggests that the priority is not identifying the superior stroke screening tool but rather to educate clinicians involved in prehospital and in-hospital stroke care to use the recommended tool when making clinical decisions.

3.4 Literature Search

The goal of this step was to collect data that met the inclusion criteria for this integrative review. Extensive literature search process drives the integrative review that includes what data are found on databases and then shape the body of literature (Torraco, 2016). Nowadays, anyone can publish or upload online articles that are not always reliable or factual (Hart, 2001). Hence, developing clear inclusion and exclusion criteria is essential (de Souza et al., 2010).

3.4.1 Inclusion/exclusion criteria

In the literature search stage, this integrative review focused on studies regardless of their research design, such as cross sectional or cohort, which evaluated the use of prehospital stroke screening tools even at urgent care clinics. Medline, Scopus and CINAHL databases were used to search for relevant articles. After a discussion with a specialised librarian, these specific databases were chosen due to their reputation in academic research and ease of accessibility via the AUT library. As mentioned, clearly defined inclusion and exclusion criteria are key to a successful integrative review and it makes the data analysis and extraction stage easier (de Souza et al., 2010; Whittemore & Knafl, 2005). The author looked at the selected articles' reference lists to check for additional useful studies.

The author searched and collected literature using the Medline, Scopus and CINAHL databases. The literature was collected and duplicates were removed using Endnote. In total, 208 articles were removed after reading 317 articles' titles and/or abstracts. The author consulted with the supervisors throughout research process to maintain research rigor and validity. The PRISMA flowchart (see Appendix A) explains the process of elimination quantitatively.

The summary of inclusion and exclusion criteria are shown in Table 2. The included articles evaluated the FAST, MASS or CPSS tools used in the adult population in prehospital settings to recognise stroke, rather than measuring the severity of stroke or categorising different types of stroke. Prehospital setting includes ambulance dispatch, EMS assessment at the scene, and walk-in urgent care clinics. The articles included hospital transfer via ambulance as this dissertation aimed to review the FAST, MASS and CPSS when these were used in a prehospital environment. Therefore, transferring patients to SMCH and confirming diagnosis must be documented in the study as a reference standard.

Primary assessors of the screening tool are doctors, nurses, paramedics and any other allied healthcare professionals who are trained and experienced in using any stroke screening tools. The author is well aware that there are more than three stroke screening tools available, so articles examining or comparing the chosen screening tools versus other screening tools are also included. However, findings from the analysis of other screening tools are excluded from this research and only the parts directly related to the FAST, MASS and CPSS are included in this research.

To justify the findings with the current and future prehospital management, articles dated from 2009 to 2019 are included. Articles that have full text access in the selected database are included so that the author can capture the complete view of study. Search terms are stroke, cerebrovascular accident (CVA), cerebrovascular disease, prehospital, emergency medical, urgent care, walk-in clinic, afterhours clinic, screen, FAST, MASS, CPSS, accuracy, early recognition, early detection and early diagnosis. Data collection was tracked using a PRISMA flow chart (see Appendix A).

The purpose of Table 2 is to summarise inclusion and exclusion criteria for this research.

Table 2. Inclusion and exclusion criteria

Inclusion criteria	**Exclusion criteria**
Published between 2009 to 2019.	Research not published in English.
Peer reviewed and published on Medline, Scopus and CINAHL databases.	Public awareness of the FAST, MASS or CPSS.
Confirmed diagnosis should be documented in the article	Studies undertaken outside of USA, UK, Australia or New Zealand.
Evaluating the FAST, MASS or CPSS tools using adult population in prehospital settings.	Not considering the confirmed diagnosis when evaluating the FAST, MASS or CPSS.
The screening tools must be used by healthcare professionals including allied healthcare professionals who are experienced or have received training for using the tool.	Attempting to distinguish different types of stroke or measure the severity of the stroke.
Transfer to the hospital via ambulance after assessing patients using the FAST, MASS, or CPSS	No documentation of transferring to hospital after assessing patient using the FAST, MASS or CPSS.

3.5 Data Evaluation

A successful integrative review needs high quality literature (Russell, 2005; Whittemore & Knafl, 2005). The quality of literature is essential as it determines relevance of empirical and theoretical knowledge to practice and future direction for stroke prehospital management (Whittemore & Knafl, 2005). Therefore, the focus of data evaluation is to collect high quality literature that meets the inclusion criteria, rather than finding a lot of articles that meet the inclusion criteria.

Data evaluation and analysis processes are compulsory to ensure precise data collection with minimal errors; these processes require the reviewer to be organised (de Souza et al., 2010). Quality appraisal is needed to ensure a thorough, systematic and well-prepared review. Although quality appraisal is requisite, there is no gold standard for assessing methodological quality (Whittemore & Knafl, 2005).

After full-text assessment, the author, in consultation with supervisors, adapted the JBI appraisal tool to assess methodological quality of research and identify potential bias in the research method and analysis (see Appendix B) (Joanna Briggs Institute, 2019). The author used this tool to evaluate the quality of seven included articles, rather than a tool to eliminate more articles. The JBI is an evidence-based resource centre for nursing research in Australia and it has developed multiple appraisal tools for researchers to choose depending on the study design (Joanna Briggs Institute, 2019). There are many appraisal tools to select depending on the study design. Reading through JBI Reviewer's Manual (Joanna Briggs Institute, 2019), the JBI critical appraisal checklist for quasi-experimental studies (non-randomised experimental studies) was chosen for measuring the effectiveness of the stroke screening tools. Under the effectiveness subcategory, there were only two appraisal tools available, which were randomised and non-randomised studies (Joanna Briggs Institute, 2019). None of the included studies were non-randomised studies; hence, the quasi-experimental studies' critical appraisal tool was selected for systematic appraisal. The JBI tool was preferred as it allowed the user to classify the study quality based on the total appraisal score. The score from the appraisal tool was not taken into a consideration because the author was more interested in grasping the seven studies' potential bias in study method and conduct, and raw data analysis.

3.6 Data Analysis

Well-conducted and organised reviews are crucial tools for the research field and clinicians because they scrutinise and integrate available evidences within one full body (Cook, Mulrow, & Haynes, 1997). The data analysis stage involved interpreting the data objectively and rigorously after organising the data into common themes and summarising the findings (Whittemore & Knafl, 2005). Without critical data analysis, collecting available literature on the stroke screening

tool does not minimise the theory-practice gap, nor does it provide integrative review benefits (Crossetti, 2012; Nowell, Norris, White, & Moules, 2017; Whittemore & Knafl, 2005).

The author sought a way to sort and examine all of the collected raw samples without creating bias of information. Minimising bias of the information was challenging as this integrative review was conducted by a single author. Given that broad and deep understanding of the sample are the centre of this integrative review, it is important to organise the findings into overarching themes, through thematic analysis (Braun & Clarke, 2006). The thematic analysis strategy offers a robust and sophisticated approach for analysing qualitative data, making it easier for audiences with non-academic backgrounds to understand the findings (Braun & Clarke, 2014). The thematic analysis strategy enables this research to be influential in the stroke research field and contribute to EBP by reviewing the best available evidence (Bourgault, 2018). This is a widely used analytic strategy to comprehend and categorise the definitional information, yet it has limited guidelines (Antaki, Billig, Edwards, & Potter, 2003; Braun & Clarke, 2006; Jones, MacGillivray, Kroll, Zohoor, & Connaghan, 2011). The author chose the thematic analysis because it did not require in-depth and technological knowledge in qualitative approaches, yet able to detect common themes and differences in the broad dataset and summarise main key points constructively through following the guidelines correctly (Braun & Clarke, 2006; Nowell et al., 2017). The design of this dissertation thematic analysis is outlined in the below paragraph.

Effective continual comparison should be made up of data extraction, conversion of extracted data, data comparison to identify patterns within collected data, conclusion drawing and verification through interpreting findings and patterns (Miles et al., 2014; Whittemore & Knafl, 2005). A spreadsheet was used throughout the thematic analysis to aid the author to analyse the literature systematically and for constant comparison of findings.

There are six steps for an efficient thematic analysis: 1) familiarisation with data, 2) generating initial codes, 3) searching for themes, 4) reviewing themes, 5) defining and naming themes and 6) producing the report (Braun & Clarke, 2006). The first four steps were completed by reading the full texts of the seven articles repeatedly. After understanding each article, the author started to highlight the initial codes with different colours in each article print-out in an attempt to detect common themes. The third and fourth steps were done through brainstorming on the side of each article print-out and placing sticky notes on a board to ensure these themes reflected on extracted data (Braun & Clarke, 2006). Each article was reviewed according to 1) who used the screening tools, 2) confirmed diagnosis, 3) the frequency of employing the screening tools and 4) what initial symptoms the patient had or displayed to trigger the assessors to use the screening tools. The latter two steps aided the author to understand the essence of the entire data set and develop a clear argument in regard to the research question (Braun & Clarke, 2006).

3.7 Presentation

Efficient presentation strengthens and assists the review to meet the outcomes (Whittemore & Knafl, 2005) and enables readers to assess the outcomes critically (de Souza et al., 2010). The purpose of presentation is to analyse and critique the findings to provide an overview and descriptive facts of the findings before applying the final outcome into practice (Whittemore, 2005). In this integrative review, chapter four consists of a summary of the reviewed literature. Critical analysis of findings and recommendations that are applicable to present and future practice are included in chapter five.

3.8 Summary

The author strongly believed that an integrative review is an appropriate methodology for this research question and has a potential to provide unique perspectives in prehospital stroke management. The gap in current stroke prehospital management has less focus on urgent care clinics even though they play an important role in this country's healthcare system. This integrative review has been prepared using the five steps of integrative review methodology framework to increase the applicability of findings in practice.

This chapter has provided the rationale for and defined the chosen methodology and detailed description of how this integrative review was conducted. This integrative review applied constructionism and interpretivism in its research methodology to combine quantitative and qualitative data collection and analysis. A description of the author's current clinical position led to problem identification in this research. The author used the Medline, Scopus and CINAHL databases to collect literature then endnote to manage references and citations, and to eliminate duplicates. In the data evaluation stage, the author adopted the JBI non-randomised appraisal tool and none of the studies were rejected after using the appraisal tool. Thematic analysis was used for analysing the findings. These methods were laid out based on the integrative review framework prescription. The summary and descriptive information of the findings in are presented in chapter four and chapter five presents critical analyses of the findings and recommendations for future research and practice.

Chapter 4 Results

4.1 Introduction

This chapter reveals the findings of data evaluation and thematic analysis. Both processes were described in Chapter three. Careful review of the collected literature provides an exhaustive understanding of the sample, which eventually becomes the body of this integrative review (Torraco, 2016). Seven articles were selected for analysis for the purpose of addressing the aim of this integrative review.

Following presentation of the findings and themes in this chapter, a thematic analysis map is presented to aid understanding of the collected data into overarching themes. In the next chapter, critical analysis of the findings will be explained.

4.2 The Data Evaluation Results

The data evaluation process was followed by completing the initial three steps in the integrative review process. This integrative review appraised the seven literature articles by adapting the JBI critical appraisal checklist for quasi-experimental studies (non-randomised experimental studies) and then synthesising into themes (Joanna Briggs Institute, 2019). The author believed the quasi-experimental studies checklist was the most suitable to review all seven literature articles consistently (see Appendix B). This process was for the author to recheck the quality of literature through a rigorous, systematic and well-prepared critical appraisal tool. Thus, there was no further elimination of the literature.

Overall, all of the seven articles described the study population, how they collected data, how data was validated and analysed, and study findings. Five out of seven articles had a clear illustration of ‘cause’ and ‘effect’ group (Asimos et al., 2014; Bray et al., 2010; Fothergill, Williams, Edwards, Russell, & Gompertz, 2013; Pickham et al., 2019; Studnek et al., 2013). These studies used at least two different stroke screening tools when grouping study participants. Mould-Millman et al. (2018) and Oostema, Konen, Chassee, Nasiri, and Reeves (2015) evaluated the accuracy of the CPSS by classifying study participants as EMS-suspected or missed, and confirmed stroke. Hence, there was no cause and effect groups. None of the studies included a follow up as all of them measured the prehospital stroke screening tool accuracy.

Multiple variable analyses were performed using statistical software (Asimos et al., 2014; Bray et al., 2010; Fothergill et al., 2013; Mould-Millman et al., 2018; Pickham et al., 2019; Studnek et al., 2013). One study used different tests for different types of variables; for instance, ordinal versus continuous variables. There was limited information on the tests the researchers used, so it was difficult to determine the reliability and robustness of their statistical analysis (Oostema et al., 2015).

Fothergill et al. (2013), Pickham et al. (2019) and Bray et al. (2010) asserted that documenting transparent and precise documentation such as staff training in their data collection process demonstrated that there was minimal bias in study conduct and compliance. As an integrative review author, this helped to understand how the results and recommendations took place, and to screen for presence of reporting bias (Joanna Briggs Institute, 2019). The JBI critical appraisal checklist for quasi-experimental studies (non-randomised experimental studies) is used not only for assessing the methodological quality, it also informs the author that the research findings are reliable for information synthesis (Joanna Briggs Institute, 2019).

In compliance with the scope of a 45-point dissertation, the author did not spend excessive amount of time on the appraisal. 'Peer-review' and being published on academic databases were inclusion criteria for this integrative review. Hence, if individual literature met both these two inclusion criteria, the author judged that it was safe to assume the seven literature articles had high methodological quality. This is another reason why no further literature was eliminated by the author after the data evaluation process.

4.3 Summary of Reviewed Literature

Seven studies were selected for analysis and the summary of the reviewed literature can be found in Appendix A. All seven studies used a quantitative approach but with different study methods (Asimos et al., 2014; Bray et al., 2010; Fothergill et al., 2013; Harbison et al., 2003; Mould-Millman et al., 2018; Oostema et al., 2015; Studnek et al., 2013). There was only one study that used a combined method - a retrospective, observational, and cohort-based study (Mould-Millman et al., 2018). The author retrieved the data from Atlanta's three local medical databases to assess accuracy of local EMS stroke recognition, focusing on the population who were transported to the local stroke management capable hospital by local EMS. There were two retrospective studies that collected data from EMS documentation, stroke registries and stroke specialist documentation (Asimos et al., 2014; Studnek et al., 2013). There was only one cross-sectional study evaluating how the MASS had been used in the field after its implementation by searching through a stroke or transient ischaemic attack confirmed discharge summary and cases where paramedics used the MASS (Bray et al., 2010). There were two prospective studies. These were conducted after training EMS on their specific stroke screening tool and compared the final diagnosis with hospital records (Fothergill et al., 2013; Pickham et al., 2019).

Five of the seven studies were conducted in United States (Asimos et al., 2014; Mould-Millman et al., 2018; Oostema et al., 2015; Pickham et al., 2019; Studnek et al., 2013), one was conducted in Australia (Bray et al., 2010) and one in the United Kingdom (Fothergill et al., 2013). No studies were conducted in New Zealand. The number of participants ranged from 295

(Fothergill et al., 2013) to 2,442 (Asimos et al., 2014). Four studies explored the CPSS using different methods (Asimos et al., 2014; Mould-Millman et al., 2018; Oostema et al., 2015; Studnek et al., 2013). Two studies examined the FAST using the prospective study method (Fothergill et al., 2013; Pickham et al., 2019). Only Bray et al. (2010) studied the MASS using the cross-sectional study method.

All of the reviewed studies mainly focused on EMS or paramedics, and EMD. Even though this integrative review has a broader scope of prehospital setting, none of the selected studies included urgent care clinicians and nurses. Thematic analysis revealed that stroke screening tools are mainly used by EMD and EMS or paramedics to identify stroke in the prehospital setting in effect of avoiding under and over-triage and to increase frequencies of thrombolytic treatment. This will be explained in detail in the following sections.

4.4 Thematic Analysis Results

During the initial review, it was apparent that EMD and EMS were the main users of the FAST, MASS and CPSS tools in prehospital settings. Subsequent readings with highlighting of themes and commonly used words in different colours highlighted when EMD and EMS used the prehospital stroke screening tools. The seven articles commonly stated that EMD and EMS were selective in initiating the prehospital stroke screening tools. Hence, 'using the FAST, MASS and CPSS in a prehospital setting' is placed on top of the thematic analysis map indicating the first phase in using the tool. The prehospital stroke screening tools were used for making clinical decisions prior to diverting patients to SMCH, also known as triage. The lower section of the thematic analysis map denotes the themes. During this stage the clinical decisions are made by EMD and EMS and as a result of using the tools, the cases were either over and under-triage. Figure 1 represents a thematic analysis map that summarises the final thematic analysis findings.

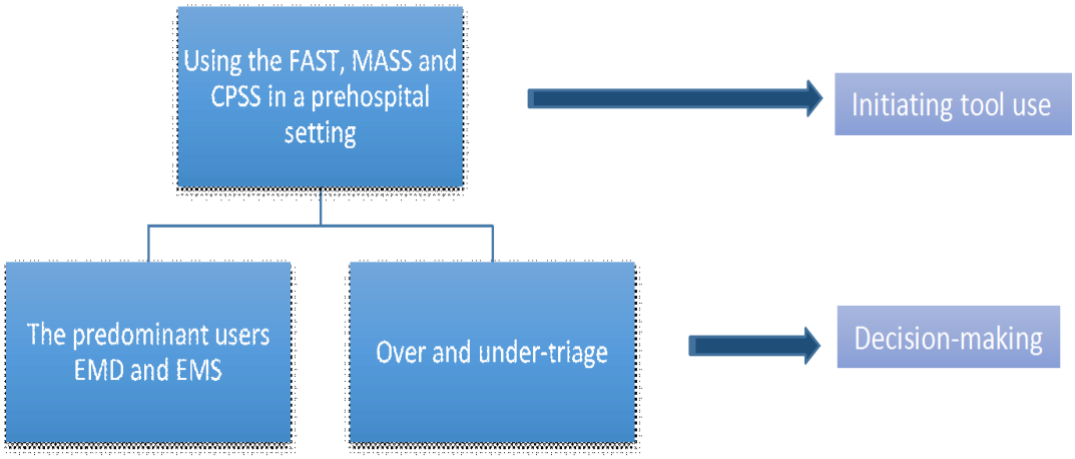

Figure 1 Thematic analysis map

4.4.1 The predominant users EMD and EMS

Within the seven reviewed articles, it was evident that EMD and EMS are the main users of the prehospital stroke screening tools. The reviewed seven studies discovered that both EMD and EMS detected stroke satisfactorily using the FAST, MASS and CPSS tools. No literature was located that included clinicians working at urgent care clinics using the prehospital stroke screening tools. Hence, this integrative review provides limited information for clinicians other than EMS and EMD working in the prehospital setting.

As the main users of the stroke screening tool, EMS and EMD clinicians play a critical role in identifying stroke in prehospital settings (Asimos et al., 2014; Bray et al., 2010; Fothergill et al., 2013; Mould-Millman et al., 2018; Oostema et al., 2015; Pickham et al., 2019; Studnek et al., 2013). The statistical findings demonstrated how accurately EMD and EMS detected stroke using the prehospital stroke screening tools. It was found that not all seven articles included both EMD and EMS; however, overall, all of them provided statistical figures indicating accuracy in detecting true stroke, or namely sensitivity. Both EMD and EMS attribute the successful collaboration of detecting stroke in a prehospital setting to using the prehospital stroke screening tools. For instance, the true stroke detection rate was augmented when EMD classified the call as a stroke for in-field EMS (Mould-Millman et al., 2018; Oostema et al., 2015).

Table 3 captures the overall view of the thematic analysis of the first theme

Table 3. Descriptive summary of the first theme

Theme	**Description**	**Quote**
The predominant user EMD and EMS	The main role of EMD is to receive and evaluate emergency calls while EMS assess patients in the field and divert them based on their assessment, local policies and pathways. Using the prehospital stroke screening regularly is recommended for assessing suspected stroke patients.	"Paramedic diagnostic accuracy appeared to be augmented by positive CPSS screening and by EMD recognition of stroke, utilising this same tool, telephonically" (Mould-Millman et al., 2018, p. 741)

Three of the retrospective studies examined EMS and EMD using the CPSS (Asimos et al., 2014; Mould-Millman et al., 2018; Studnek et al., 2013). The sensitivity of the CPSS was around 80% with a specificity of 48% when used by EMS (Asimos et al., 2014). The poor specificity was due to atypical or vague symptoms that patients presented with during EMS assessment in the field (Asimos et al., 2014). The sensitivity was as low as 48.9% when used by

EMD and considered all types of stroke, however the sensitivity was increased to 58.4% when the haemorrhagic stroke was excluded (Mould-Millman et al., 2018). Haemorrhagic stroke patients often presented with heterogeneously or severely altered mental status which could not be assessed by solely using the CPSS, thus it produced such a variation between sensitivity of the same tool (Mould-Millman et al., 2018). The cohort study for the CPSS tool yielded the EMS stroke recognition sensitivity of 73.5% and a positive predictive value (PPV) 52.3% when EMS documented the CPSS use (Oostema et al., 2015). Both Mould-Millman et al. (2018) and Oostema et al. (2015) decided that it was not feasible to set up a true negative group in order to calculate specificity, therefore both studies calculated PPV instead prior to determine the CPSS diagnostic accuracy. Although documenting all types of stroke and all stroke recognition were not possibly practical, documenting CPSS screening results and CPSS positive results from EMD were associated with accuracy of EMS prehospital stroke recognition (Mould-Millman et al., 2018; Oostema et al., 2015).

For the FAST tool, EMS adequately detected acute stroke in the prehospital setting with the maximum sensitivity of 97% (Fothergill et al., 2013; Pickham et al., 2019). Statistically, the sensitivity of the FAST tool was 97% but when it came to the specificity, the FAST was 13% and ROSIER was 18% (Fothergill et al., 2013). These finding suggested that EMS are good at detecting true stroke cases with the simple FAST screening tool but a different strategy is required to detect true negative stroke cases (Fothergill et al., 2013). Within the selected studies for the FAST, none of the studies evaluated EMD stroke identification using stroke screening tools. There was no explanation as to why the researchers did not include the evaluation focusing on EMD stroke identification with a prehospital stroke screening tool. There was no specific information on whether the countries where each study was located used EMD and EMS personnel. Nevertheless all of the identified studies use English as primary language.

The paramedic or EMS use of the MASS tool was demonstrated using a cross-sectional study in Melbourne, Australia (Bray et al., 2010). The authors found that after training and implementing the MASS, EMS diagnosis of stroke was improved although the sensitivity of MASS was the lowest when compared with paramedic diagnosis, and CPSS in the study (Bray et al., 2010). The authors did not include EMD in the study as it aimed to investigate how accurately EMS diagnosed acute stroke using the MASS (Bray et al., 2010). Utilisation of the MASS aided EMS to detect acute stroke as well as increased thrombolytic therapy usage from 5% to 11% (Bray et al., 2010).

This theme revealed that EMD and EMS were the main users investigated for the prehospital stroke screening tool, but given that each individual study had different study populations, aims and methods, there is no one particular prehospital stroke screening tool that is

suitable for every scenario. Moving forward, the next theme explores what happens when EMD and EMS use the prehospital stroke screening tools.

4.4.2 Over and under-triage

'Triage' was one of the commonly mentioned codes during the thematic analysis. It was absolutely clear that EMD and EMS used the prehospital stroke screening tools for assessing and diverting suspected stroke patients to the SMCH (Asimos et al., 2014; Bray et al., 2010; Fothergill et al., 2013; Mould-Millman et al., 2018; Oostema et al., 2015; Pickham et al., 2019; Studnek et al., 2013). While there was no stipulated definition of the term triage within the seven reviewed articles, the purpose of using prehospital stroke screening tools could be considered in relation to defining the term. The prehospital stroke screening tools guided EMS to identify stroke symptoms quickly and correctly (Studnek et al., 2013). EMS plays a crucial role in diverting and transporting patients to an appropriate hospital in a timely manner (Asimos et al., 2014; Pickham et al., 2019). There are protocols and pathways available for local EMS to divert patients to appropriate SMCH based on the prehospital stroke screen findings (Fothergill et al., 2013; Studnek et al., 2013).

The term 'triage' was used often,, first when EMD and EMS initiated and utilised the prehospital stroke screening tools. More EMS recognised stroke in a prehospital setting when EMD used the stroke screening tools (Mould-Millman et al., 2018; Oostema et al., 2015). Similarly, EMS initiated the prehospital stroke screening tools when the EMD had already classified the patient as having a stroke (Mould-Millman et al., 2018; Oostema et al., 2015). Both EMD and EMS initiated the prehospital stroke screening tools when a patient complained or displayed symptoms listed in the screening tools (Asimos et al., 2014; Fothergill et al., 2013; Mould-Millman et al., 2018; Oostema et al., 2015; Pickham et al., 2019). This made straightforward for EMS to pre-alert and transfer patients to SMCH.

Two different types of triage consequences were identified. The selected studies described the result of using the tools as 'over-triage' and 'under-triage'. When the researchers concluded that there were benefits and disadvantages from using the tools, and these had strong connections to each tool sensitivity and specificity (Asimos et al., 2014). 'Over-triage' is represented as transferring or diverting patients to stroke centres unnecessarily or when there is no suspicion of stroke (Asimos et al., 2014). A stroke screening tool with low specificity is more likely to cause over-triage because non-stroke patients would be transferred to SMCH (Asimos et al., 2014). Conversely, 'under-triage' is referred to as EMS misdiagnosing stroke in the field, resulting in a patient missing out on hospital transfer, specialist assessment and treatment (Mould-Millman et al., 2018).

In particular, over-triage was explored in relation to the rationale of developing an accurate prehospital screening tool and the purpose of using the tools (Bray et al., 2010; Oostema et al., 2015). The ability to detect a true negative stroke case is crucial because transferring negative stroke patients or over-triaging can increase the specialist workload and may cause eventual and correct treatment to be delayed for these patients (Fothergill et al., 2013). While over-triage enabled more patients to access thrombolytic therapy (Asimos et al., 2014), transferring incorrectly suspected stroke patients to stroke centres would be an unnecessary hospital transfer and a waste of health expenditure and resources (Studnek et al., 2013). Over-triage can cause unnecessary overcrowding in the receiving SMCHs (Asimos et al., 2014; Pickham et al., 2019). This is important when there is a bypass protocol in place taking patients with stroke screening positive results directly to hospitals capable of administering thrombolytic therapy (Asimos et al., 2014). For example, when EMS utilises the prehospital stroke screening tool in an area where there are limited ambulances available, incorrect diversion to SMCH would leave other trauma and emergencies under-treated (Asimos et al., 2014).

It is a fact that under-triage can cause costly sequelae, such as lengthy hospitalisation, long-term disabilities and increased mortality (Oostema et al., 2015; Pickham et al., 2019; Studnek et al., 2013). Also, using the tool assists EMS or paramedics to alert the SMCH so suspected stroke cases can be diverted to a hospital that is capable of providing thrombolytic therapy (Asimos et al., 2014).

Currently, there are no guidelines advising how much under and over-triage are acceptable. Over-triage is acceptable to some extent because it would increase the accessibility of thrombolytic therapy for stroke patients. Under-triage needs to be explored further as it can cause fatality in some patients and increased health expenditure. Mould-Millman et al. (2018) admitted that there is a limitation to measure under-triage or true negative cases because these cases were not taken further by EMS and did not transfer to hospital to confirm their diagnosis. Also, it is not ethically acceptable to use multiple stroke screening tools on patients who were displaying stroke-like symptoms to compare which tool cause either under or over-triage. Such tools sensitivity and specificity are valuable when determining the most practical tool to yield optimal health outcomes, particularly in a screening scenario. An extremely sensitive screening tool is less likely to have false negative result, which means under-triage. Whereas a greatly specific screening tool is less likely to result in false positive. Expressed differently, over-triage is unlikely to happen. Considering FAST, MASS and CPSS sensitivity and specificity figures from the seven selected studies, it means FAST is likely to affect over-triage due to high sensitivity and CPSS is likely to result in under-triage due to high specificity result. However, solely looking at each tool's specificity and sensitivity value is not a horizontal comparison because they may not have had robust explanation in selecting a superior tool.

Table 4 encapsulates the overall view of the thematic analysis for the second theme.

Table 4. Descriptive summary of the second theme

Theme	**Description**	**Quote**
Over and under-triage	EMD use a scripted questionnaire to classify stroke over the phone and dispatch an ambulance simultaneously. EMS/ paramedics tend to use a stroke screening tool if EMD has already classified stroke or if a patient displays symptoms that are already included in the screening tools.	"Accepting the precept that some level of over-triage is justified to improve overall access to thrombolytics and other acute stroke therapies, …" (Asimos et al., 2014, p. 514)

Studnek et al. (2013) and Bray et al. (2010) did not identify the common theme, over and under-triage, as seen in the other five studies. Studnek et al. (2013) were interested in examining the effectiveness of their two selected tools (Med PACS and CPSS) and compare them using sensitivity and specificity. This study only looked at the objective findings such as sensitivity and specificity of Med PACS and CPSS, and failed to fully acknowledge the tools how were utilised in the field, and by whom. Also, Studnek et al. (2013) explained over and under-triage or result of using the tools differently. For instance, there is minimal risk of administering thrombolytic treatment to stroke mimics in comparison with not administering the treatment to hyperacute ischemic stroke patients, thus sensitivity and specificity of the prehospital stroke recognition tools have emphasized. The second study appeared to be over ambitious in its claim, implementing MASS in assessing hyperacute stroke in the field enabled the patients to have more access to thrombolytic treatments instead of categorise the result of using the tool as over or under triage (Bray et al., 2010).

4.5 Summary

In light of this integrative review inclusion criteria, particularly being peer-reviewed and published on academic databases, as well as completion of the JBI appraisal checklist led the author determining that all of the seven literature articles have high methodological quality. Thematic analysis revealed that EMD and EMS are the main users investigated when using the prehospital stroke screening tools. Over and under-triage are strongly linked to using the prehospital stroke screening tools. Through rapid and accurate assessment as well as immediate transport to SMCH, more patients received thrombolytic treatment. The reviewed literature

highlighted that increased frequencies of thrombolytic treatment is also due to shortened door-to-needle time and EMS being able to alert the receiving SMCHs. The last chapter proceeds to the discussion, recommendations and limitations to finalise this integrative review.

Chapter 5 Discussion and Recommendations

5.1 Introduction

This chapter departs from data evaluation and thematic analysis. This integrative review has revealed that EMD and EMS play a bigger role in prehospital stroke identification and are the main users of the prehospital stroke screening tools. Thematic analysis verified that the effect of using the stroke screening tools was linked to over-triage, and increased frequency of thrombolytic therapy. The findings need to be laid out to exhibit a logical view of the acute stroke care chain for using the prehospital stroke screening tools.

Chapter 5 focuses on the two research questions to demonstrate depth and extensive understanding of the prehospital stroke screening tools (Whittemore & Knafl, 2005).

1. **How did the utilisation of FAST, MASS and CPSS by the assessor in a prehospital setting impact on hospital admissions?**
2. **What are the gaps when using the prehospital stroke screening tools?**

Within each research question subheading, practical implications and recommendations are highlighted. This is an opportunity to revisit and interpret all of the findings so the knowledge base in prehospital stroke screening tool and hyper-acute stroke care can be strengthened (Russell, 2005). Limitations of this integrative review and priorities for future research will also be outlined.

5.2 How did the utilisation of FAST, MASS and CPSS by the assessor in a prehospital setting impact on hospital admissions?

This first research question looks at the consequences of using prehospital stroke screening tools from the moment the EMD receives a call, to the transfer of a patient to SMCH by EMS. In Chapter 4, it was revealed that mainly EMS and EMD utilise prehospital stroke screening tools to assess patients accurately and rapidly, to exclude stroke mimics before transferring patients to an appropriate stroke management capable hospital. As a result, the use of a stroke screening tool enabled EMD and EMS to provide high-quality, quick assessments in a prehospital setting because the stroke screening tool functioned as a checklist (Intercollegiate Stroke Working Party, 2016). Rapid clinical decisions could be made by using the tool because the three incorporated items are classic symptoms of stroke (Sheppard et al., 2015). Sensitive prehospital stroke screening tools assist EMS and EMD to make appropriate clinical judgements in a timely manner. Assuming that EMS alert the receiving SMCHs as a result of a positive screen, the receiving SMCH has time to organise a CT scan and neurologist review prior to the patient's arrival at the

hospital (Stroke Foundation, 2017; Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010). This means door-to-needle time can be reduced.

Modern medicine and technology, and rising evidence indicating positive outcomes post-thrombolytic treatment has allowed stroke to become a treatable emergency like acute injury and myocardial infarction (Harrington, 2019; Ruland et al., 2002). This is why prehospital stroke care, EMD and EMS have been receiving attention recently. This is also why directing patients to the right facility for appropriate care in a timely manner is important in prehospital stroke management (Swartz et al., 2017; Wendt et al., 2015). Bray et al. (2010) demonstrated that long term use of the MASS increased thrombolytic therapy frequencies from 5% to 11%. This showed that prehospital stroke screening made an appropriate and timely start in the hyper-acute care cascade. This is an essential step in stroke guidelines and quality standards (Intercollegiate Stroke Working Party, 2016; Powers et al., 2018; Sheppard et al., 2015; Stroke Foundation, 2017; Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010).

While highlighting rapid assessment using the prehospital stroke screening tools, the author sought precise quantitative data referring to how quickly EMD and EMS could detect stroke in the field and how much additional time EMD and EMS took when they utilised the stroke screening tool in addition to their usual assessment. There was no data indicating the assessment time within the reviewed articles; hence, it was not possible to describe the relationship between the assessment time and effectiveness of the stroke screening tool quantitatively. However, the reviewed articles insisted that using a prehospital stroke screening tool does not lengthen the assessment time significantly, because the purpose of stroke screening tools is to make a quick decision based on the screening result.

Sensitive prehospital stroke screening tools helped EMD and EMS to avoid over-triage, which can cause overcrowding in the receiving SMCH and restrict the availability of human and material resources (Asimos et al., 2014; Pickham et al., 2019; Studnek et al., 2013). Over-triage is a significant risk for the receiving SMCH's emergency departments and their staff due to excessive workload (Fothergill et al., 2013). From the patient's perspective, there can be a delay in receiving essential care if their case is proven not to be stroke.

Over-triage in rural areas or where there is a bypass protocol that EMS should follow is another important perspective to consider. The bypass protocol directs EMS to transfer suspected stroke cases directly to SMCH to provide advanced stroke treatment and is proven to be an effective strategy to reduce door-to-needle time (Asimos et al., 2014; Hasegawa et al., 2013). The combination of using the prehospital stroke screening tool and bypass protocol mitigate geographical barriers for people who have difficulties accessing acute stroke care (Hansen, Balm, Schellenberg, Alcock, & Ghrooda, 2017). However, when these are over-used or if the low-

suspicion stroke is diverted to the nearest stroke management capable hospital, this leaves fewer EMS and ambulance staff to attend other life-threatening emergencies (Mathur et al., 2019). Transporting stroke-negative patients to hospital is costly to the public healthcare system and can overwhelm clinicians and patients with false-positive stroke (Asimos et al., 2014).

In terms of practice implications and recommendations, training EMD and EMS staff on stroke disease avoids negative effects from over and under-triage. Prehospital stroke screening tools should be used for all patients with neurological symptoms to avoid under-triage, particularly patients with atypical stroke symptoms. Continual training for prehospital clinicians is vital to avoid over and under-triage because not everybody has an identical stroke presentation (Sheppard et al., 2015; Swartz et al., 2017). This will also provide consistency in assessment of stroke patients. For a successful collaboration, prenotification to the receiving SMCH should also be implemented and reinforced consistently. It has been proven that pre-notifying the receiving SMCH can reduce further delay in administering treatment (Audebert et al., 2017; Wang et al., 2018). There is no point in diverting patients to SMCH if in-hospital specialists are unaware and unprepared for the patient's arrival as this would increase door-to-needle time.

5.3 What are the gaps when using stroke screening tools in the prehospital settings?

Prehospital stroke screening tools are designed to detect stroke by reviewing whether a patient presents with the most common symptoms of stroke (Studnek et al., 2013). It can be argued that awareness of stroke symptoms makes a difference to initiating hyper-acute stroke management and predicts how effectively the care is delivered, rather than seeking a sensitive prehospital stroke screening tool (Swartz et al., 2017). Everybody's stroke presentations are not identical, so it is possible for EMS and EMD to misdiagnose stroke, resulting in under-triage. While there is no data currently available for true-negative cases, this would be beneficial to consider (Mould-Millman et al., 2018). Alternatively, having a tool specifically designed for detecting stroke mimics would be useful to avoid overburdening the receiving SMCH as a result of over-triage (Doorenbos, 2014; McClelland, Flynn, Rodgers, & Price, 2017).

Two studies were designed to identify determinants of stroke for EMD and EMS to detect stroke in a prehospital setting (Mould-Millman et al., 2018; Oostema et al., 2015). Both studies found that EMD and EMS were selective in initiating the tools as seen in augmented EMS stroke detection rates if a patient displayed obvious stroke symptoms and EMD had already classified the case as stroke (Mould-Millman et al., 2018; Oostema et al., 2015). Being inconsistent in initiating the prehospital stroke screening tools can lead EMS and EMD to under-triage stroke cases (McClelland et al., 2017).

In terms of practice implications and recommendations, there should be increased awareness of stroke symptoms so that practitioners in prehospital settings feel confident in initiating the prehospital stroke screening tools without delay. This is supported by Studnek et al. (2013) recent data suggesting there is minimal risk of administering IV tPA to patients with stroke mimics, whereas not administering IV tPA to stroke patient can cause significant damage. Additionally, more robust data is needed to explain the prehospital stroke screening tools' sensitivity and specificity. This could then be used for evidence-based practice for prehospital clinicians.

5.4 Future research

New Zealand's current stroke guidelines (Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010) drives this country's prehospital stroke management. Local policies and protocols aid local stroke management capable hospitals to manage human and financial usage and allow all the suspected stroke patients to have equal and immediate access to stroke treatment. However, through this integrative review, it was revealed that there is limited published literature focusing on New Zealand (NZ) prehospital stroke management. Therefore, the foremost suggestion is to initiate research that focuses on NZ prehospital stroke management and identification. Quantitative data could be collected from urgent care clinics and St John, the main EMS provider in NZ, to assess accuracy of the FAST when used in New Zealand prehospital settings. How quickly a patient is seen in the stroke management capable hospital when they are transferred from an urgent care clinic could be measured. Additionally, collection of qualitative data could evaluate NZ prehospital clinicians' understanding of and compliance with prehospital stroke care guidelines.

A similar study was done in Toronto with a "quality-improvement initiative" (Swartz et al., 2017, p. 476). The study aimed to observe care quality and transferring time when routing patients from walk-in, non-stroke facilities to regional stroke centres for intervention when implementing a bypass protocol (Swartz et al., 2017). Although patients visited the walk-in clinic first, they still managed to arrive at the stroke management capable hospital within the ideal timeframe for thrombolytic therapy (Swartz et al., 2017). This study emphasises that additional studies in NZ are needed to show that these observations hold relevancy and are applicable in a NZ prehospital setting, and how effectively patients flow in the NZ healthcare system when St John and NZ urgent care clinicians collaborate (Swartz et al., 2017; Wendt et al., 2015).

There are abundant opportunities for further progress and research. Knowing that there are limited data available focused on urgent care practitioners and evaluating their performance, an integrative literature review or any mixed method research methodology would be ideal for future

research focusing on urgent care clinics and prehospital management in NZ. The mixed method research methodology is applicable in nursing research as it provides multifaceted perspectives of a phenomenon (Doorenbos, 2014; Foss & Ellefsen, 2002). In this context, urgent care clinics are a new and not well-understood setting, and little research has been undertaken. Research that includes quantitative and qualitative approaches is important and necessary to obtain an extensive view of urgent care. The quantitative approach would be helpful for collecting statistical data such as stroke screening tool sensitivity and specificity. If possible, it would be helpful to evaluate which stroke screening tool takes longer to use. It is not ethical to use different screening tools on the same patient during an emergency call or assessment; however, calculating the time could be achieved by looking at each component of the different tools because the three stroke screening tools have similar components. Gathering qualitative data would be useful to grasp the assessor's perception and understanding of using the stroke screening tool in a prehospital setting (Squires & Dorsen, 2018). Qualitative data provides data that cannot be seen in administrative or clinical documentation, which might be critical to overcoming barriers in providing care (Doorenbos, 2014).

5.5 Limitations

5.5.1 Data availability

This integrative review aimed to review the use of the FAST, MASS and CPSS in prehospital settings in USA, New Zealand, Australia and UK. However, there was limited literature from Australia and no literature from New Zealand. Therefore, it is difficult to draw out recommendations that can be feasible and applicable to both countries even though all of the above countries except the USA have similar healthcare systems. Local policies and protocols for how prehospital stroke is managed may differ even within the same country (Audebert et al., 2017).

All of the seven reviewed studies mainly illustrate EMD and EMS perspectives of using the prehospital stroke screening tools. This provides a limited view of prehospital stroke care. While current guidelines recommend that prehospital care should include using the prehospital stroke screening tools, there is no specific instruction about who should use the prehospital stroke screening tools (Intercollegiate Stroke Working Party, 2016; Powers et al., 2018; Stroke Foundation, 2017; Stroke Foundation of New Zealand and New Zealand Guideline Group, 2010). As described in Chapter 1 and 2, urgent care is one of the important specialities in healthcare, particularly in New Zealand, and urgent care physicians have a similar scope of practice as EMS when it comes to recognising stroke in prehospital settings and activating the hospital stroke team (McClelland et al., 2017). It is clear that EMD and EMS frequently use the prehospital stroke

screening tools in prehospital settings. However, there is no data indicating how other clinicians performed using the prehospital stroke screening tools. Even though this integrative review aimed to draw out conclusions and recommendations for the prehospital setting, the drawn recommendations and conclusions might only be suitable for EMS and EMD.

5.5.2 Potential bias in analysis

Most of the literature revealed the benefits of using screening tools in prehospital stage. From there, the scholars recommended the use of prehospital stroke screening tools for prehospital stroke identification. One disadvantage was listed briefly in the reviewed literature. For instance, when there is a bypass protocol or limited availability of EMS, CPSS and LPSS are not useful because of these tools' extremely low specificity (Asimos et al., 2014). The majority of the articles put more weight on describing the benefits. It is evident that using the prehospital stroke screenings tools is far more beneficial than not using the tools. To critically analyse the findings, equal weight should be put on both advantages and disadvantages of using the prehospital stroke screening tool. In conclusion, in this integrative review, it was easy to comprehend the benefits of using prehospital stroke screening tools but challenging to compare advantages and disadvantages.

5.6 Summary

This chapter has critically analysed the findings by answering two sub-questions. Using the prehospital stroke screening tool aided EMD and EMS in triaging, but over and under-triage are important matters to consider when making clinical decisions. Stroke screening tools were most widely used by EMD and EMS, facilitating improved recognition and timely management of stroke. In order to minimise gaps in over and under-triaging and being selective in initiating the prehospital stroke screening tools, continual training to prehospital clinicians is recommended as not all the stroke presentations are the same.

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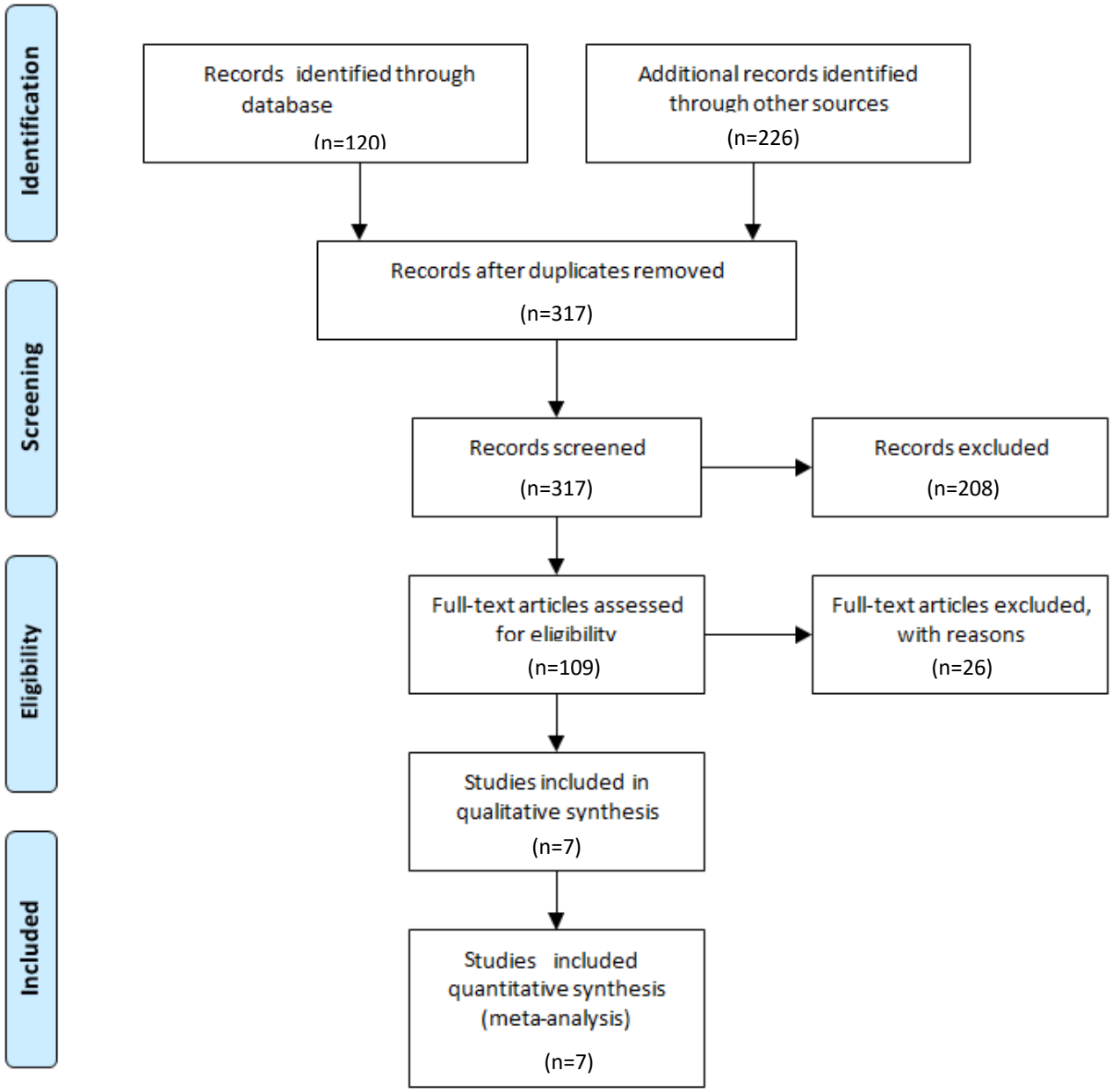
Glossary

CPSS	Cincinnati Prehospital Stroke Screening	
CT	Computed tomography	
EMD	Emergency medical dispatcher	
EMS	Emergency medical service	
FAST	Fast Arm Speech Test	
IV	Intravenous	
JBI	Joanna Briggs Institute	
LPSS	Los Angeles Prehospital Stroke Screen	
MASS	Melbourne Ambulance stroke Screening	
Prehospital	Any clinical environment that is outside of a secondary and tertiary hospital. For example, an accident scene or a walk-in clinic.	
ROSIER	Recognition of Stroke in the Emergency Room	
Thrombolysis	Intervention to dissolve or retrieve a clot.	
tPA	Tissue Plasminogen Activator	“Clot-busting” drug for CT-confirmed ischaemic stroke

Appendix A PRISMA Flow Diagram



Appendix B Summary of Critical Appraisal

Table structure transcribed from Joanna Briggs Institute (2019).

	Asimos et al. (2014)	Pickham et al. (2019)	Fothergill et al. (2013)	Bray et al. (2010)	Oostema et al. (2015)	Mould-Millman et al. (2018)	Studnek et al. (2013)
1. Is it clear in the study what is the "cause" and what is the "effect" (i.e. there is no confusion about which variable comes first)?	Y	Y	Y	Y	U/C	U/C	Y
2. Were the participants included in any comparisons similar?	Y	Y	Y	Y	U/C	U/C	Y
3. Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?	Y	Y	Y	Y	U/C	U/C	Y
4. Was there a control group?	Y	Y	Y	Y	U/C	U/C	Y
5. Were there multiple measurements of the outcome both pre and post the intervention/exposure	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analysed?	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7. Were the outcomes of participants included in any comparisons measured in the same way?	Y	Y	Y	Y	Y	Y	Y
8. Were outcomes measured in a reliable way?	Y	Y	Y	Y	Y	Y	Y

9. Was appropriate statistical analysis used?	Y	Y	Y	Y	U/C	Y	Y
10. Comment?	Clear description of the study population and cause and effect group. No need for follow up as it was to evaluate the diagnosing accuracy using two different screening tools.	Comparing modified FAST (BEFAST) vs FAST. Comparison done using nonstroke patients vs stroke patients, within the stroke patients. BEFAST and FAST were used for analysis.	Clear description of the study population and cause and effect group. Comparing ROSIER and FAST without actually applying the both tools twice (ethically not acceptable). No need for follow up as it was evaluating the screening tool accuracy.	Clear description of the study population and cause and effect group. There was an additional comparison between pre and post training for EMS.	Hospital records were used for ischaemic stroke or TIA cases (and patient was transported by EMS) and also either suspected, confirmed or missed stroke cases. Limited information about X_2 test, so unsure how reliable their statistical analysis is; no explanation of why different tests were used for different types of variables.	Clear description of the study population but unclear description of cause and effect groups.	Comparing Med PACS and CPSS. Clear description of the study population and clear description of cause and effect group.

Y= Yes

N=No

N/A= Not applicable

U/C=Unclear

Appendix C Summary of the Reviewed Articles

Author (Year), country	Purpose	Method	Sample	Major findings (related to the screening tools)
Asimos et al. (2014), USA	To evaluate accuracies of CPSS (Cincinnati Prehospital Stroke Screen) and LAPSS (Los Angeles Prehospital Stroke Screen) for identifying acute stroke when compared with ED diagnostic information.	Quantitative, Retrospective study	N= 2442	1) Overall, CPSS had a sensitivity of 80% and specificity of 48%; excluding TIA diagnosis code, the sensitivity increased to 86%. LAPSS had a sensitivity of 74% and specificity of 48%; excluding TIA diagnosis code, the sensitivity increased to 85%. 2) In the light of EMS protocol routing suspected stroke patients to the acute stroke centres, low specificity of the screening tool can cause over-triage by diverting nonstroke patients to the stroke centres. 3) Assuming the worst (meaning positive stroke screen patients moved from stroke group to the nonstroke group and negative stroke screening patients moved from nonstroke group to the stroke group) and best scenarios (meaning positive stroke screening patients moved from nonstroke group to stroke group and negative stroke screening patients moved from stroke group to nonstroke group) and possible 6% mismatch, (based on the calculation), the best scenario specificity reaches only to the 50% range for both CPSS and LAPSS. Thus, not to use CPSS and LAPSS when EMS protocol routing suspected stroke patients to the acute stroke centre.
Pickham et al. (2019), USA	To assess whether adding balance/coordination and eyes/diplopia to FAST enhances prehospital stroke detection.	Quantitative, multisite prospective study	N= 359	1) When the scoring was at least 1 using either BEFAST or FAST, the stroke patients were distinguished from stroke mimics. 2) This study had a specific interest in identifying posterior circulation stroke through modifying FAST screening tool. Adding balance/coordination and eyes/diplopia did not make significant differences in detection. A positive BEFAST had lower PPV than positive FAST. 3) Every 100 patients who were assessed with BEFAST, additional 4 patients had false positive on top of 47 stroke-mimic patients who would have been assessed by FAST screening tool solely. 4) Authors are warned that using stroke screening tool may increase stroke detection. While this can lead patients to have a better health outcome from receiving more stroke treatment, it can increase

				logistic burden on the receiving stroke centre when large numbers patients with mild stroke symptoms are diverted to the stroke centre. 5) Both BEFAST and FAST have demonstrated similar performance so it seems unnecessary to add two components to FAST due to added time required in BEFAST.
Fothergill et al. (2013), UK	To examine whether ROSIER (Recognition of stroke in the emergency room) is superior to the FAST when used in the ambulance setting for prehospital stroke recognition.	Quantitative, Prospective	N= 295	1) The positive predictive value of ROSIER was 64%, similarly FAST had of 62%. In terms of the negative predictive value, the ROSIER had 78% and the FAST had 71%. The ROSIER had specificity of 18% and 13% for the FAST. Both equally had 97% for the sensitivity. 2) When compared with the consultant diagnosis, ROSIER confirmed 64% of stroke and 78% of non-stroke which are similar to the proportion of cases accurately detected by the extracted FAST 3) ROSIER has seven items (facial weakness, arm weakness, speech disturbances, leg weakness, visual field deficit, loss of consciousness or syncope, and seizure activity) and incorporates all of the three items (facial weakness, arm weakness and speech disturbances) of FAST screening tool. 4) Having more components to assess in the ROSIER, it requires longer time at the scene for the assessment. The duration of assessment was not measured in the study. However, the authors warned that it may only increase a few minutes, millions of neurons will be damaged in each minute. Given that ROSIER was not notably superior to the FAST based on this study's statistical findings, the authors concluded that ROSIER cannot replace FAST to use in prehospital stroke detection by ambulance services. 5) The ability of identifying nonstroke is essential as it will decrease nonstroke patient's eventual treatment time and less overloading ED or specialist unit. 6) The study analysis found out that three of ROSIER components were significant in predicting stroke which are facial weakness, arm weakness and seizure activity. The items that did not significantly predict the stroke final diagnosis also had significant correlation to the items it did predict stroke. Speech disturbance- facial weakness Loss of consciousness- seizure activity

				Leg weakness- facial and arm weakness Visual field deficit- facial and arm weakness but no seizure activity.
Bray et al. (2010), Australia	To evaluate MASS use in the field after three years of its implementation.	Quantitative, cross-sectional study	N= 850	1) The sensitivity of MASS the lowest when compared with paramedic diagnosis and CPSS (83%, 93% and 88% respectively). The specificity was the second highest when compared with paramedic and diagnosis and CPSS (85%, 87% and 79% respectively). 2) MASS was highly valued and regularly used by paramedics in the field for identifying stroke. 3) Thrombolytic therapy was used more with implementation of MASS and in-hospital stroke code system, statistically it increased from 5% to 11%. 4) There was no clear definition of paramedic diagnosis of stroke. However, the authors described that after implementing MASS, the paramedic diagnosis of stroke has improved.
Oostema et al. (2015), USA	To examine the relationship between CPSS and EMS diagnostic accuracy, and identify clinical predictors of accurate prehospital stroke identification.	Quantitative, cohort study	N= 441	1) Out of all the variables and based on analysis, CPSS documentation was independently associated with sensitivity of EMS stroke recognition and higher PPV of EMS stroke suspicion. The CPSS documentation had OR of 12.02 (95% CI, 5.66-25.51) 2) The EMS stroke recognition was higher in people who presented symptoms incorporated in CPSS. 3) The authors raised a point that EMS preferentially use CPSS when patients displays obvious signs of stroke symptoms. 4) Besides utilising CPSS to increase EMS stroke recognition sensitivity the authors suggested EMD also play a significant role as this provide degree of priming for paramedics to consider stroke. Thus, the authors suggested to incorporate CPSS to EMD's practice.
Mould-Millman et al. (2018), USA	To evaluate accuracy of EMD and EMS stroke recognition in prehospital setting.	Quantitative, retrospective, observational, cohort-based study	N=548	1) The local prehospital stroke diagnosis protocol is consist of seven items, including CPSS. The field EMD assessment in identifying acute stroke had the sensitivity of 76.2% with a positive predictive value of 49.3%. The EMD had the sensitivity value of 48.9% and positive value was 24%. 2) The sensitivity paramedic diagnosis for stroke was heavily influenced by presence of one or more of CPSS components. Also, the more paramedics diagnosed positive stroke when the patient was already classified as stroke by EMD.

				3) Paramedic stroke diagnosis coincided with the confirmed diagnosis when patient had CPSS score at least 1 at the scene.
Studnek et al. (2013), USA	To assess CPSS and Med PACS for correctly classifying stroke when using in prehospital setting.	Quantitative, retrospective	N= 416	1) The Med PACS had the sensitivity value of 0.742 (95% CI, 0.672-0.802), whereas the CPSS had 0.790 (95% CI, 0.723-0.845). 2) From the specificity standpoint, The Med PACS had 0.326 (95% CI, 0.267-0.391) and the CPSS had 0.239 (95% CI, 0.187-0.300). 3) Although the Med PACS is more complicated with more eligibility criteria and physical assessment, the CPSS produced higher sensitivity. The authors believe that having more criteria should have increased sensitivity, it is possible that eligibility criteria decreased sensitivity benefits from the physical assessment results. 4) The authors agreed with other literature that the stroke screening tool sensitivity is more important than the specificity given that all of local hospital can administer IV t-PA. Additionally, there are minimal possibilities for false positive stroke patient receiving IV t-PA while there is significant sequelae for true positive stroke patient not receiving IV t-PA. Therefore author recommended using CPSS based on its statistical significance and less complexity for assessors.