

Byron Thornhill

Clinical guidelines

Designing for accurate decision-making

Acknowledgments

I would like to acknowledge my supervisors, Eden Potter and Dr. Stephen Reay, to whom I am grateful for not only for their guidance and knowledge, but their belief and support throughout the entire course.

I would like to thank Dr. Kerry Gunn for his advice, encouragement, and expertise, your time and dedication throughout this research has not gone unnoticed. Furthermore, the Auckland DHB, Anaesthesia and Pharmacy Departments, thank you for your time, support and knowledge.

I would like to also thank Scott Mackenzie for his collaboration and expertise developing the 'Ida' software throughout this project. To the crew at the DHW Lab, thank you for your support and encouragement throughout this research.

I am indebted to the Joint Anaesthesia Faculty Auckland Trust Board (JAFA Trust) for funding this research and the Design for Health and Wellbeing Lab (DHW Lab), for awarding me the research scholarship that supported the development of this thesis.

And finally Lisa... there are no words, this one too, is for you.

This exegesis is submitted to the Auckland University
of Technology for the degree of Master of Art & Design, March 2017.

Byron Thornhill

Bachelor of Art & Design Honours [First Class]
AUT University: Auckland, 2014

Bachelor of Design, AUT University: Auckland, 2009

Attestation of authorship

I hereby declare that this submission is my own work and that to the best of my knowledge it contains no material previously published or written by another person, nor material which to a substantial extent has been accepted for the award of any other degree or diploma by a university or other institution of higher learning, except where due recognition is given in the acknowledgements.



03 /03/2017

Intellectual property rights

The designer asserts the intellectual and moral copyright of the creative work contained in this dissertation. All rights of the owner of the work are reserved. The publication contained in all its formats is protected by copyright. Any manner of exhibition and any diffusion, copying, resetting or editing constitutes an infringement of copyright, unless previously written consent of the copyright owner thereto has been obtained.



03 /03/2017

Table of figures

Figure 1. Schön. (1983).
Action research process.

Figure 2. Swann. (2002, p.5).
Design journey.

Figure 3. IDEO. (2015).
Creating real impact.

Figure 4. Sanders & Stappers. (2014).
Map of design research.

Figure 5. Sanders & Stappers. (2014).
Movements across design.

Figure 6. Thornhill, B. (2017).
Research timeline.

Figure 7. Thornhill, B. (2017).
Clinician journey map.

Figure 8. Thornhill, B. (2017).
Clinical guideline review and analysis.

Figure 9. Thornhill, B. (2017).
Workshops with project stakeholders
and clinicians.

Figure 10. Auckland DHB. (2016).
Original Idarucizumab guideline.

Figure 11. Thornhill, B. (2017).
Typeface metric diagram.

Figure 12. Thornhill, B. (2017).
Aktiv Grotesk font matrix.

Figure 13. Thornhill, B. (2017).
Metric micro-typography.

Figure 14. Thornhill, B. (2017).
Metric document formatting.

Figure 15. Thornhill, B. (2017).
Typographic grid system.

Figure 16. Thornhill, B. (2017).
Document feedback from clinicians.

Figure 17. Thornhill, B. (2017).
Refined Idarucizumab administration
criteria for Boehringer Ingelheim
pharmaceuticals.

Figure 18. Thornhill, B. (2017). Clinician
journey map accessing and adopting
the Idarucizumab guideline in Auckland
City Hospital.

Figure 19. Thornhill, B. (2017). Approved
administration criteria and guideline
design by the Anaesthesia Department,
Auckland City Hospital.

Figure 20. Auckland DHB. (2016).
Anticoagulation bridging guideline.

Figure 21. Thornhill, B. (2017). Initial anticoagulation bridging guideline algorithm concepts.

Figure 22. Thornhill, B. (2017). Hand drawn algorithms used to sequence the bridging guidelines information.

Figure 23. Thornhill, B. (2017). Bridging anticoagulation guideline wireframe concepts.

Figure 24. Thornhill, B. (2017). Further bridging anticoagulation guideline wireframe concepts.

Figure 25. Thornhill, B. (2017). Wireframe workshops with a focus group of senior clinicians finalised the guideline decision pathway no.1.

Figure 26. Thornhill, B. (2017). Wireframe workshops with a focus group of senior clinicians finalised the guideline decision pathway no.2.

Figure 27. Thornhill, B. (2017). Paper prototypes interlinked and formed an information structure.

Figure 28. Thornhill, B. (2017). Bridging anticoagulation guideline information streams sequenced.

Figure 29. Thornhill, B. (2017). Bridging anticoagulation guideline wireframe developed into a user interface.

Figure 30. Thornhill, B. (2017). Idarucizumab guideline information restructured into a wireframe.

Figure 31. Thornhill, B. (2017). Refined Idarucizumab guideline document.

Figure 32. Thornhill, B. (2017). The guideline's information architecture coded using Java

Figure 33. Thornhill, B. (2017). Basic headings and buttons arranged into a user interface.

Figure 34. Thornhill, B. (2017). An Android smartphone device was used to test and refine the guideline's decision processes within its interface.

Figure 35. Thornhill, B. (2017). Design concepts of the user interface incorporating icons, dialog boxes and windows.

Figure 36. Thornhill, B. (2017). Interface style, layout and components prototyped using Adobe's Creative Suite.

Figure 37. Thornhill, B. (2017). Navigation and selection icons designed for the user interface.

Figure 38. Thornhill, B. (2017). Designed icons for the Idarucizumab administration procedure.

Figure 39. Thornhill, B. (2017). The icon set for the Idarucizumab native application prototype.

Figure 40. Thornhill, B. (2017). Clinician journey map accessing and adopting the Idarucizumab guideline in Auckland City Hospital.

Figure 41. Thornhill, B. (2017). Idarucizumab guideline application prototype no.1.

Figure 42. Thornhill, B. (2017). Idarucizumab guideline application prototype no.2.

Figure 43. Thornhill, B. (2017). Idarucizumab guideline application prototype no.3.

Figure 44. Thornhill, B. (2017). Idarucizumab guideline application prototype no.4.

Figure 45. Thornhill, B. (2017). User testing clinicians.

Figure 46. Thornhill, B. (2017). Clinician usability of interface no.1.

Figure 47. Thornhill, B. (2017). Clinician usability of interface no.2.

Figure 48. Thornhill, B. (2017). Clinician usability of interface no.3.

Figure 49. Thornhill, B. (2017). User interface refinements no.1.

Figure 50. Thornhill, B. (2017). User interface refinements no.2.

Figure 51. Thornhill, B. (2017). User interface refinements no.3.

Figure 52. Thornhill, B. (2017). User interface refinements no.4.

Figure 53. Thornhill, B. (2017). User interface refinements no.5.

Figure 54. Thornhill, B. (2017). User interface refinements no.6.

Contents

Abstract	1	Documentation of research	54
Introduction	2	Explorative design phase	56
Contextual review	6	Capturing insights	78
Clinical guidelines	7	Reframing the project: 1	83
Information design	18	Prototyping: 1	85
Conclusion	27	Reframing the project: 2	98
Methodology	29	Prototyping: 2	102
Action research	32	Ida: Smartphone prototype	112
Research frameworks	36	User tests	118
Ethics	40	User interface refinements	135
Research timeline	42	Discussion	143
Methods	44	References	148
		Appendices	157

¹ Merriam-Webster (2016) defines **perioperative** as, "relating to, occurring in, or being the period around the time of a surgical operation".

Abstract

This project explores how the use of clinical guidelines can be improved through a design-led approach. Clinicians in surgical operation settings at Auckland City Hospital, as primary users of clinical guidelines, were placed at the centre of the project design process in order to gain an in-depth and holistic understanding of guideline users. The guideline design was prototyped to ensure key principles of information design are adhered to, setting structure, user accessibility and visual design at the forefront of the information design process. The outcome of the research was a smartphone application for haematology-related guidelines that enables efficient and accurate decision-making in perioperative¹ settings.

Introduction

Introduction

As a graphic designer employed at the Design for Health and Wellbeing Lab (DHW Lab) at Auckland City Hospital, my job involves using design to help communicate ideas or information to hospital users and stakeholders. My journey into graphic design began with a passion for typography; I have always been intrigued with how minute details in lettering lend a particular form to printed language, and how people perceive and read text on many levels. What began as purely typographic considerations led me down the broader path of communication design; how to most effectively communicate a message to an audience by employing visual design techniques, and considering people's needs in the design process.

An opportunity was identified at Auckland City Hospital to explore how clinical guidelines can be improved through a design-led approach using information design principles. Senior anaesthetists were concerned about poor guideline retention amongst their clinicians.

The Department of Anaesthesia, in particular, had a variety of haematology-related guidelines in development and due for completion by the end of 2016. This provided an ideal opportunity for this design research project, where shared knowledge and expertise in the fields of healthcare and design contribute to solving real world problems.

This research was a local project at Auckland City Hospital, under the direction of the DHW Lab. Like other projects undertaken through the DHW Lab, it aims to further knowledge in the fields of health and design. Four funding parties were responsible for this collaborative research project: Auckland University of Technology, Auckland District Health Board (DHB), Joint Anaesthesia Faculty of Auckland Trust Board (JAFA Trust) and the DHW Lab. Following a 2015 research partnership between the DHW Lab and Department of Anaesthesia, the clinical guideline redesign project was identified to improve guideline retention among clinicians.

Introduction

Guidelines within the Auckland DHB

Within perioperative treatment there are procedures and decisions that are based on the conditions of acute (unplanned) and elective (planned surgery). These are unique for each patient and the context of their treatment. Each procedure is tailored to patients' needs regarding their personal healthcare and conditions, much of which relates to blood. Currently at Auckland City Hospital, clinical guidelines are presented as multiple page documents. The medical information has been reported by practicing clinicians as being dense and cumbersome to interpret and follow. The current research explores creating and redesigning guidelines for anaesthetists and haematologists within Auckland City Hospital. The guidelines will inform surgical decisions based on blood treatment for the patient involved. Some of the drugs included in these decisions are Warfarin, Idarucizumab, and New Oral Anticoagulant (NOAC) based drugs such as Rivaroxaban, Dabigatran and Apixaban. These drugs are all involved in treatment for heart disease complications where blood needs to be thickened or thinned accordingly to assist a patient's stability throughout the entire surgical process.

A recent clinical trial of one of these drugs was initiated by Auckland District Health Board and Boehringer-Ingelheim pharmaceuticals, for the blood thickening drug Idarucizumab (referred to as 'Ida' by some clinicians in Auckland City Hospital and internationally). Clinical guidelines are required for safe use and introduction into perioperative treatment. While enabling safe use of Idarucizumab is the main reason for the guideline, it is also important to guide appropriate use since the cost of one unit is equivalent to NZD 5,000. This drug will be used in emergency procedures where the information on safe and appropriate usage needs to be presented in a structured and accessible format for clinicians operating in high-pressure environments. With these factors in mind, in this project, the clinical guideline for Idarucizumab was co-designed with Auckland DHB clinicians.

Introduction

The thesis components

In this study, the practical work forms the basis of my enquiry, while the exegesis contextualises and explains the research project's background, aims, and methodological aspects. The four documents in the thesis are:

- The exegesis
- 'Ida' smartphone (Android) guideline application
- 'Ida' smartphone (iOS) guideline application
- A video demonstrating the use of 'Ida.'

The first chapter of this exegesis presents a contextual review and introduces the topic of clinical guidelines through a discussion of critical writing relating to information design.

The second chapter discusses the research methodology, including a consideration of research paradigms, and of human-centred design and participatory design as complementary research frameworks. The methods employed throughout the research process are discussed in detail.

The third chapter documents and illustrates the research process and designed solutions. Examples of research prototypes and designs illustrate how qualitative methods of enquiry were used to drive the project towards higher levels of discovery.

The final chapter discusses the findings and implications of the research project. Barriers to clinicians' use of guidelines are discussed and a solution designed to streamline information access and communication.

The practical component of the thesis is a smartphone guideline application called 'Ida.' This has been designed with dual potentials so it can be downloaded by clinicians on both Android and iOS platform smartphones for easy use. It offers an adaptive information structure that includes diverse medical scenarios to be accurately diagnosed by the clinician using it. As an application on a smartphone device, the 'Ida' guideline's information is accessible anytime and anywhere, making it easier for clinicians to use in emergencies. At this point in time, 'Ida' is connected to both the Anaesthesia and Pharmacy Departments within Auckland City Hospital.

Contextual review

Contextual review

Clinical guidelines

2 Apothecary: A person who prepared and sold medicines and drugs. Oxford dictionary.

3 Basic research: Theoretical research aimed at discovering scientific principles and facts; opposed to applied research, which puts those principles to practical use. Oxford dictionary.

4 Duska and Elder (2016) define **clinical research** "as the study of health and illness in people. It is the way we learn how to prevent, diagnose and treat illness. Clinical research describes many different elements of scientific investigation. Simply put, it involves human participants and helps translate basic research (done in labs) into new treatments and information to benefit patients. Clinical trials as well as research in epidemiology, physiology and pathophysiology, health services, education, outcomes and mental health can all fall under the clinical research umbrella."

The establishment of clinical guidelines in healthcare

Contextual review

Clinical guidelines

Information design

Conclusion

Clinical guidelines offer explicit recommendations to clinical professionals who are uncertain about how to proceed in specific aspects of their clinical practice (Woolf, Grol, Hutchinson, Eccles, & Grimshaw, 1999). While it is unknown exactly when they originated, several theorists agree they have been used throughout medical history dating from 1700BC to aid medical practitioners' decision-making (Daly & Brater, 2000). Some early prescriptions have been found in Assyrian or Babylonian libraries or in Egyptian Papyri (Gadd, 1924), including the Ebers Papyrus, which contains prescriptions on how to use plants that have certain medicinal qualities (Ebbell, 1937). Although many of these manuscripts contain recorded methods on ancient apothecary², they are the historic beginnings of recorded knowledge to aid accurate decision-making in healthcare environments.

Medicine has a long standing tradition of both basic³ and clinical⁴ research, dating back to the early 1000s as physicians gained easier access to the translated works of Dioscorides, Galen's *Simplicium Medicorum*, and the pharmacopoeia of Avicenna's *Canon* (Gunther, 1959). Throughout the Middle Ages, the Church dominated all scholarship and regulated medical thought through the control of its clergy and of the roots of education. Originally, guidelines took the form of scribe-copied manuscripts, passed from physician to physician, and the most important are still found among the first printed books (Daly & Brater, 2000).

⁵ Rhodes & Bryant (2016) define **public health** as, "the art and science of preventing disease, prolonging life, and promoting physical and mental health, sanitation, personal hygiene, control of infection, and organization of health services. From the normal human interactions involved in dealing with the many problems of social life, there has emerged a recognition of the importance of community action in the promotion of health and the prevention and treatment of disease; this is expressed in the concept of public health."

⁶ **Social evil** is defined by Gupta and Kumar (2007) as a social circumstance which negatively affects members of society, directly or indirectly. Social determinants of health are identified as social organisation, early life events, life-course social gradient, high unemployment rates, psychosocial work environment, transport, social support and cohesion, food, poverty and social exclusion, and individual health behaviours.

⁷ Clanton (2011) defines **modern science** as an attitude of observation and experimentation quite often with the inclusion of mathematics to explain those observations.

Contextual review

Clinical guidelines

Information design

Conclusion

Recorded history has indicated that those who heal have always sought truth and predictability in their encounters with the sick and injured. However, for centuries, tracing back to the medieval university, there have been concerns over healers only meeting minimal standards in their healthcare practice (Beck, 1969). During the early modern period, local state authorities and established medical guilds regulated medical practice through apprenticeships and licences they endorsed. Medical licensing at national and regional levels was introduced and individual physicians under such licences were assumed to be competent enough to determine the appropriate medical procedures (Weisz, Cambrosio, Keating, Knaapen, Schlich, & Tournay, 2007).

The 1800s saw rapid growth in voluntary hospitals in England (Carruthers & Carruthers, 2005), and influenced the establishment and improvement of public health⁵ over the next two centuries. Initially, social evil⁶ was identified as a primary concern. This led to private philanthropists bringing social issues to the fore, and changing public opinion, which eventually led to government action (Rhodes & Bryant, 2016). Medical curricula throughout the western world was restructured accordingly, conforming to the developments and demands of modern science⁷ (Bonner, 1995).

At this time, public health intervention focused heavily on medical science and philosophy, and thus concentrated on manipulating and controlling the environment for the benefit of the public. Public sectors of medical practice were subject to various organisational imperatives for standardisation, as those directing public services needed information about the areas under their jurisdiction. One of the first to be standardised was public health data. Using these data, it was possible to define and standardize basic categories within healthcare in order to standardise effectively. Furthermore, practitioners were constrained in various ways through the use of standardised forms and instruments which provided healthcare data that was both systematic and comparable (Weisz et al., 2007).

As advancements in medical knowledge and practice became so specialised, general medical licences no longer seemed adequate as a measure of physicians' competence. Physicians working in developing institutions like hospitals and dispensaries made it possible to learn new skills, procedures and approaches from colleagues (ibid.). Surgeons went to great lengths to organise and formalise the acquisition of knowledge, publishing papers in major medical journals and organising medical meetings to advise practitioners on how to best manage a situation or condition (ibid.).

Contextual review

Clinical guidelines

Information design

Conclusion

By the 1960s, medical research had expanded dramatically, influencing numerous innovations and product developments, thus offering physicians new therapeutic tools and possibilities within practice. As a consequence, individual clinical judgement was incapable of adequately evaluating the effects of so many products. A variety of ethically complex conditions and practices in clinical medicine was created - such as brain death, life-sustaining technologies, and in vitro fertilisation – all of which required ethical guidance to supplement their very complex technical guidelines (Rothman, 1991). Guidelines then became essential to protocols defining these medical activities; their use and prevalence led to further endorsement by professional bodies and eventual uptake throughout modern healthcare systems (Tournay, 2006).

Before the end of the twentieth century, clinical decisions were based largely on “professional consensus” (Herk, Klazinga, Schepers, & Casparie, 2001, p. 267). A long standing tradition has encouraged basing decisions on clinical judgement, and trusting that each individual physician will come to the right conclusion. Although some form of evidence has always contributed to clinical practice, there was no generally accepted, formal way of ensuring a scientific, critical approach to clinical decision-making (Daly, 2005).

In the last few decades, the practice of medicine has become immensely complicated; definitions of best practice in healthcare are continually revised, new treatments developed rapidly, and hundreds of guidelines are required to detail the safe and accurate use of these treatments. With this growing pool of knowledge in modern medicine, the vast range of medical information has become too complex and detailed for a medical practitioner to reliably recall in the context of healthcare decisions (Eddy, 2002; Gawande, 2010).

In the early 1990s, a major opportunity was identified for ensuring that reliable and accurate information was used in healthcare decision-making. Rather than relying upon ‘professional consensus’, medical practice evolved towards an evidence-based approach as a way to bridge the gap between scientific research and practice. Health policy experts claim that evidence-based medicine strengthens the scientific nature of medical knowledge, where decisions are scientifically proven, researched and distilled for best clinical practice (Blank & Burau, 2014). Several theorists assert that modern guidelines advocate a standardisation of clinical practice that limits unwarranted professional judgement (Blank & Burau, 2014; Harrison, Moran, & Wood, 2002).

Contextual review

Clinical guidelines

Information design

Conclusion

Within New Zealand, clinical guidelines emanate from national health policy shaped by the Government (Blank & Burau, 2014). Between 1999 and 2012, the New Zealand Guidelines Group (NZGG) was formed, which was an organisation based within New Zealand's Ministry of Health. Its purpose was to promote the use of evidence in the delivery of health and disability services.

Researchers now must comply with the standards set by the National Ethics Advisory Committee (NEAC), which outlines the ethical standards to uphold while undertaking health and disability research. Ethics committees within the Ministry of Health (NZ) review the research and are responsible for checking that each study complies with ethical standards the NEAC mandates (Health, 2016). This high standard of oversight ensures that only robust and reliable research informs current clinical guidelines.

Contextual review

Clinical guidelines

Information design

Conclusion

Guideline use and impact

Many professional sectors demand practice guidelines to deal with the sheer amount and complexity of information needed to operate successfully. In professions such as finance, law and medicine, complex decision-making necessitates clear guidelines to direct action, rather than relying on the individual's memory and tacit knowledge. Gawande (2010) suggests clinical experts who work in complex, stressful environments are prone to memory failure and diverted attention while on the job. Routine tasks can easily be overlooked under the strain of more pressing matters - it is here that mistakes may be made. This is particularly worthy of consideration in healthcare situations. Clinicians placed under on-the-job pressure may have their decision-making negatively influenced by personal emotions and habits of mind. As every medical decision leads to action, there are biases which occur in contexts of uncertainty and risk (Reach, 2014). The aim of evidence-based practice is to help experts to eliminate personal biases and emotions from their reasoning.

Ambivalence towards evidence-based practice is common among clinical experts as they perceive that an evidence-based approach does not allow them to tailor decisions to individual patients' circumstances (Berg, Horstman, Plass, & van Heusden, 2000; Blank & Burau, 2014; Reach, 2014).

Within evidence-based medicine, experts often need room to adapt their decisions to cater for the unpredictability within clinical practice. In evidence-based practice, decisions made during the process are often dictated to the clinician, leaving no room for personal adaption to counter unpredicted circumstances that arise in practice (Gawande, 2010). While clinical guidelines are necessary for effective healthcare practices, it is important they are designed to allow enough flexibility for clinicians to adapt decisions appropriately to the healthcare circumstances.

Clinical professionals require outcome-based information to provide accurate diagnosis, treatment and results. Real-time information informs explicit recommendations to the practitioners when they are uncertain about how to proceed. This knowledge must be delivered to the patient swiftly and securely, ensuring privacy is maintained and that measures are cost-effective (McKinnell, Kador, & Pfizer Inc., 2005). Clinical guidelines are regarded as the 'natural extension' of medical audits within healthcare, as audits define and promote standards of best practice against which performance can be judged (Blank & Burau, 2014).

Contextual review

Clinical guidelines

Information design

Conclusion

By reinforcing the importance of critically appraising methods involved in clinical decision-making, clinicians are able to identify unsupported interventions and call attention to ineffective, dangerous and wasteful practices. Overall, this helps to inform doctors who are accustomed to outdated practices, improves the consistency of care, and highlights the gaps in the known literature (Woolf et al., 1999).

The effectiveness of clinical guidelines impacts upon the health system as a whole, as clinical guidelines have multiple stakeholders; some stakeholders are direct users (i.e. clinicians), while other stakeholders are indirectly affected by guidelines (e.g. patients, pharmacists and pharmaceutical companies). Effective guidelines maximise efficiency in the healthcare system as they assist with identifying under-recognised health problems, clinical services, and preventative interventions, as well as higher risk and neglected patient populations. A successful guideline will not only guide a clinician appropriately within practice to treat a patient effectively, it also reduces financial outlays for hospitalisation, drugs and surgery.

In all, effective guidelines result in better decision-making and enable the health system as a whole to optimise its value for money and funding (ibid.). Conversely, the use of flawed guidelines - such as those providing inaccurate (outdated) information and advice - will have a negative 'snow-balling' effect that essentially undermines the quality of healthcare provided.

While the need for using guidelines is well established, some practical difficulties exist in ensuring the most effective guidelines are in place. In some cases, these limitations are financial, such as unaffordable guidelines developed by various professional bodies and medical groups, and protocols advocating for costly interventions that cut into limited funding and resources (ibid.). In other cases, the difficulties lie in the implementation of clinical guidelines across the health system (ibid. pp. 527-530). These barriers to implementation affect the decisions made about the use of clinical guidelines, and ultimately impact on the wider health system and its stakeholders.

8 The Guidelines International Network is an international scientific association. It consists of a network of organisations and professionals that focus on the development and application of evidence-based guidelines and healthcare information. The network promotes evidence-based healthcare and practice by reducing inappropriate variations of information throughout the world.

Contextual review

Clinical guidelines

Information design

Conclusion

Guideline accessibility

Clinical practice guidelines are now ubiquitous.
(Weisz et al., 2007)

In the past twenty years, the evolution of research methods and the expansion of scientific evidence have dramatically increased the need for clinical practice guidelines. The Guidelines International Network⁸ database currently lists online more than 6,100 guidelines between 96 organisations, and from 76 countries. The US-based National Guideline Clearinghouse has a total collection of 4,721 guidelines to date. A number of other guidance tools, such as rapid response recommendations and computerised decision support systems, are also created to aid clinical decision-making each year.

Clinicians are no longer able to keep up with the rapid progression of the medical knowledge base. Dr. David Sackett (2002, p. 1164) highlights this problem, stating that “an internist would have to read 33 articles, 365 days a year, to stay up-to-date.” Such a rapid turnover of medical knowledge brings into question the reliability and accuracy of new research applications into clinical guidelines.

As healthcare evidence becomes more scientific, the risks of misinterpreting complex information increase. At the same time, the likelihood of any clinician getting a complete and balanced picture decreases (Cochrane, 2016; Duff, Kitson, Seers, & Humphris, 1996). To address this issue, organisations such as the Cochrane Library (online medical database) gather and summarise the best evidence from medical research to help clinicians make informed choices about clinical treatment. Medical evidence is critiqued and tested by professional review groups, promoting the credibility of this information in supporting clinical decision-making (ibid.). Various web-based libraries (e.g. ELSEVIER’s Embase, and EBSCO Health’s MEDLINE) archive authoritative health evidence that can be universally accessed. Although this information is now reliable and accessible online, health professionals still face difficulties when trying to locate specific content (Coumou, Zorgverzekeringen, & Meijman, 2006; Graber, Randles, Ely, & Monnahan, 2008). An obvious way to improve medical online resources would be to employ web usability principles such as prioritising a simple search functionality to enable fast-tracking of information, and ordering information whereby a systematic process ensures hierarchy and categorisation of its content (Rosenbaum, Glenton, & Cracknell, 2008).

Contextual review

Clinical guidelines

Information design

Conclusion

In terms of this research, information design is just one way to promote the accessibility for clinical guidelines. An immediate concern is the ability of information technology to redefine how clinical guidelines are accessed and kept up-to-date. This is because it is fundamental that clinical decision-making is established based on more accurate and recent evidence (Rodrigues, 2000). Although information technology has transformed the ways we can access and use information in wider society, within healthcare it has not yet been optimised due to the acceleration of health innovation and research. Currently there is a distinguishable time-lag between the discovery of evidence in medical research and the implementation of findings within medical practice (Oborn, Barrett & Racko, 2012); a concern that might be positively bridged using technology.

Technology is gradually being adopted by practitioners in order to improve healthcare in a wide sense, beyond clinical guidelines. Global healthcare services are adapting from sporadic acute healthcare to continuous and integrated health care—an approach that influences anywhere, anytime healthcare services (Anwar, Joshi, & Tan, 2015).

Advances in e-health informatics, digital transformation and remote data exchange, mobile communication, and medical technologies enable this new development within healthcare services (ibid). According to research conducted in the last few years (Mobasheri, Johnston, Syed, King, & Darzi, 2015), there is increasing interest in the use of smartphone and tablet technologies in healthcare. Within developed healthcare systems, such devices are carried in the pockets of a majority of healthcare professionals, and there are currently 40,000 mobile health applications available for download through app stores (ibid.).

An opportunity is readily available for clinical guidelines to be adapted into the same devices clinicians are already using (such as smart phones), in order to ensure that they are as accessible as possible and promote the most relevant and up to date information to aid accurate clinical decision-making.

⁹ **Clinical inertia** is defined by Phillips, Branch, Cook, Doyle, El-Kebbi, Gallina, & Barnes (2001), as the lack of compliance of healthcare professionals with current guidelines.

Contextual review

Clinical guidelines

Information design

Conclusion

Guideline design

A major incentive for the evolution of evidence-based medicine was the recognition of the need for reliable and accurate information — a way to bridge the gap between research and practice (Ragan & Quincy, 2012). Reach (2014) suggests that guidelines must be appreciated for their teaching value — clinical guidelines are education tools to improve the quality of care. However, health care organisations tend to concentrate more on the scientific evidence within the literature than on how the information is implemented by clinicians using the guidelines. Design can bridge a further gap; one that exists between the clinical evidence and how it is communicated to healthcare practitioners.

Guideline development is complex and interdisciplinary. It involves expert clinicians, health service researchers, process leaders and financial supporters, all of whom systematically review and evaluate relevant literature to determine evidence-based outcomes (Graham & Harrison, 2005). Due to the scope of the users' roles it is essential that guideline information be easily understood and not open to differing interpretations across people or roles. Contrary to this, most clinical guidelines are presented in dense linear textual formats which display type at small sizes, proving tedious and time consuming to read - some can also exceed 600 pages (Pereira, Hassler, Hamek, Boog, Leroy, Beuscart-Zéphir, & Lamy, 2014; Woolf et al., 1999).

While adopting guidelines within a clinical setting is difficult, a key contributor to this is the way in which information is presented to clinicians. Studies have shown that clinicians are often not accustomed to written guidelines as they do not align appropriately with the actual care process a patient goes through (Vissers, Hasman, & van der Linden, 1996). Consequently, there is a lack of compliance with current guidelines among clinicians, and this "clinical inertia"⁹ may represent an impediment to efficient care (Reach, 2014).

To resolve this issue, Watters (2008) suggests clinical guidelines should relieve the practising clinician of the burden of attempting to read and evaluate all the information being published in their area of practice. An example could be to include algorithms and tables, which physicians commonly prefer over heavily textual documents, as time availability is limited during consultations (Sinuff, Eva, Meade, Dodek, Heyland, & Cook, 2007). While algorithms that simplify patient care into a sequence of yes / no decisions are often considered to undermine the complexity of medicine (and the parallel and iterative thought processes essential in clinical judgement), more succinct and accessible information must be made available for circumstances where time is limited (Woolf et al, 1999; Reach, 2014).

Contextual review

Clinical guidelines

Information design

Conclusion

Furthermore, preferences vary widely among clinicians with regard to guideline format and presentation. Sinuff et al. (2007) suggest that clinicians prefer simple formats (like preprinted forms) and presentation (such as algorithms). While clinicians can access guidelines via their hospital's intranet, others prefer short pamphlets, pocket cards, posters and manuals. Few clinicians use original research articles, narrative or systematic reviews, or other literature such as textbooks to inform their clinical decision-making. This suggests that implementing information design strategies for more effective clinical guideline usage needs to account for clinicians' preferences in order to increase guideline use in clinical practice settings (ibid.).

Contextual review

Information design

Contextual review

Clinical guidelines

Information design

Conclusion

Information design is the study and practice of bringing clarity and comprehensibility to visual materials that are meant to direct, teach, explain, or otherwise inform (Lipton, 2007). The International Institute for Information Design (IIID) defines information as "the result of processing, manipulating and organizing data in a way that adds to the knowledge of the person receiving it" (2017). The IIID also describes design as the creative and intellectual efforts required to resolve a problem. Combining these areas in the form of information design results in a crafted definition, plan and shape of the message to suit the environments it is presented in, in order to best fulfil the information needs of recipients (IIID, 2017). The principles of information design are apt for usage in clinical guideline design as they will ensure clinicians clearly understand the information required and are readily able to access it in relevant healthcare environments.

Designers must use numerous tactics and methods to make information meaningful, involving numerous fields such as; user-interface design and interaction design, instructional design, data visualisation, information architecture, library sciences and technical information (Baer & Vacarra, 2009).

The multidisciplinary nature of information design involves a range of activities including writing, editing and creating visual representations of information, as well as researching and testing with potential audiences so the right decisions are made throughout the design process (ibid.). According to Lipton (2007), effective information design has the ability to accomplish the following:

- Assist with the navigation and comprehension of complex theories, facts, figures and demands
- Ensure information meets people's needs by helping them answer a question, solve a problem, or complete a task
- Remove or reduce frustration or confusion
- Begin and end with understanding the needs of the people who will use the information, and ensuring the content and display of information serves these needs.

Contextual review

Clinical guidelines

Information design

Conclusion

For information design to achieve these goals, design considerations can be broadly classified into three key areas. Namely, information architecture which addresses how the structure of information enhances clear communication, user accessibility in terms of the information being easy to understand and access for the intended audience, and graphic design which focuses on visual representations of information to reduce the amount of written content required.

With these considerations at the forefront of the clinical guideline design process, information design allows for an optimal design solution which will succinctly provide the relevant, up-to-date information that clinicians require to make accurate clinical decisions, in an accessible format for the healthcare contexts in which the guidelines will be used.

Contextual review

Clinical guidelines

Information design

Conclusion

Information architecture

Information architecture is about helping people understand their surroundings and find what they're looking for, in the real world as well as online. (Information Architecture Institute (IAI), 2017)

As information designers are concerned with creating usable, easy to understand information (Information Design Association, 2017), key to such clear communications is the organisation of that information. This is referred to as information architecture and can include classifying themes to use in software, websites and other applications, in both online and offline environments (Baer & Vacarra, 2009). The field of information architecture draws on multiple disciplines and areas of knowledge, including cognitive psychology, semiotics, architecture, mathematics and library science (IAI, 2017). While the field is interdisciplinary, it is particularly relevant to information design as it involves the consideration of shared information environments, where principles of design and architecture are used to support usability and findability, and to solve problems when using vast amounts of available information (IAI, 2017; Resmini & Rosati, 2012). Frequently, solving these problems requires usability testing and analysis with the users or audience (Baer & Vacarra, 2009).

Making use of information architecture in designing clinical guidelines will ensure clinicians are able to easily find and follow the guidelines they require in the healthcare contexts the guidelines are used in.

With people currently experiencing richer information environments and technologies than ever before, there are now endless ways we are being exposed to information (Lurie, 2004). The resulting 'information overload' can cause difficulty when a clinician is trying to understand an issue or make a decision as they can be confronted with too much information to consider (Yang, Chen & Hong, 2003). Furthermore, as clinicians have numerous ways of absorbing and understanding information (e.g. online, print-based, environmental, and experiential), it is important for designers to craft experiences for the intended audience and define ways in which design can eliminate clutter to clearly emphasise a message (Baer & Vacarra, 2009). With the exponentially expanding body of healthcare information, this is of

10 Data is described by Baer & Vacarra (2009, p.12) as "words, pictures, movement, sound— basically anything a human being's senses can absorb and translate into meaning." This definition is further refined by Potter (2010, p.2) as "raw, unstructured and unorganised units or facts, which are given form and translated into meaningful information. They can be analogue or digital."

Contextual review

Clinical guidelines

Information design

Conclusion

particular concern when designing effective clinical guidelines as the key information needs to be identified and included in such a way as to avoid this cognitive overload. For example, if a clinical guideline specifies whether or not a drug should be used on a patient, it may outline numerous criteria that determine whether the drug is appropriate for that individual. Often this information is provided in paragraph format, rather than each criteria listed in bullet-point form whereby a clinician could 'check-off' each item in the list against the patient's requirements. Providing too much information in a text-heavy format is more likely to cognitively overload a clinician, particularly in a stressful healthcare context, and result in errors as some information could be missed.

A further difficulty faced by clinicians is the issue of unstructured information

that simply reads as a cluster of data¹⁰, which can cause confusion among information users and fail to convey the intended message. In information-rich environments, such as those found in clinical settings, a crafted designed structure can enhance the efficiency of the information seeking process; this enables clinicians to filter and translate the most important information into responsive decisions, resulting in improved understanding and decision-making (Lurie, 2004). With these goals in mind, information architecture is a primary consideration in designing effective clinical guidelines.

Contextual review

Clinical guidelines

Information design

Conclusion

User experience

The translation of complex, unorganised, or unstructured data into valuable, meaningful information can involve a shift in focus from what we want to say, to what the audience wants and needs, and how the audience wants and needs it (Lipton, 2007).

This focus on the audience as an essential consideration of the information design process is reinforced by the Information Design Association's (IDA) (2017) definition of information design as being empathetic and inclusive design that enables people to use information effectively and efficiently. Effectively designed information has been designed to anticipate the needs of the audience and to exceed their expectations, thus providing an elegant, seamless and useful solution (Baer & Vacarra, 2009). Key aspects of achieving this include planning the presentation of information during the design process around the content, language and form of the communication (IDA, 2017).

User experience is at the centre of effective information design as it encompasses users' attitudes, emotions and interactions while using a product or service (Norman, 2002). It covers all aspects of a user's interaction while trying to achieve a goal, and particularly relates to how a person feels when using the tools required to achieve that goal (Norman & Nielsen, 2017; Kraft, 2012). An exemplary user experience is considered to be a process whereby a person can achieve their goal and have their needs met in an enjoyable and seamless manner (Norman & Nielsen, 2017). This is of utmost importance within hospitals where multiple processes must align smoothly. When clinicians interact with various interfaces (such as other people, technology or departments), it has the potential to result in a disjointed user experience (Norman, 2011). The implications of a poor user experience in the healthcare sector must be considered in the context that clinicians operate in - the large amounts of data they process to make clinical decisions ultimately affect patient health and safety (Trbovich, 2014). Making improvements to the design of processes and equipment are considered essential ways to reduce errors and promote patient safety (ibid.).

Contextual review

Clinical guidelines

Information design

Conclusion

Large organisations within healthcare have shown an understanding of the importance of how they communicate complex information to their audiences. There is now wide recognition that audiences vary in how they engage with the communication due to their particular understanding or belief system (Tyler, 1992). For this reason, it is important that users play a vital role in the information design process to discover the best approach to creating a positive experience (ibid.). The ease of using a product is a key consideration of user experience and relates to how easily understandable it is without prior learning (Norman, 2011; Norman & Nielsen, 2017).

In order to make information more usable it needs to produce a desirable internal state for the user, in terms of both reducing cognitive load and promoting positive emotion. User experience considerations focus on these two key areas to promote good behavioural design and satisfy the requirements users have of the product (Norman, 2004). An aesthetically pleasing design will work better with the user; as Norman (2004) states, "attractive things make people feel good, which in turn makes them think more creatively, making something easier to use, [and] find solutions to the problem they encounter" (p. 19).

Conversely, if users cannot easily understand how to achieve their goals, they become confused and frustrated, and negative emotions are associated with the product (ibid.). This is important for information design in healthcare as negativity results in a narrowed thought process and can impair decision-making ability (Norman, 2004).

On the other hand, if user experience is enhanced it has the ability to promote the learning of information and retention (Norman, 2011). An example of enhancing user experience through reducing cognitive load is evident in the widespread use of iconic interfaces to reduce system complexity in medical emergency information settings (Salman, Cheng, & Patterson, 2012). Well-designed and easily recognisable icons reduce the complexity of interpreting information so that the cognitive effort required to make a decision is reduced (ibid.). In understanding the user experience as a whole within a particular healthcare context, iconic interfaces can be effectively employed across the technologies that are convenient to clinicians (Anwar, Joshi, & Tan, 2015; Salman, Cheng, & Patterson, 2012). The accessibility of mobile devices within healthcare and advances in e-health informatics provide an opportunity to improve information design and enhance the user experience of clinicians in emergency settings (Anwar, Joshi, & Tan, 2015).

Contextual review

Clinical guidelines

Information design

Conclusion

Graphic Design

Graphic design has the ability to elevate clinical guideline communication, improving clinicians' retention and decision-making in medical practice; the discipline of graphic design is to visually communicate ideas and messages concisely (Barnard, 2005). Thus, a considerable facet of design involves understanding, analysing and strategising the narration of information, which in turn influences the overall communication goal (Bergström, 2008). Crafting specific messages in an accessible and comprehensive manner to intended audiences requires exploring ways in which rhetoric, imagery, typography, layout and form can cohesively enhance communication (Visocky O'Grady & Visocky O'Grady, 2008).

In medicine, the daily expansion of medical information threatens the ability for clinicians to remain up-to-date with advancements in their fields (Zender, Pestian, & Glauser, 2010). Another factor affecting clinicians' ability to find and adopt medical information is due to time pressures in clinical practice and surgery (Clarke, Belden, Koopman, Steege, Moore, Canfield, & Kim, 2013). The ways in which information is presented has a major impact on its accessibility and use within practice (Lamy, Duclos, Bar-Hen, Ouvrard, & Venot, 2008). Visual design can improve both the efficiency and accuracy of recognition of medical ideas and their relationships, encouraging users to convert raw data into

usable information and knowledge (Zender et al., 2010). Compared to written information, visual outputs such as graphs and tables enable greater efficiency when analysing large quantities of quantitative medical data. Iconography and pictograms aid the reading and navigation of large amounts of text (Lupton, 2010).

Graphic design aids the processing of information as humans have a dominant ability to remember and recognise graphics and patterns cognitively; visual data can rapidly accelerate the comprehension of information amongst clinicians (Krum, 2014). A clinical study by Lamy et al. (2008) evaluated the comprehensibility of clinicians adopting medical information expressed using Visualisation Medical Knowledge (VCM) methods compared to text-based information. The results show that clinicians using VCM were able to adopt information more rapidly and accurately than text-based information. As words are not particularly ocular and have no visual relationship to what they represent or communicate, iconography enables concepts and ideas to be conveyed quickly compared to written language and has the capability to be universally understood unlike words which are language specific (Lupton, 2010; Ware, 2004). Communicating complex medical information in a visual format can improve clinical decision-making and learning experiences.

Contextual review

Clinical guidelines

Information design

Conclusion

The incorporation of basic visual forms in clinical guidelines enables information to be easily summarised, making it faster for clinicians to scan and navigate through content (ibid.). In comparison to the current text-based guidelines implemented within Auckland DHB, graphic design can improve guideline engagement and efficiency amongst clinicians in complex, stressful perioperative environments. By condensing long text-based information into specific recommendations and visualisations, clinicians can rapidly make effective decisions within medical practice.

At present, clinical guidelines at Auckland City Hospital lack graphical design elements in their presentation, causing information overload and uncertainty amongst practising clinicians. Guideline use and etiquette, as a result, is not widely embraced in medical practice. Clinical guideline information currently consists of vast amounts of written text occurring in large format documents, which take time to read and decipher. Although the discipline of graphic design is often overlooked by clinicians and researchers when developing clinical guidelines, it has a key role to play in enhancing efficient and accurate decision-making in healthcare contexts, while also educating and engaging with practising clinicians.

Contextual review

Conclusion

Contextual review

Clinical guidelines

Information design

Conclusion

Clinicians at Auckland City Hospital reported facing a number of difficulties in using clinical guidelines effectively and efficiently to make accurate healthcare decisions. Clinical guidelines were difficult to access in the required contexts, and the information contained was often complex and hard to decipher. These difficulties in effectively using clinical guidelines resulted in fewer clinicians making use of the guidelines due to time pressure or assumptions made about the usefulness or relevancy of the information they contain. The senior anaesthetists identified opportunities to explore the use of design to improve clinical guidelines to be more accessible and usable; a need that can be addressed by utilising information design principles. These principles focus on refining structure in the information, making the information cognitively and physically accessible in the required healthcare contexts, and improving the visual representation of information by employing graphic design and reducing the amount of text that has to be read. Applying these principles to clinical guidelines may improve the frequency with which they are used, enhancing the accuracy of healthcare decisions and ultimately making clinical processes more efficient. In all, a greater healthcare experience can be achieved across both clinical professionals and receivers of healthcare.

Methodology

Methodology

Action research

In order to design clinical guidelines that promote accuracy, efficiency and best practice in healthcare, it is essential to understand the wider context in which clinical guidelines are used. From guiding a doctor through making a decision about the appropriateness of a treatment for the first time, to a pharmacist accurately filling patients' prescriptions, all facets of the healthcare system must be considered when designing effective clinical guidelines. With this objective in mind, this research required a holistic approach to understanding the complex, varied and interacting processes currently impeding the efficacy of clinical guidelines.

Research frameworks

Ethics

Research timeline

Methods

A natural starting point for scoping the field is through qualitative research as it lends a depth of individual perspective unable to be gleaned from traditional quantitative (data-based) approaches, through harnessing a person's subjective experience and expertise.

Qualitative research is a means for exploring and understanding the meaning individuals or groups ascribe to a social or human problem. The process of research involves emerging questions and procedures; collecting data in the participants' setting; analyzing the data inductively, building from particulars to general themes; and making interpretations of the meaning of the data. (Creswell, 2014, p.294)

This first phase of research is critical in shaping the next steps. Through the insights gained during the qualitative phase, I was guided down a naturally developing path of discovery, each conversation yielding new information, new questions and new potential issues to accommodate. Such an approach to research is termed 'action research', where the research cycles through iterative stages of discovery and refinement, continually improving as it is tested with users (Swann, 2002).

Methodology

Action research

As an overarching goal of the research is to design effective communications, the audience or user is ultimately placed at the centre of the research process by employing a human-centred design framework to ensure that communications are understood and meet the needs of the end user

Research frameworks

(Greenhouse, 2012). A key component of this study is to work in conjunction with all users of clinical guidelines in the context of haematology-related guidelines in Auckland City Hospital, whether they are directly following the guidelines or dealing with information submitted through the guidelines as indirect stakeholders. To accommodate such a range of individual experiences, the design process needs to be participatory in nature, obtaining the personal perspectives of all stakeholders involved in each stage of the project and using their insights to further refine clinical guideline design (Kang, Choo, & Watters, 2015; Sanders & Stappers, 2014).

Ethics

Research timeline

Methods

Recognizing people as the primary source of innovation is crucial in order to reach designs that will serve the needs of the people who will work, learn or teach with the designed tools. (Durall & Leininen, 2014, p. 109)

In summary, this research will employ the frameworks of human-centred design and participatory design using an action research approach, which continually develops, informs and refines the final outcome. The value in combining these frameworks using a cyclic, analytical approach to problem solving is that the resulting design is optimised for relevancy, accessibility and functionality, all while maximising buy-in among users due to their involvement in the process.

Methodology

Action research

Methodology

Action research

Research frameworks

Ethics

Research timeline

Methods

Action research is essentially a cyclical form of enquiry which involves four key components: planning, acting/implementing, observation and reflection (Swann, 2002). The value in action research lies in a designer's reflection on their actions throughout the entire research process; these reflections inform new iterations of their design to further improve its efficacy (Schön, 1983; Figure 1).

To adequately understand this range of experience and perception, it is essential to undertake an action research approach to investigating and collaborating with users of clinical guidelines (Figure 2). From this initial collaborative starting point, the discussion of guideline users' needs and barriers stimulates the design cycle – entering the next phase of action research requiring the initial findings be put into design action (Swann, 2002).

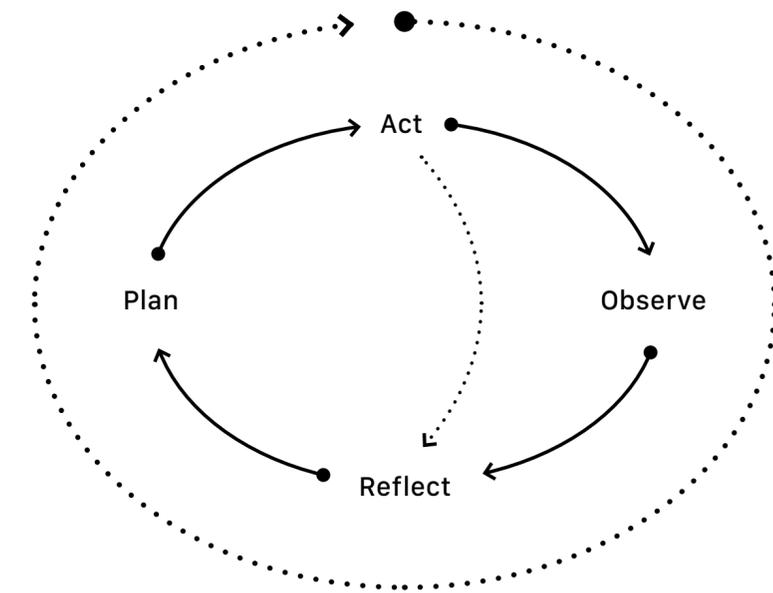


Figure 1.
Schön (1983). Action research process.

Methodology

Action research

Research frameworks

Ethics

Research timeline

Methods

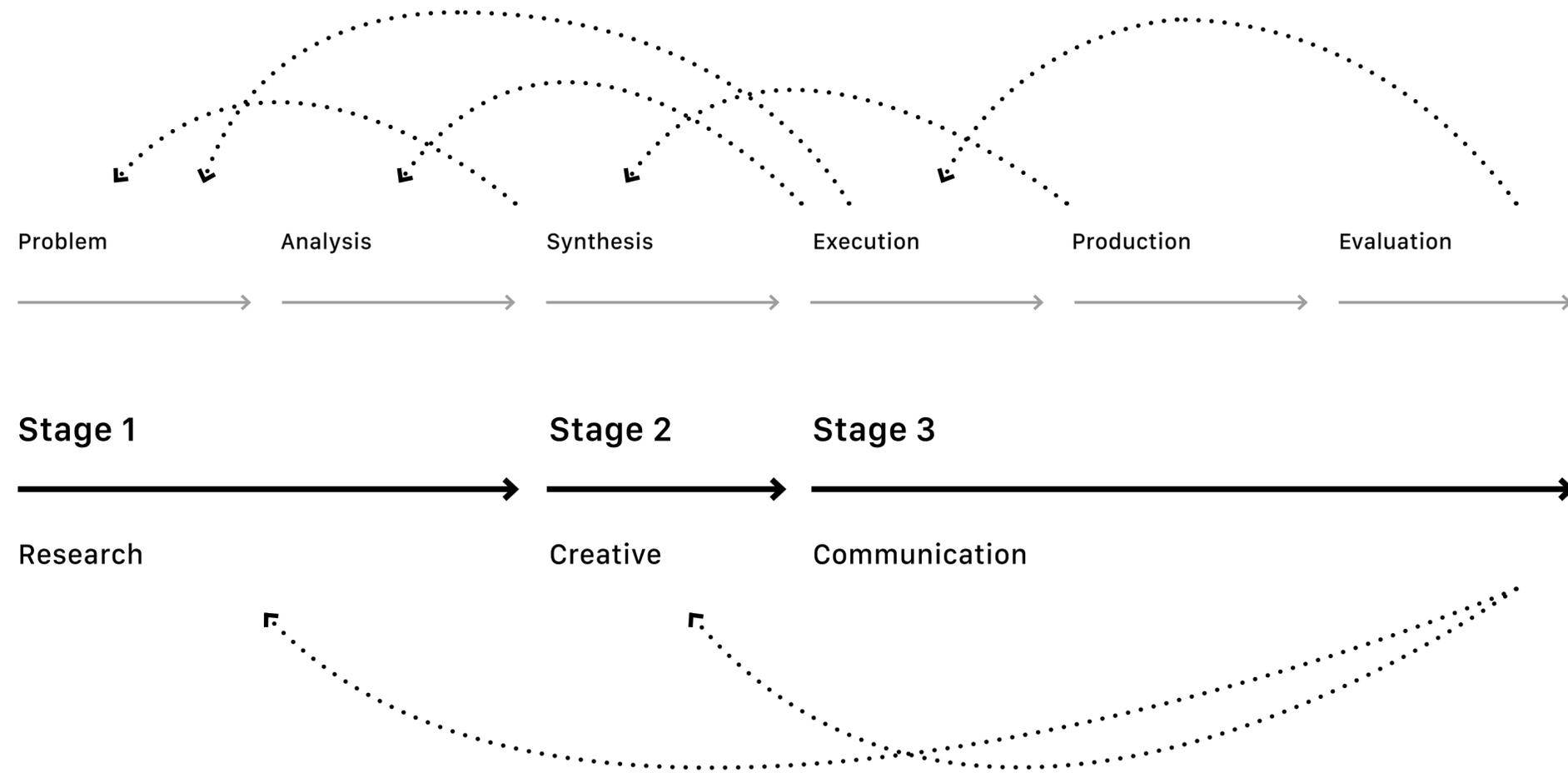


Figure 2. Swann. (2002). Design journey. Action research is an iterative design process, "it can only be effective if it is a constant process of revisiting the problem, reanalysing it and synthesizing revised solutions" (p. 53).

Methodology

Action research

Research frameworks

Ethics

Research timeline

Methods

One cycle of an action research model is carried out as follows: the first phase requires identifying a problem and devising a plan to address the issue (Swann, 2002). Following this phase, the plan is implemented and then evaluated based on an appropriate assessment of how it performs in the natural environment (Swann, 2002; Somekh & Noffke, 2003). The final phase of reflection requires consideration of the whole process and outcomes of the evaluation, which may lead to identifying new problems. This reflection then naturally leads into a further cycle of "planning, acting, observing and reflecting" (Swann, 2002, p. 55).

The process of research is cyclical and focused both on producing new knowledge and on creating actions which will affect directly the social situation in which the issue emerges. It is temporal, as well as cumulative. (Somekh & Noffke, 2003, p. 92)

The nature of action research is that it does not come to a natural and obvious conclusion (ibid.). Continual cycles of reflection and planning can lead to discoveries of issues outside of the scope of the research focus. It becomes necessary for the researcher to define a point at which the outcome meets the key objective of the research by consulting with stakeholders and users (also a necessary component when utilising a participatory design framework).

Methodology

Research frameworks

Methodology

Action research

Research frameworks

Ethics

Research timeline

Methods

Human-centred design

Human-centred design enables users to function at optimal capacity as it requires the users' needs to be placed at the center of the design process, rather than users having to adapt their physical or psychological processes to suit the design (Greenhouse, 2012; Figure 3). Such a framework focuses on users and their tasks early in the research process and is grounded in information about users in terms of their physical needs, cognitive ability, task requirements and barriers to use (Greenhouse, 2012; Travis, 2009).

A human-centred design process is informed by users' behaviour in natural contexts, rather than design solutions being formulated in a controlled environment based on assumptions about the 'average' user (IDEO, 2015). It involves an empathetic and collaborative process of working with users to understand their patterns of decision-making and thinking (Young, 2015). Learnings gained from users' in-depth knowledge of their needs are applied to the creative process, in order to formulate an empathetic solution to the problem (IDEO, 2015; Young, 2015). Users are treated as experts in this process and their knowledge informs prototypes which can be further refined to optimise functionality and usability (IDEO, 2015). Through a human-centred design framework, this approach results in products or services that are physically, emotionally and cognitively intuitive (Giacomin, 2014).

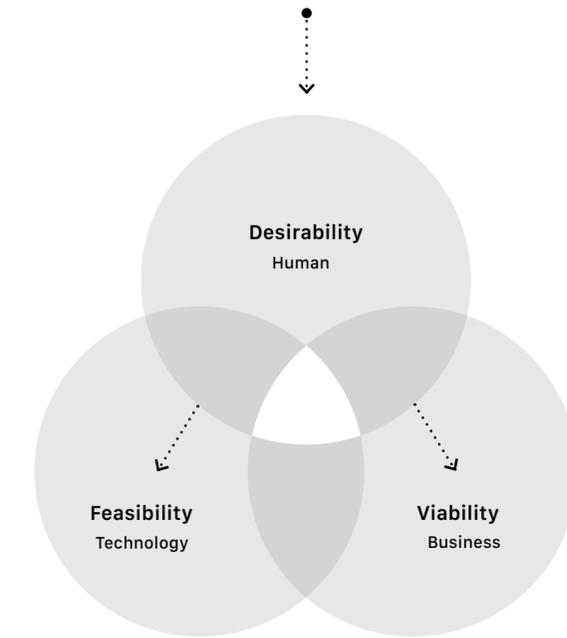


Figure 3.
IDEO. (2015). Creating real impact.

An ineffective design solution, in this context, is a reflection of an incomplete understanding of users' needs; ultimately, this means the design is at fault rather than the user not understanding the design (IDEO, 2015; Norman, 2002).

A human-centred design framework is essential to the success of clinical guideline design in order to understand how an individual's subjective thoughts and emotions affect their decision-making in the naturalistic healthcare settings in which these decisions are made. As Jones (2013) suggests, while human decision-making is widely recognised as logical and rational, in reality it is affected by numerous factors relating to a person's individual experience and education, and prior assumptions held about similar healthcare situations. Human decision-making is largely affected by an individual's emotions and cognitive biases, particularly when they are required to make decisions under pressure (such as in healthcare settings). Recognition of the user's individuality—their emotions and experiences—demands a particularly in-depth approach to guideline design.

Methodology

Action research

Research frameworks

Ethics

Research timeline

Methods

Participatory design

Within participatory design, the most critical part of this approach is working in partnership with guideline users, designing both for and with the user in a shared mindset driven toward discovering solutions (Sanders & Stappers, 2014; Figure 4).

To engage users in the design process, various methods are employed to facilitate coordination between the designer and end users throughout the process, such as probes, toolkits, and prototypes (Sanders & Stappers, 2014; Robertson & Simonsen, 2012). These methods are used to stimulate users and stakeholders into thinking and experiencing future ideas and concepts beyond their existing perceptions. This process involves a collaborative translation of meaning and construction of solutions (Sanders & Stappers, 2014; Figure 5). The benefits of participatory design can include clarifying "goals and needs of users, designing coherent visions for change, initiating participation and partnerships with different stakeholders, conducting iterative experiments aimed at organizational change and managing stepwise implementation based on comprehensive evaluation [from users]" (Simonsen & Hertzum, 2012, p.10).

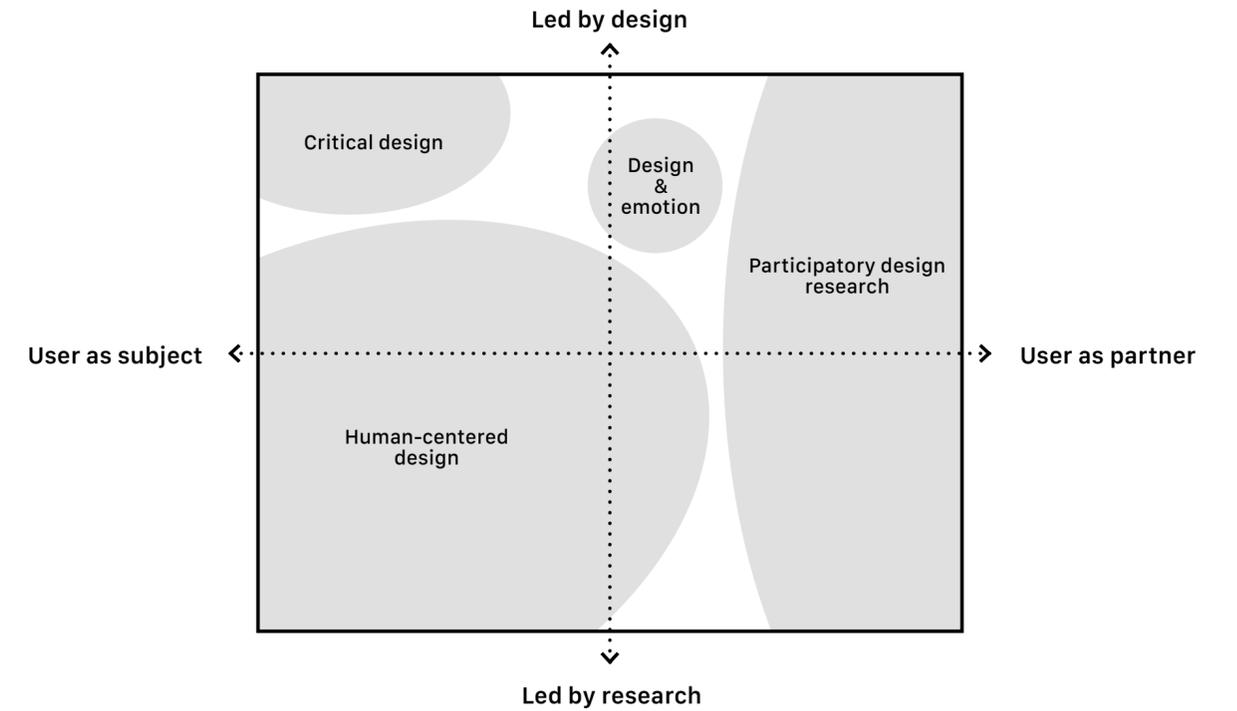


Figure 4. Sanders & Stappers. (2014). Map of design research

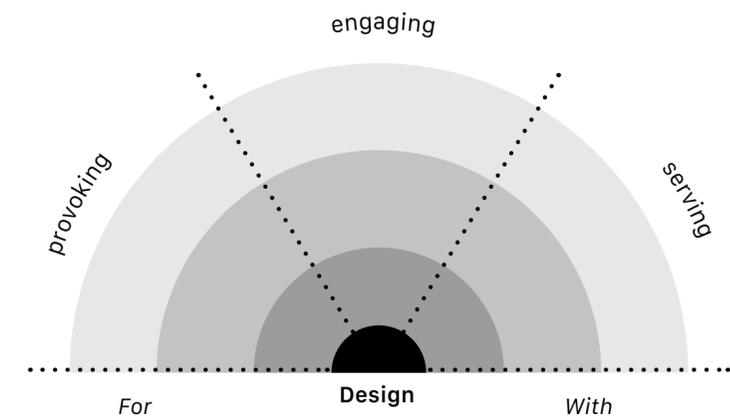


Figure 5. Sanders & Stappers. (2014). Movements across design

Methodology

Action research

Research frameworks

Ethics

Research timeline

Methods

Within this approach, the role of the designer is to facilitate the discussion of ideas with guideline users and extract their subjective expertise in handling guidelines in their day-to-day lives (Manzini & Rizzo, 2011; Luck, 2003). Design devices including prototypes, mock ups, models and sketches are used as participatory design tools to trigger new actions and sequences among users within the process (Manzini & Rizzo, 2011).

Methodology

Ethics

Methodology

Action research

Research frameworks

Ethics

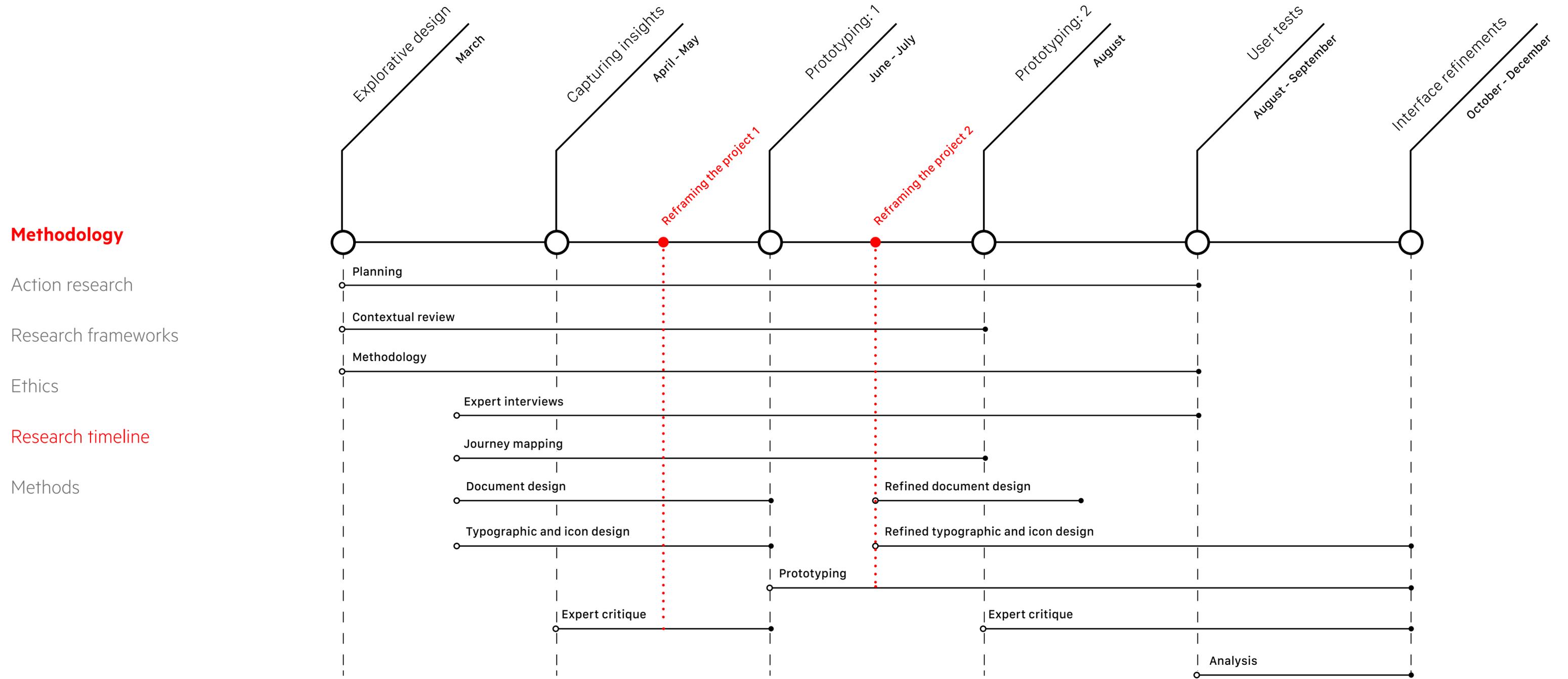
Research timeline

Methods

This research was situated within Auckland City Hospital and involved collaborating with clinicians through expert interviews and user tests. Within the framework of human-centred design, participation was required in order to validate or challenge assumptions, to ensure that the proposed design was applicable not only to clinicians, but also to stakeholders and staff. As well as expert interviews and conducting user tests, participation within the research also involved feedback on design solutions. Due to complexity of this research, working alongside a software developer funded by the Joint Anaesthesia Faculty of Auckland Trust Board was extremely beneficial. Furthermore, clinicians (both novices and experts) and pharmacists were the participants in this research, as its focuses on their user experience when accessing and using clinical guidelines. Formal ethical approval for this project was given by AUTEK on 3 August 2016 (number 16/164). See Appendix 1 (p.159) for ethics approval.

Methodology

Research timeline



Methodology

Action research

Research frameworks

Ethics

Research timeline

Methods

Figure 6. Thornhill, B. (2017). Research timeline.

Methodology

Methods

Methodology

Action research

Research frameworks

Ethics

Research timeline

Methods

Literature review

A literature review summarises and describes theoretical perspectives in the field of chosen interest and helps researchers to orient their own project around previous findings of relevance to the problem at hand (Leedy & Ormrod, 2010; p. 66). By reviewing the relevant literature, the researcher becomes well informed about the state of knowledge in their field of interest (Gray, 2009).

An extensive literature review was conducted early in the research to gain a comprehensive understanding of the topic of clinical guidelines within perioperative practices and environments.

Initially, the focus of the review included literature on the establishment of clinical guidelines within healthcare, their use and impact, accessibility and design. The review involved note taking and summarising key themes and continued to develop throughout the project as the focus of the research became more refined. Further topics of enquiry included information design and its multiple disciplines; information architecture, audience and users, and visual communication.

Methodology

Action research

Research frameworks

Ethics

Research timeline

Methods

Expert interviews

[In a] contextual inquiry, the focus is on the exploration of the socio-cultural context of design. The aim is to understand the environment, situation, and culture where the design takes place. The results of the contextual inquiry are better understanding of the context by recognizing in it possible challenges and design opportunities. (Durall & Leinonen, 2014, p. 110)

Talking with expert clinicians (within their fields of anaesthesiology and haematology) enabled me to gain valuable perspectives and a holistic understanding of their areas of expertise. Through the inspiration phase of a project, experts can help inform researchers about recent innovations, including successes and failures, as well specific technical advice (IDEO, 2015). As a researcher, being curious and gaining empathy of other people's perspectives while listening can help develop stronger solutions collectively and impact on the way in which work is produced (Young, 2015). Expert interviews were used to gain a holistic understanding of the context, and to identify the perception of current clinical guidelines among healthcare practitioners at Auckland City Hospital. The experts interviewed come from a variety of backgrounds within healthcare, from clinical directors to registrars and house officers.

They were contacted through the department of anaesthesia, the specialist anaesthetist, or directors of the DHW Lab. All experts were based at Auckland City Hospital. Interviews with experts were semistructured as eight questions were used as prompts. Intuitive questions were further asked throughout the interviewing process enabling deeper insight to be gained from interviewees. All interviews were conducted in person and the interview locations varied due to time and availability of the participants involved. The experts who were interviewed came from a range of medical backgrounds, allowing for a comprehensive understanding through various mindsets and viewpoints, given the complexity of the problem.

Interviews were held with me facilitating the conversation while audio recording the conversation so details were not missed or overlooked. I took reflective notes after each interview to retain what was expressed by participants, then the audio recordings were transcribed. By waiting until the end of the interview to write down data and insights, a comfortable engagement and discussion was established between the researcher and expert, which helped me to intuitively tailor the interview as topics of interest were presented accordingly.

12 A **touchpoint** is defined by Stickdorn & Schneider (2011) as, "a contact point between a customer using a service and its provider."

Methodology

- Action research
- Research frameworks
- Ethics
- Research timeline

Methods

Journey mapping

A journey map is a strategic tool that visually captures critical insights into complex interactions that occur across an end user's experience within a service or ecosystem (Adaptive path, 2013). Mapping is a useful tool for capturing human interactions that occur at various touchpoints¹² throughout their journey. The incorporation of end users within the process builds knowledge and insight as behavioural patterns are realised within the journey process (Young, 2015). By identifying and separating the different touchpoints of the end user's experiences, the researcher / designer can develop design solutions to better enhance the user experience (Adaptive path, 2013). A journey map was used in the early stages of this project, following the gathered knowledge obtained from the clinicians in the expert interviews. This helped to position and develop design solutions within the overall user experience of guideline use within Auckland City Hospital (Figure 7).

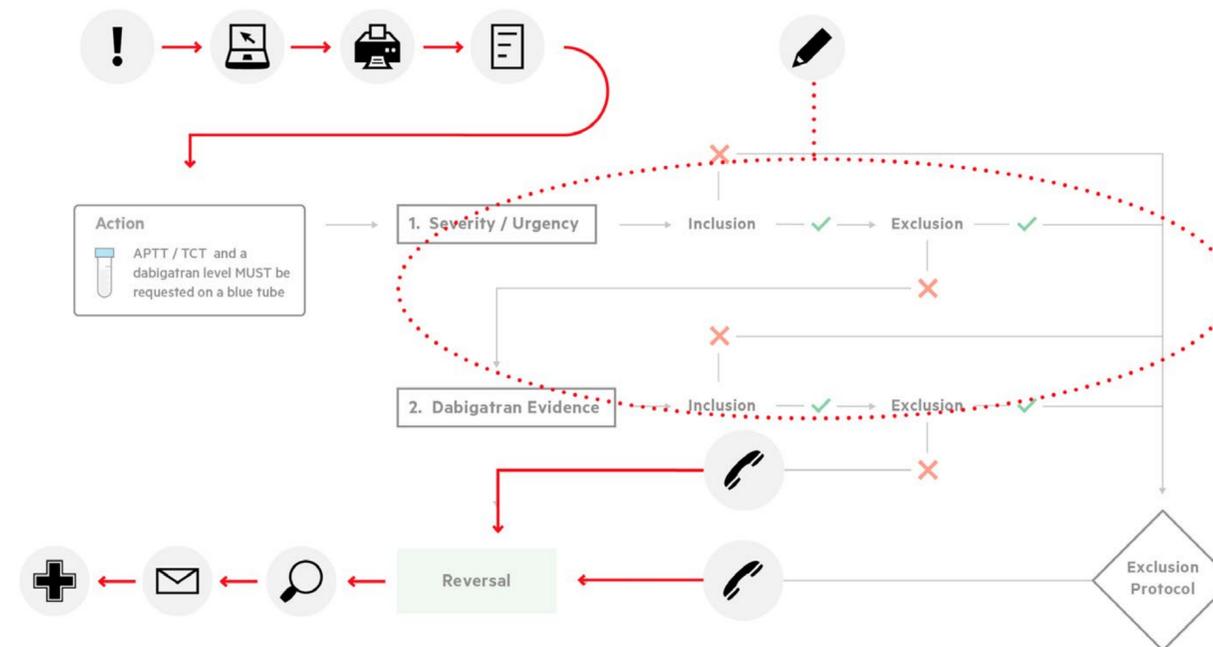


Figure 7. Thornhill, B (2017). Clinician journey map

Methodology

Action research

Research frameworks

Ethics

Research timeline

Methods

Review and analysis of existing guidelines

An analysis and review of existing clinical guideline designs from multiple platforms and databases was undertaken to better understand the design and execution of clinical protocols within healthcare. This was achieved by searching various web-based guideline databases (international and national), including the internal Auckland DHB intranet resource used by clinicians within Auckland City Hospital. Various guideline designs were printed and documented where notes and comparisons were made (Figure 8). Furthermore, the downloading of medical guideline smartphone applications explored the future possibilities of guideline execution and accessibility. Throughout this process, notes, screen shots and first impressions were documented through the eyes of the first time user. These approaches explored how clinical guidelines were accessed and perceived, both for the user and the stakeholder. Although the clinical guidelines archived ranged in medical practices and contexts, relevant themes were realised and categorised that reflected clinical guideline design principles.

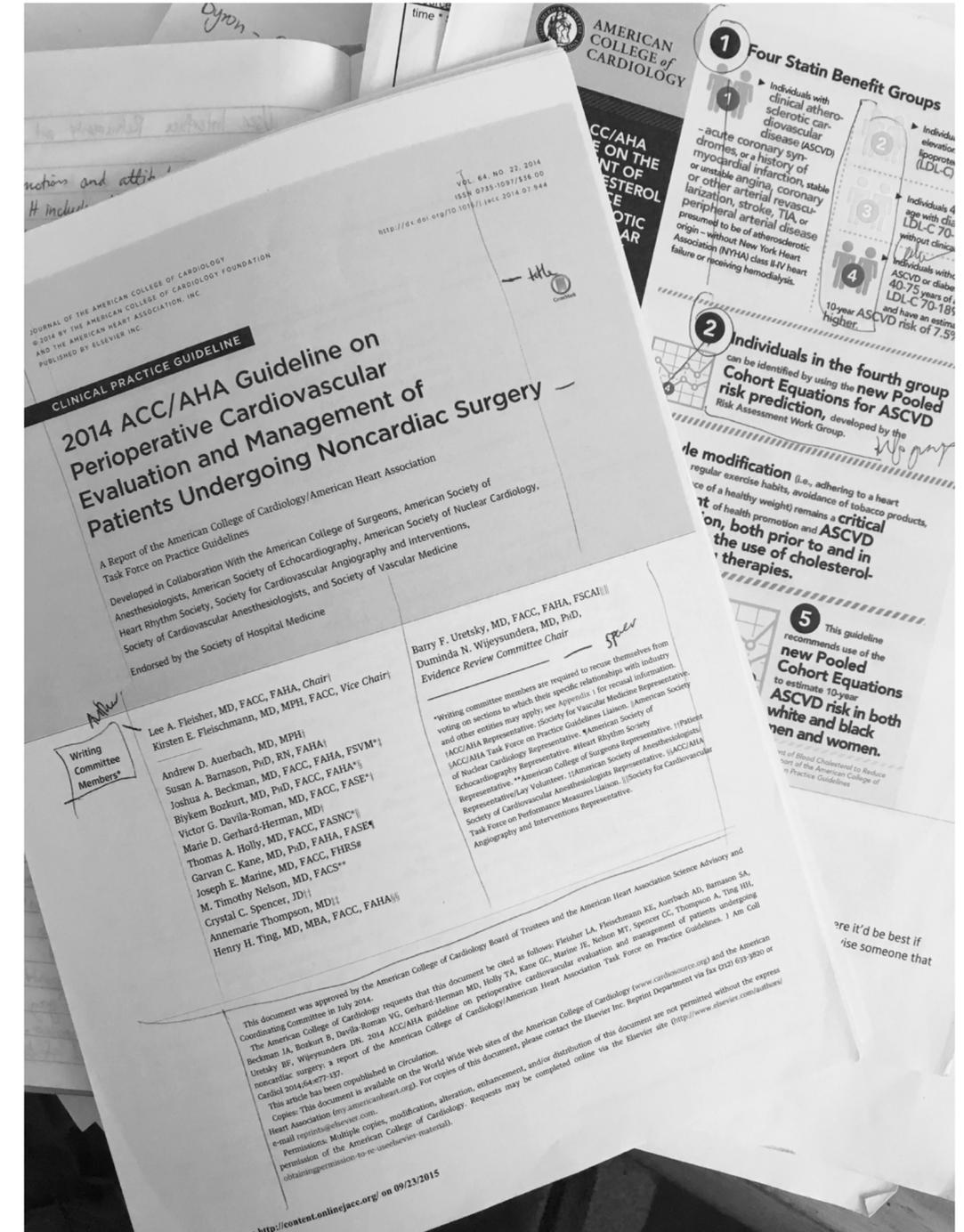


Figure 8. Thornhill, B (2017). Clinical guideline review and analysis.

Methodology

Action research

Research frameworks

Ethics

Research timeline

Methods

Research journal

The keeping of a research journal is described by Newbury (2001, p. 2) as a method to “facilitate research processes via the recordings of observations, thoughts and questions as they happen, for later use by the researcher, and to stimulate reflective thinking about the research.” Throughout this research process, the collection of insights, ideas and explorations was documented. This enabled the ability for past thoughts and revelations to be correlated and reflected on, influencing the discovery of how to resolve the problems faced within clinical guideline design and its impact amongst clinicians in perioperative settings.

Throughout the research process, documentation was archived using a text book, A4 filing sleeves and later included digital documentation. Theory, planning and practice within the research were documented conjointly, influencing design decisions for potential solutions. Initially, the use of a research journal involved the gathering of notes, possible ideas and concepts.

As the research progressed further, sketching, information wireframes and planning of exploratory concepts were documented for further execution. In addition to the bound journal, digital documentation included the collation of refined concepts and thoughts that were initiated and realised through reflection. As a more formal analysis tool, digital documentation was used to review and compare ideas that were considered important to the research.

Methodology

Action research

Research frameworks

Ethics

Research timeline

Methods

Prototyping

Prototyping is an effective method for testing design ideas and concepts in a clear and tangible manner (Prototype, 2015; IDEO, 2015). An integral component within the design process, prototyping allows designers to observe and evaluate early models of a product when in use. Learning is promoted through process making, and enables the designer to quickly gather feedback from the people being designed for (IDEO, 2015). If a prototype reveals problems, designs can then be modified and built on as ideas and concepts are further explored. As an iterative method to refine products and processes before large scale implementation, final products often go through several rounds of prototyping cycles before the design is finalised.

Paper prototyping was used in the initial stages of this project as it enabled me to test design ideas and solutions instantaneously, to meet the clinicians' expectations and needs. Paper prototypes consisted of low fidelity drawings and concepts, arranging multiple layers of information in order to gain a greater understanding of the design problem.

Wireframing is another facet of prototyping depicting a visual guide that represents the skeletal framework of a website or application (Brown, 2010). Also, described as screen blueprints, wireframes are purposeful within their creation, arranging basic elements, content areas and page navigation usually informed by business objectives or a creative idea (Brown, 2010; Lupton & Cunningham, 2014). Wireframes portray a simplified view of what the content will look like within the final product, avoiding colour, typographical styles and images. This is to avoid designers getting too involved in early conversations about visual elements and instead focus on the essential structure and functionality of the information within the website or application. Wireframes allow engagement by the whole project team, including developers, designers and stakeholders as they validate requirements and make it more likely the design will meet objectives (Brown, 2010).

Methodology

Action research

Throughout this research process, the use of wireframes enabled me as researcher, the software developer who worked with me, and stakeholders to establish the functionality, behaviours and relative priorities in regard to the content within the guidelines presented.

This way of working was largely due to the restraints within the project, where medical content and information consisted of convoluted language that wasn't easily understood by me. However, once an understanding of the information had been gained, a functional skeletal framework was realised.

Research frameworks

Ethics

The original guidelines supplied by the specialist anaesthetists were interpreted into basic structural skeletons to gain a clearer understanding of how the content and resulting clinical decisions needed to function within a clinical setting. This approach explored a variety of concepts and resolutions regarding how to navigate through the guidelines content and an understanding of how to group relating content together.

Prototyping enabled user involvement at an early stage within the project where insights were discovered and built on throughout the process, meeting stakeholder expectations within the project.

Research timeline

Methods

Through efficient wireframing, guideline content can be suitably structured to parallel clinical services and processes within perioperative environments situated at Auckland City Hospital. Workshops involving key stakeholders were established to gather an expansive overview of clinical scenarios and their decisions. Stakeholders from various medical backgrounds, including haematology and anaesthesia, helped initiate the design process and were able to elaborate on the functional details as well as gaining access to the projects feasibility.

¹³ Nielsen Norman Group (2014) defines **task scenario user tests** as tests that “engage participants by writing task scenarios that are realistic, encourage an action, and don’t give away how the interface should be used.”

Methodology

Action research

Research frameworks

Ethics

Research timeline

Methods

User testing

Within human-centred design, user testing is a method used to evaluate a product or system by testing with its users. It’s described by Nielsen (1993) as an irreplaceable practice, as it gives insight on how users use a system or product. In this research, user tests were conducted to measure the capacity and usability of the Idarucizumab guideline smartphone application and whether it meets its intended purpose amongst clinicians and stakeholders at Auckland City Hospital. This involved task scenario user tests¹³, guided by nonspecialist and specialist clinicians who represent the guidelines user group. The user tests were facilitated, observed and video recorded within the guidelines intended environment, the operating rooms situated on level 8, Auckland City Hospital.

A total of twelve user tests were conducted involving eight nonspecialist clinicians (novice users) and four specialist clinicians (expert users). Clinicians were initiated and recruited into the research via the Department of Anesthesia’s administration team, who supplied contact names and phone numbers. Due to the clinician’s time restraints and pending responsibilities, user tests were designed to be efficient and in a location in the hospital that suited each individual clinical (the hospital's surgical facilities, a surgical meeting room between two operating theatres).

Four clinical scenarios were supplied by the specialist anaesthetists that represented likely or common clinical situations (see Appendix 2, p.163).

The user test material was designed to establish clear goals and tasks for the clinicians to perform, all of which had different outcomes and involved different processes. Usability tests included pre-test and post-test questions as well as a reaction card to gather further insights and analysis on the guideline applications' service and design (see Appendix 2, p. 164). These questions emerged from early research and the subsequent understanding of clinical guideline use within perioperative environments. Initially novice users were tested, to gain a fresh perspective and understanding of how the application functioned as senior anaesthetists had assisted me along the Idarucizumab design process. Subsequently, advanced users were tested, enabling a deeper understanding and evaluation of each scenario. Three of the four advanced users were also stakeholders within the Idarucizumab's guidelines creation. As patterns and discoveries within the user tests were identified, expert analysis fortified discoveries and suggestions made by novice users.

Methodology

Action research

Research frameworks

Ethics

Research timeline

Methods

Stakeholder critiques

Regular meetings, presentations and workshops were maintained with Auckland DHB stakeholders throughout this research (Figure 9). This ensured clarity and understanding of the project's objectives and outputs. Communication between all stakeholders informed the progress and findings of research. Weekly meetings enabled further opportunities to gain and receive feedback on processes and ideas, and to jointly solve challenges regarding accessibility and feasibility within the project. Feedback meetings and workshops included regular meetings with specialist anaesthetists and fellow postgraduate students enabled accelerated problem solving, progress updates, and coordination. These were conducted weekly throughout the project.



Figure 9.
Thornhill, B. (2017). Workshops with the project stakeholders and clinicians.

Documentation of research

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

This research was initiated in late 2015 as a collaboration between the Auckland City Hospital's Department of Anaesthesia and the DHW Lab. Established as a design studio within Auckland City Hospital, the lab is a collaboration between Auckland DHB and AUT. Its goal is to improve healthcare experiences for patients, families and staff. Students at undergraduate and postgraduate levels work with the hospital through the Lab in the real-world context of healthcare (Reay et al., 2015). Initially, consultation was undertaken with anaesthesia department clinicians who wanted to improve the design, distribution, and communication efficacy of clinical guidelines. With the department due to release further clinical guidelines throughout 2016, this research was identified as an opportunity to shape the design of future clinical guidelines. The goal was to present clinical guidelines in a way that helps clinicians to learn more effectively, make well informed decisions, and help them to better remember guideline information in perioperative settings. A specialist anaesthetist became our primary contact once the research began in early 2016. The following chapter discusses in detail the research process of this project.

Documentation of research

Explorative design phase

14 "Gatekeeper" is defined by Farlex Parnter Medical Dictionary (2012) as, "a physician who manages a patient's healthcare services, coordinates referrals, and helps control healthcare costs by screening out unnecessary services; many health plans insist on a gatekeeper's prior approval for special services, in the absence of which the claim will not be covered."

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Initially, the anaesthesia department provided an existing guideline for refinement and development. This guideline addressed the clinical decision-making process that determined the appropriateness of using a specific drug (Idarucizumab). With Idarucizumab undergoing a clinical trial, there were multiple stakeholders in the anaesthesia and haematology departments as well as with the supplier, Boehringer Ingelheim pharmaceuticals. Considering the high price of a single dose of Idarucizumab, strict criteria for gatekeeping¹⁴ its administration to patients needed to be enforced to mediate any risks associated with the use of the drug. These are currently presented in guidelines for use by clinicians who are considering administering the drug. After establishing whether it is appropriate to administer Idarucizumab, clinicians submit the guideline to a specialist for approval. Within this initial stage of the Idarucizumab guideline development, the main focus was to visually refine the way the approval criteria were communicated to clinicians. Formatted on an A4 size printed page, the supplied guideline was text-based, incorporating a number of medical equations that were shown by mathematical formulae, scientific measurement symbols and capitalised abbreviations. Due to the amount of textual information, line spacing between titles and columns was condensed to squeeze all the content on to a single page. (Figure 10).

Coloured sub-headings establish hierarchy between the columns for 'inclusionary' and 'exclusionary' criteria.

The document was formatted into three sections

DABIGATRAN PATIENT: CONSIDERATION OF REVERSAL WITH IDARUCIZUMAB
 Urgent APTT, dTCT and (if available) a dabigatran level **MUST** be requested on a blue tube

STEP 1: SEVERITY/URGENCY

<p>INCLUSION – 1 MUST BE MET</p> <ul style="list-style-type: none"> • Acute intracranial or spinal haemorrhage • Chronic subdural haematoma with neurological impairment • Immediate emergency surgery* • GI bleed with significant haemodynamic instability OR an urgent procedure must be performed within 2-3 hours • Major trauma • Other massive bleed with immediate threat to life 	<p>EXCLUSION: REVERSAL NOT APPROPRIATE</p> <ul style="list-style-type: none"> • Elective surgery • Surgery can be deferred with a conservative alternative strategy • Surgery would be needed but not a candidate due to comorbidities • Treatment likely futile/palliative • Local measures to arrest bleeding could be undertaken while anticoagulated • Last dose more than 24 hours prior unless CrCl <30ml/min
--	---

STEP 2: EVIDENCE OF DABIGATRAN EFFECT

<p>INCLUSION – 1 MUST BE MET</p> <ul style="list-style-type: none"> • DTCT>80 seconds • APTT generally prolonged: if not look closely at the dTCT and dabigatran level • At a minimum a dTCT and APTT must be available for all patients except critical surgery with a door to theatre time of <30 minutes (eg vascular emergencies) 	<p>EXCLUSION: REVERSAL NOT APPROPRIATE</p> <ul style="list-style-type: none"> • dTCT <80 seconds • If the dTCT is < 80 seconds and other coagulation tests are prolonged then consider other causes of coagulopathy
--	--

STEP 3: REVERSAL

<p>CRITERIA IN 1 AND 2 DEFINITELY MET</p> <ul style="list-style-type: none"> • IV idarucizumab 2.5g • APTT/dTCT immediately afterwards • Complete retrospective approval form (the admitting team MUST do this) • Monitor for REBOUND dabigatran: APTT/TCT at 12 hours, 24 hours, if more bleeding or surgery required • Consider thrombotic potential/prophylaxis if appropriate • Supportive care with fluids and rbc/plasma transfusion as indicated by the clinical situation 	<p>CRITERIA IN 1 AND/OR 2 NOT MET BUT</p> <ul style="list-style-type: none"> • APTT > 80 secs } <i>with major bleeding</i> • CrCl <30ml/min } <i>or needing surgery</i> • Surgery cannot be delayed more than 12 to 24 hours without high mortality risk • Thrombocytopenia/aspirin may be relevant • Significant post reversal rebound and surgery needed or bleeding • Consider discussion with local panel re reversal: a quorum of 2 needed
---	---

***Surgery should be deferred as long as safely possible:**

- The coagulation tests must be assessed for step 2 within 2 hours of the procedure to ensure that reversal is still necessary
- IV fluids should be given to enhance clearance
- Most surgical procedures can be undertaken with a dabigatran level of <0.04 µg/L
- Consider intraoperative use of idarucizumab **if bleeding occurs** rather than upfront use

Three labelled steps; each had two columns of bullet-pointed text under coloured sub-headings.

Bold letters were used to highlight the most important content within the document

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Figure 10. Auckland DHB (2016). Original Idarucizumab guideline

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

As a guideline document, the content within the original document was difficult to visually scan and use. Navigation through the guideline information was impeded by the cluttered content, intense colours and lack of a formal layout grid system. The critical steps and procedures were lost among the clutter, making it hard for clinicians to pick out important criteria in the intended step by step process. It was cumbersome to quickly scan and accurately interpret all of the information displayed. A clinician practising acute surgery would not be supported in on-the-spot decision-making on whether or not to administer Idarucizumab to patients. The final design solution needed to enhance the document's usability for clinicians in perioperative settings.

15 Sans serif typefaces are defined by Jong (2006) as "a style of lettering without final serifs, also known as grotesque, lineal or gothic. Traditionally the faces have no beginning or end strokes, and all extenders, bowls and apertures in the line are optically of an equal thickness."

Aa

Metric
7 Weights (thin - black)
1 font family
App - Web Applications
14 weights in total (normal)
large x - height
[Type Foundry: Klim Type Foundry](#)

Documentation of research

Typographic consideration in document design

Explorative design phase

Coming from a background in typographic design, I was interested in exploring how typographic considerations may affect the reading process. To try and make the Idarucizumab guideline readable, I initially explored how more legible typefaces enhanced the text's readability. First, I analysed and compared five font families. I established their key characteristics (e.g. x-height, caps height, glyph variation) to determine which typefaces optimised readability and functionality. The fonts chosen were san-serif typefaces¹⁵ for their enhanced practicality and readability, suited to instruction manuals, headings, and captions (Simmonds & Reynolds, 1994; Schriver, 1997).

Aa

Gotham
8 Weights (thin - ultra)
3 font family
App - Web Applications
40 weights in total
(condensed - normal - rounded)
Large x-height - wide width
[Type Foundry: Hoefler & Co](#)

Capturing insights

Reframing the project: 1

Prototyping: 1

The five font families analysed within the case study are as follows;

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

Aa

Operator
5 Weights (extra light - bold)
3 font family
App - Web Applications
10 weights in total (mono)
Large x-height - narrow width
[Type Foundry: Hoefler & Co](#)

User tests

Aa

FF Clan
7 Weights (thin - ultra)
App - Web Applications
41 weights in total
(normal - condensed - extended)
Large x - height
[Type Foundry: Font Shop](#)

User interface refinements

Aa

Aktiv Grotesk
16 Weights (hairline - black)
App - Web Applications
48 weights in total
(normal - condensed - extended)
Large x - height
[Type Foundry: Dalton Maag](#)

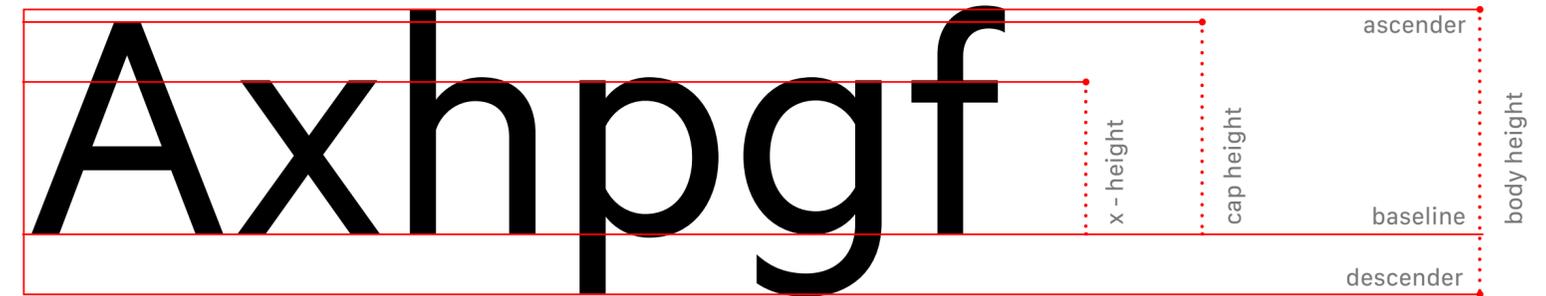


Figure 11.
Thornhill, B (2017). Typeface metric diagram.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Arranged into type specimen posters (Figure 12), each font family was catalogued and compared. Different type styles (regular, italic, condensed, extended) and font features (numeral sets, ligatures and fractions) were analysed for their inclusion of textual medical context. The type specimen posters catalogued the following:

- Font metrics (e.g. x-height, baseline, descender, ascender; Figure 11)
- Font weights (e.g. light, regular, semibold, bold)
- Glyph sets (e.g. accented characters, numeral sets, ligatures and fractions)
- Point sizes (e.g. point size waterfall)
- Body text (flow of continuous text)

16 Feature-rich is defined by Font Shop (2017) as a "font format that offers numerous advanced typographic features. Feature-rich or fully-featured fonts have a large number of those advanced functionalities built in."

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Due to the nature of medical information being presented (such as equations in the guideline), certain characters needed to be included within the overall font system. This included accented characters, numeral sets, math operators, punctuation and symbols. Some fonts were less functional than others, and as a result I considered the metric construction of the typeface to enhance text's readability (Hochuli, 2015). An example of this is where a typeface with a large x-height enables larger lower case letters at smaller point sizes. When individual letters are more recognisable, the readability of words is enhanced, conveying text-based information succinctly. The fonts compared within this case study were all feature-rich¹⁶ to establish typographic hierarchy.

Following this case study, the typeface Metric was selected as the most suitable font family for the guideline document redesign (see Appendix 3, p.166). Along with its typographic features, Metric font's personality aligned with its rational 'medical', instructional application (Sowersby, 2012).

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Typographic refinements to optimise readability

Before establishing the guideline document's format, I explored ways to further enhance the legibility of text when using Metric (Figure 13). A range of typesetting experiments using Metric—incorporating the micro-typographic concerns of kerning, tracking, and line-spacing (Hochuli, 2015)—provided a greater understanding of the design of letters and words before the clinical information was formatted into an organised document (Figure 14). Once the finer details were finalised, the wider design of the document was considered.

1 Severity / Urgency

2 Evidence of Dabigatran Effect

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

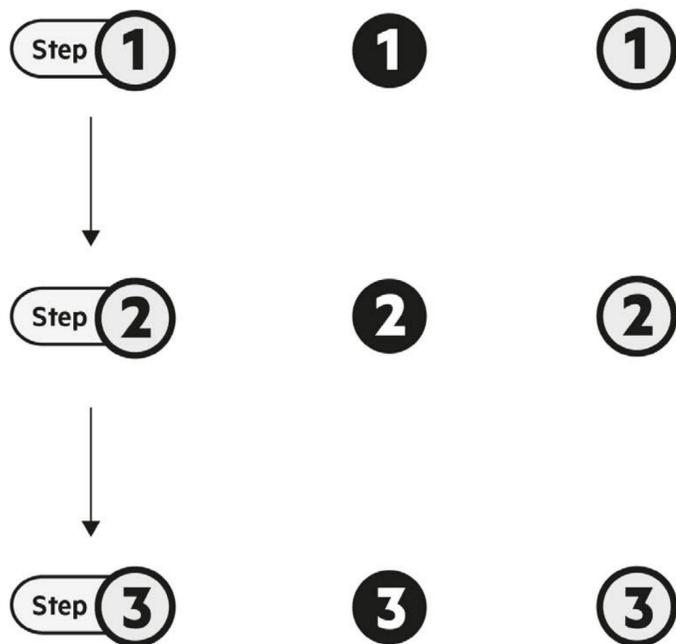
Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements



Inclusion - 1 MUST be met

Inclusion - 1 box MUST be ticked

Exclusion: Reversal not appropriate

Exclusion: Reversal not appropriate
- if any box ticked

Dabigatran Patient: Consideration of Reversal with Idarucizumab

Urgent APTT, dTCT and (if available) a dabigatran level MUST be requested on a blue tube

Dabigatran Patient: Consideration of Reversal with Idarucizumab

Urgent APTT, TCT and (if available) a dabigatran level MUST be requested on a blue tube

Dabigatran Patient:
Consideration of Reversal with Idarucizumab

Urgent APTT, TCT and (if available) a dabigatran level MUST be requested on a blue tube

Criteria in steps 1 and/or 2 not met BUT clinical team prefer to reverse:
phone local panel, 2 approvals to reverse.
Considerations:

Criteria in steps 1 and/or 2 not met BUT clinical team prefer to reverse:
phone local panel, 2 approvals to reverse.
Considerations:

Severity / Urgency
Evidence of Dabigatran Effect
Reversal

TCT < 80 seconds

APTT > 80 seconds } with major bleeding

CrCl < 30ml / min } or needing surgery

Criteria in 1 and 2 Definitely Met

- IV idarucizumab 2.5g
- APTT / TCT immediately afterwards
- Complete retrospective approval form (the admitting team MUST do this)
- Monitor for REBOUND dabigatran: APTT / TCT at 12 hours, 24, if more bleeding or surgery required
- Consider thrombotic potential / prophylaxis if appropriate
- Supportive care with fluids and rbc / plasma transfusion as indicated by the clinical situation

Criteria in 1 and 2 Definitely Met

- IV idarucizumab 5.0g
- APTT / TCT immediately afterwards
- Complete retrospective approval form (the admitting team MUST do this)
- Monitor for REBOUND dabigatran: APTT / TCT at 12 hours, 24, if more bleeding or surgery required
- Consider thrombotic potential / prophylaxis if appropriate
- Supportive care with fluids and rbc / plasma transfusion as indicated by the clinical situation

***Surgery should be deferred as long as safely possible:**

- The coagulation tests must be assessed for step 2 within 2 hours of the procedure to ensure that reversal is still necessary
- IV fluids should be given to enhance clearance
- Most surgical procedures can be undertaken with a dabigatran level of < 0.04ug / L
- Consider intraoperative use of idarucizumab **if bleeding occurs** rather than upfront use

***Surgery should be deferred as long as safely possible:**

- The coagulation tests must be assessed for step 2 within 2 hours of the procedure to ensure that reversal is still necessary
- IV fluids should be given to enhance clearance
- Most surgical procedures can be undertaken with a dabigatran level of < 0.04ug / L
- Consider intraoperative use of idarucizumab **if bleeding occurs** rather than upfront use

Figure 13.
Thornhill, B (2016). Metric micro-typography

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Dabigatran Patient: Consideration of Reversal with Idarucizumab

Urgent APTT, TCT and (if available) a dabigatran level MUST be requested on a blue tube

Step 1 Severity / Urgency

Inclusion - 1 box MUST be ticked

- Acute intracranial or spinal haemorrhage
- Chronic subdural haematoma with neurological impairment
- Immediate emergency surgery *
- GI bleed with significant haemodynamic instability OR an urgent procedure must be performed within 2 - 3 hours
- Major trauma
- Other massive bleed with immediate threat to life

Exclusion: Reversal not appropriate - if any box ticked

- Elective surgery
- Surgery can be deferred with a conservative alternative strategy
- Surgery would be needed but not a candidate due to comorbidities
- Treatment likely futile / palliative
- Local measures to arrest bleeding could be undertaken while anticoagulated
- Last dose more than 24 hours prior unless CrCl < 30ml / min

Step 2 Evidence of Dabigatran Effect

Inclusion - 1 box MUST be ticked

- APTT > 40 seconds (no TCT available)

Exclusion: Reversal not appropriate

- TCT < 80 seconds
- No APTT or TCT (except critical surgery box 3)

Step 3 Reversal

Criteria in 1 and 2 Definitely Met

- IV idarucizumab 2.5g
- APTT / TCT immediately afterwards
- Complete retrospective approval form (the admitting team MUST do this)
- Monitor for REBOUND dabigatran: APTT / TCT at 12 hours, 24, if more bleeding or surgery required
- Consider thrombotic potential / prophylaxis if appropriate
- Supportive care with fluids and rbc / plasma transfusion as indicated by the clinical situation

Criteria in steps 1 and/or 2 not met BUT clinical team prefer to reverse: phone local panel, 2 approvals to reverse. Considerations:

- APTT > 80 seconds } with major bleeding
- CrCl < 30ml / min } or needing surgery
- Surgery cannot be delayed more than 12 to 24 hours without high mortality risk
- Thrombocytopenia / aspirin may be relevant
- Significant post reversal rebound and surgery needed or bleeding

***Surgery should be deferred as long as safely possible:**

- The coagulation tests must be assessed for step 2 within 2 hours of the procedure to ensure that reversal is still necessary
- IV fluids should be given to enhance clearance
- Most surgical procedures can be undertaken with a dabigatran level of < 0.04ug / L
- Consider intraoperative use of idarucizumab if **bleeding occurs** rather than upfront use

Dabigatran Patient: Consideration of Reversal with Idarucizumab

Urgent APTT, TCT and (if available) a dabigatran level MUST be requested on a blue tube

1 Severity / Urgency

Inclusion - 1 box MUST be ticked

- Acute intracranial or spinal haemorrhage
- Chronic subdural haematoma with neurological impairment
- Immediate emergency surgery *
- GI bleed with significant haemodynamic instability OR an urgent procedure must be performed within 2 - 3 hours
- Major trauma
- Other massive bleed with immediate threat to life

Exclusion: Reversal not appropriate - if any box ticked

- Elective surgery
- Surgery can be deferred with a conservative alternative strategy
- Surgery would be needed but not a candidate due to comorbidities
- Treatment likely futile / palliative
- Local measures to arrest bleeding could be undertaken while anticoagulated
- Last dose more than 24 hours prior unless CrCl < 30ml / min

2 Evidence of Dabigatran Effect

Inclusion - 1 box MUST be ticked

- APTT > 40 seconds (no TCT available)

Exclusion: Reversal not appropriate

- TCT < 80 seconds
- No APTT or TCT (except critical surgery box 3)

3 Reversal

Criteria in 1 and 2 Definitely Met

- IV idarucizumab 5.0g
- APTT / TCT immediately afterwards
- Complete retrospective approval form (the admitting team MUST do this)
- Monitor for REBOUND dabigatran: APTT / TCT at 12 hours, 24, if more bleeding or surgery required
- Consider thrombotic potential / prophylaxis if appropriate
- Supportive care with fluids and rbc / plasma transfusion as indicated by the clinical situation

Criteria in steps 1 and/or 2 not met BUT clinical team prefer to reverse: phone local panel, 2 approvals to reverse. Considerations:

- APTT > 80 seconds } with major bleeding
- CrCl < 30ml / min } or needing surgery
- Surgery cannot be delayed more than 12 to 24 hours without high mortality risk
- Thrombocytopenia / aspirin may be relevant
- Significant post reversal rebound and surgery needed or bleeding

***Surgery should be deferred as long as safely possible:**

- The coagulation tests must be assessed for step 2 within 2 hours of the procedure to ensure that reversal is still necessary
- IV fluids should be given to enhance clearance
- Most surgical procedures can be undertaken with a dabigatran level of < 0.04ug / L
- Consider intraoperative use of idarucizumab if **bleeding occurs** rather than upfront use

Dabigatran Patient: Consideration of Reversal with Idarucizumab

Urgent APTT, TCT and (if available) a dabigatran level MUST be requested on a blue tube

1 Severity / Urgency

Inclusion - 1 box MUST be ticked

- Acute intracranial or spinal haemorrhage
- Chronic subdural haematoma with neurological impairment
- Immediate emergency surgery *
- GI bleed with significant haemodynamic instability OR an urgent procedure must be performed within 2 - 3 hours
- Major trauma
- Other massive bleed with immediate threat to life

Exclusion: Reversal not appropriate - if any box ticked

- Elective surgery
- Surgery can be deferred with a conservative alternative strategy
- Surgery would be needed but not a candidate due to comorbidities
- Treatment likely futile / palliative
- Local measures to arrest bleeding could be undertaken while anticoagulated
- Last dose more than 24 hours prior unless CrCl < 30ml / min

2 Evidence of Dabigatran Effect

Inclusion - 1 box MUST be ticked

- APTT > 40 seconds (no TCT available)

Exclusion: Reversal not appropriate

- TCT < 80 seconds
- No APTT or TCT (except critical surgery box 3)

3 Reversal

Criteria in 1 and 2 Definitely Met

- IV idarucizumab 5.0g
- APTT / TCT immediately afterwards
- Complete retrospective approval form (the admitting team MUST do this)
- Monitor for REBOUND dabigatran: APTT / TCT at 12 hours, 24, if more bleeding or surgery required
- Consider thrombotic potential / prophylaxis if appropriate
- Supportive care with fluids and rbc / plasma transfusion as indicated by the clinical situation

Criteria in steps 1 and/or 2 not met BUT clinical team prefer to reverse: phone local panel, 2 approvals to reverse. Considerations:

- APTT > 80 seconds } with major bleeding
- CrCl < 30ml / min } or needing surgery
- Surgery cannot be delayed more than 12 to 24 hours without high mortality risk
- Thrombocytopenia / aspirin may be relevant
- Significant post reversal rebound and surgery needed or bleeding

***Surgery should be deferred as long as safely possible:**

- The coagulation tests must be assessed for step 2 within 2 hours of the procedure to ensure that reversal is still necessary
- IV fluids should be given to enhance clearance
- Most surgical procedures can be undertaken with a dabigatran level of < 0.04ug / L
- Consider intraoperative use of idarucizumab if **bleeding occurs** rather than upfront use

Figure 14. Thornhill, B (2016). Metric document formatting

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Document design: Idarucizumab clinical trial

As documents are frameworks for communication, comprised of text and graphics, and include fixed and variable pieces of information (Schwesinger, 2010), designed formats and structural grid systems have the ability to enhance the ordering and understanding of information (Norman, 2004). The incorporation of typographical grid systems (Figure 15) enabled me to systematically arrange the Idarucizumab content within the restricted space of an A4 page. As a response to the internal tensions of the clinical content supplied (text, headings, checklists), the designed grid functioned as a flexible framework to arrange the clinical information coherently in relation to an A4 page.

	patient label
	Dabigatran Patient: Consideration of Reversal with Idarucizumab Urgent APTT, TCT and (if available) a dabigatran level MUST be requested on a blue tube
1	Severity / Urgency Inclusion - 1 box MUST be ticked <input type="checkbox"/> Acute intracranial or spinal haemorrhage <input type="checkbox"/> Chronic subdural haematoma with neurological impairment <input type="checkbox"/> Immediate emergency surgery* <input type="checkbox"/> GI bleed with significant haemodynamic instability OR an urgent procedure must be performed within 2 - 3 hours <input type="checkbox"/> Major trauma <input type="checkbox"/> Other massive bleed with immediate threat to life Exclusion: Reversal not appropriate - if any box ticked <input type="checkbox"/> Elective surgery <input type="checkbox"/> Surgery can be deferred with a conservative alternative strategy <input type="checkbox"/> Surgery would be needed but not a candidate due to comorbidities <input type="checkbox"/> Treatment likely futile / palliative <input type="checkbox"/> Local measures to arrest bleeding could be undertaken while anticoagulated <input type="checkbox"/> Last dose more than 24 hours prior unless CrCl < 30ml / min * Surgery should be deferred as long as safely possible: <ul style="list-style-type: none">The coagulation tests must be assessed for step 2 within 2 hours of the procedure to ensure that reversal is still necessaryIV fluids should be given to enhance clearanceMost surgical procedures can be undertaken with a dabigatran level of < 0.04ug / L (TCT should be normal for neuraxial anaesthesia to be considered)Consider intraoperative use of Idarucizumab if bleeding occurs rather than upfront use
2	Evidence of Dabigatran Effect Inclusion - 1 box MUST be ticked <input type="checkbox"/> TCT > 80 seconds CR <input type="checkbox"/> APTT > 40 seconds (no TCT available) CR <input type="checkbox"/> Critical surgery with an admission to theatre time < 60 minutes Exclusion: Reversal not appropriate <input type="checkbox"/> TCT < 80 seconds <input type="checkbox"/> No APTT or TCT (except critical surgery box 3)
3	Reversal Criteria in 1 and 2 Definitely Met... phone UHB specific panel - details attached Idarucizumab use authorised by: <input type="checkbox"/> IV Idarucizumab 5g (2 x 2.5g vials) <input type="checkbox"/> APTT / TCT immediately afterwards <input type="checkbox"/> Print and complete this approval form and fax to the number on the attached sheet. This MUST be done following drug administration and will be audited for compliance <input type="checkbox"/> Monitor APTT / TCT at 12h, 24h, and if more bleeding / surgery required <input type="checkbox"/> Consider thrombotic potential / prophylaxis if appropriate <input type="checkbox"/> Supportive care with fluids and rbc / plasma transfusion as indicated by the clinical situation Criteria in steps 1 and / or 2 not met BUT clinical team prefer to reverse: phone DHB specific panel - details attached Considerations: <input type="checkbox"/> APTT > 80 seconds } with major bleeding <input type="checkbox"/> CrCl < 30ml / min } or needing surgery <input type="checkbox"/> Surgery cannot be delayed more than 12 to 24 hours without high mortality risk <input type="checkbox"/> Platelet count < 80 / anti-platelet agents might be relevant <input type="checkbox"/> Significant post reversal rebound and surgery needed or bleeding <small>Fax completed form to extension 23557 (pharmacy)</small>

Figure 15.
Thornhill, B (2016). Typographic grid system

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Within this phase of the project, what started as a basic redesign of guideline criteria rapidly developed as further clinical processes and protocols were realised and defined by the anaesthetists and haematologists involved. This meant that additional content needed to be edited and included over several iterations. With more words included, text size had to be decreased, which affected readability. Consequently, the grid system structuring the information was constantly tweaked and recalculated to fit the content comfortably, and the size of the check boxes included wasn't big enough for clinicians to intuitively tick. Even without formal user testing, I felt that a redesigned document that should have been well organised and improved had become visually messy and not intuitive to scan and use.

Throughout the document redesign phase, I kept up regular email correspondence with a specialist anaesthetist and a member of the haematology department. Both provided input into the design process (Figure 16). I also needed to consider functional guideline requirements during the initial redesign stages. For example, the guideline needed to fit an A4 format so it could be sent via facsimile machine.

Dabigatran Patient: Consideration of Reversal with Idarucizumab
 Urgent APTT, TCT and (if available) a dabigatran level MUST be requested on a blue tube

1 Severity / Urgency

Inclusion - 1 MUST be met *bcx*

- Acute intracranial or spinal haemorrhage
- Chronic subdural haematoma with neurological impairment
- Immediate emergency surgery*
- GI bleed with significant haemodynamic instability OR an urgent procedure must be performed within 2 - 3 hours
- Major trauma
- Other massive bleed with immediate threat to life

Exclusion: Reversal not appropriate *if any bcx ticked*

- Elective surgery
- Surgery can be deferred with a conservative alternative strategy
- Surgery would be needed but not a candidate due to comorbidities
- Treatment likely futile / palliative
- Local measures to arrest bleeding could be undertaken while anticoagulated
- Last dose more than 24 hours prior unless CrCl < 30ml / min

2 Evidence of Dabigatran Effect

Inclusion - 1 MUST be met

- TCT > 80 seconds *240 seconds available*
- APTT prolonged - *not look closely at the TCT and dabigatran level*
- At a minimum a TCT and APTT must be available for all patients except critical surgery with a door to theatre time of < 60 minutes

Exclusion: Reversal not appropriate

- TCT < 80 seconds
- If the TCT is < 80 seconds and other coagulation tests are prolonged then consider other causes of coagulopathy
- No APTT or TCT (except critical surgery box 3)

3 Reversal

Criteria in 1 and 2 Definitely Met

- IV idarucizumab 2.5g *(5g)*
- APTT / TCT immediately afterwards
- Complete retrospective approval form (the admitting team MUST do this)
- Monitor for REBOUND dabigatran: APTT / TCT at 12 hours, 24, if more bleeding or surgery required
- Consider thrombotic potential / prophylaxis if appropriate
- Supportive care with fluids and rbc / plasma transfusion as indicated by the clinical situation

Criteria 1 and / or 2 Not Met BUT *clinical team prefer to reverse. phone local panel - 2 approvals to proceed to proceed considerations*

- APTT > 80 seconds } with major bleeding
- CrCl < 30ml / min } or needing surgery
- Surgery cannot be delayed more than 12 to 24 hours without high mortality risk
- Thrombocytopenia / aspirin may be relevant
- Significant post reversal rebound and surgery needed or bleeding
- Consider discussion with local panel - ~~re-reversal a quorum of 2 needed~~

***Surgery should be deferred as long as safely possible:**

- The coagulation tests must be assessed for step 2 within 2 hours of the procedure to ensure that reversal is still necessary
- IV fluids should be given to enhance clearance
- Most surgical procedures can be undertaken with a dabigatran level of < 0.04ug / L
- Consider intraoperative use of idarucizumab if bleeding occurs rather than upfront use

Figure 16. Thornhill, B (2016). Document feedback from clinicians

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

At this concept stage, a redesigned draft of the guidelines document was supplied to the anaesthesia department. This allowed them to deliver their refined Idarucizumab administration criteria to Boehringer Ingelheim pharmaceuticals for their approval (Figure 17). Although the criteria were approved by Boehringer Ingelheim pharmaceuticals, Idarucizumab's guideline document was not finalised by the anaesthetists. Furthermore, I needed to understand and consider the clinical aspects incorporated within Idarucizumab's administration process before the guideline could be refined, tested and released for clinical use.

Figure 17.
Thornhill, B. (2017). Refined Idarucizumab administration criteria for Boehringer Ingelheim pharmaceuticals

Dabigatran Patient: Consideration of Reversal with Idarucizumab

Urgent APTT, TCT and (if available) a dabigatran level **MUST** be requested on a blue tube

1 Severity / Urgency

Inclusion - 1 box **MUST** be ticked

- Acute intracranial or spinal haemorrhage
- Chronic subdural haematoma with neurological impairment
- Immediate emergency surgery *
- GI bleed with significant haemodynamic instability **OR** an urgent procedure must be performed within 2 - 3 hours
- Major trauma
- Other massive bleed with immediate threat to life

Exclusion: Reversal not appropriate - If any box ticked

- Elective surgery
- Surgery can be deferred with a conservative alternative strategy
- Surgery would be needed but not a candidate due to comorbidities
- Treatment likely futile / palliative
- Local measures to arrest bleeding could be undertaken while anticoagulated
- Last dose more than 24 hours prior unless CrCl < 30ml / min

* Surgery should be deferred as long as safely possible:

- The coagulation tests must be assessed for step 2 within 2 hours of the procedure to ensure that reversal is still necessary
- IV fluids should be given to enhance clearance
- Most surgical procedures can be undertaken with a dabigatran level of < 0.04ug / L
- Consider intraoperative use of idarucizumab if **bleeding** occurs rather than upfront use

2 Evidence of Dabigatran Effect

Inclusion - 1 box **MUST** be ticked

- TCT > 80 seconds
- OR** APTT > 40 seconds (no TCT available)
- OR** Critical surgery with an admission to theatre time < 60 minutes

Exclusion: Reversal not appropriate

- TCT < 80 seconds
- No APTT or TCT (except critical surgery box 3)

3 Reversal

Criteria in 1 and 2 Definitely Met...

- IV idarucizumab 5.0g
- APTT / TCT immediately afterwards
- Complete retrospective approval form (the admitting team **MUST** do this)
- Monitor APTT / TCT at 12h, 24h, **and** if more bleeding / surgery required
- Consider thrombotic potential / prophylaxis if appropriate
- Supportive care with fluids and rbc / plasma transfusion as indicated by the clinical situation

Criteria in steps 1 and/or 2 not met **BUT clinical team prefer to reverse:** phone local panel, 2 approvals to reverse.

Considerations:

- APTT > 80 seconds } with major bleeding
- CrCl < 30ml / min } or needing surgery
- Surgery cannot be delayed more than 12 to 24 hours without high mortality risk
- Thrombocytopenia / aspirin may be relevant
- Significant post reversal rebound and surgery needed or bleeding

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Expert interviews: Phase 1

Within this initial stage of the research, expert interviews were conducted after I started designing the paper guidelines for pharmaceutical approval with the specialist anaesthetists and haematologists. It wasn't easy to make contact with clinicians due to their schedules and responsibilities.

All experts interviewed had experience using clinical guideline documents in the anaesthesia department and worked in Auckland DHB's specialist and managerial roles. Open-ended interviews enabled me to gain a deeper understanding of how guideline documents were sourced, interpreted and documented by clinicians in Auckland City Hospital (see Appendix 2, p.161, for interview questions). Actions that clinicians described in the expert interviews confirmed that they relied on obtaining clinical information via the Auckland DHB intranet, followed by a time-consuming manual administration load. For example, a clinician who was authorised to administer a certain drug through use of a clinical guideline would then have to log and archive its administration to the hospital's pharmacy. Expert interviews identified processes and communication as probable factors contributing to inadequate clinical guideline provision. Thus, it became clear to me that guideline efficiency and effectiveness involved more than graphical document design.

Something else I observed during the interviews and consultations was that clinicians routinely carry personal smartphone devices, answering calls and replying to emails instantaneously, attaining responsibility to be 'on call' to regulate patients under their treatment.

Below details the current process that clinicians use in acute surgery at Auckland City Hospital. I obtained this from the expert interviews; it was not information offered to me along with the guideline at the outset of the design process. It includes details about how the Idarucizumab guideline is used in practice.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

1. Acute surgery identified

First, a patient needing acute surgery must be identified by the clinician. If the clinician suspects the patient is currently taking Dabigatran medication, they need to administer Idarucizumab to reverse the patient's Dabigatran dosage.

2. Find guideline on Auckland DHB intranet

While in surgery, the clinician must use a desktop computer and navigate through the Auckland DHB intranet to find the Idarucizumab guideline. They need this to establish whether Dabigatran reversal is required.

3. Print guideline

Once the guideline is found on the intranet, the clinician needs to print it out.

4. Read and follow protocol

The printed guideline must then be read and followed so that the clinician can try to make an accurate decision about whether to reverse Dabigatran in the patient.

5. Call member panel

Once the clinician has completed reviewing the guideline and has reached a conclusion regarding the patient's medical situation, a member of an expert panel responsible for gatekeeping the drug is called by cell phone to discuss whether its administration should be approved. The clinician needs formal approval from this expert to be allowed to administer Idarucizumab.

6. Fill out the guideline document

After reaching a decision and gaining approval from the member panel, the guideline must be filled out in writing to show the drug has been administered, along with the patient's information, like their National Health Index (NHI) number.

7. Find Idarucizumab medicine in the pharmaceutical stock room

Considering there is a vast range of medicines kept at the hospital, locating a specific medicine is difficult. For example, Idarucizumab is not stored at the Auckland City Hospital's main pharmacy. Clinicians need access to the operative medicine stock room where it is stored. Here, the drug must also be logged to keep record of when it was used to track expiry.

8. Administer Idarucizumab

Guided by the Idarucizumab step-by-step document, the clinician administers the drug to the patient. Note that this process alone involves four actions by the clinician.

9. Fax completed Idarucizumab guideline to the pharmacy department

After Idarucizumab is administered by the clinician, the completed (filled out) guideline must be faxed to the pharmacy department for archiving and documentation purposes.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Journey mapping

Following the insights gained from the expert interviews, the creation of a user journey map gave a visual representation of how clinicians at Auckland City Hospital access clinical guidelines within perioperative settings (Figure 18). Touchpoints within the clinician's journey were recorded, along with the actions involved in the process of clinical guideline retrieval, use and documentation. Information was mapped and streamlined alongside clinical guideline decisions. This enabled clarity and understanding of clinical guideline information, aligning content to better suit medical processes and procedures. The documented user journey is a typical one for clinicians.

The administration of Idarucizumab was very laborious for clinicians working in high stress environments. As the process was constantly changing, there was greater opportunity for clinical errors in administering the drug. It was clear that while all of the above stages needed to be incorporated within the guideline redesign, it needed an adaptable system to cope with any procedural changes.

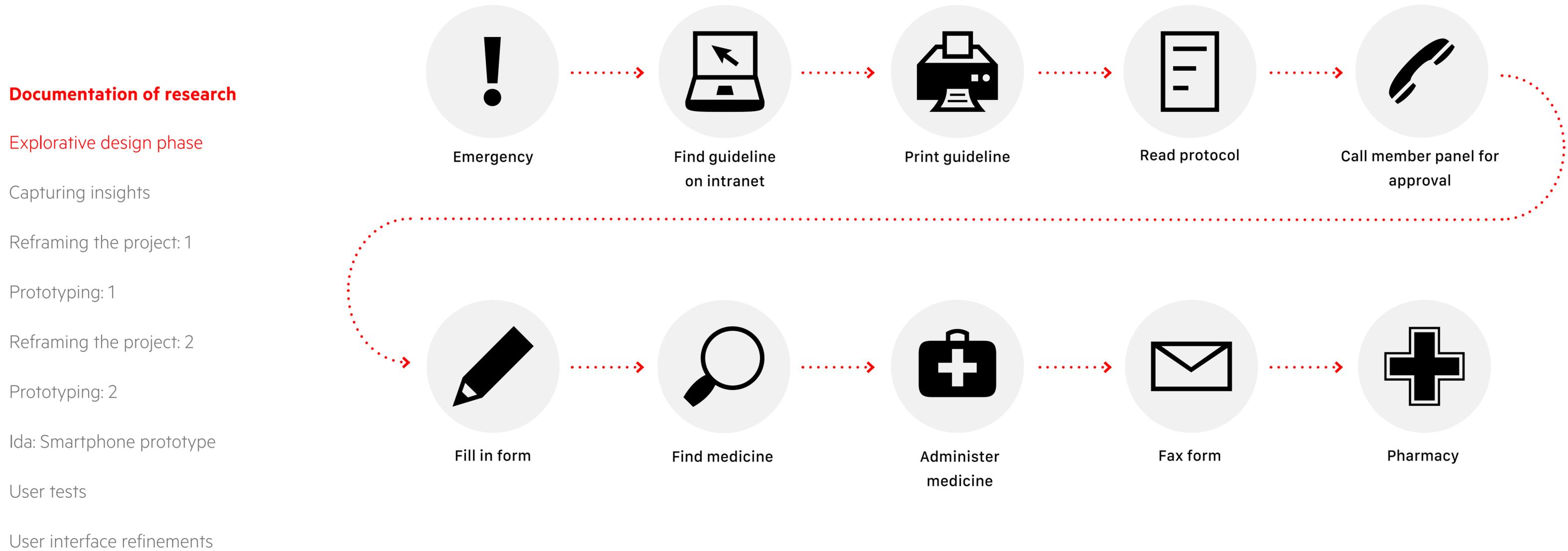


Figure 18. Thornhill, B (2017). Clinician journey map accessing and adopting the Idarucizumab guideline in Auckland City Hospital

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Document design: Idarucizumab guideline within ACH

After gaining a deeper understanding of Idarucizumab's administration and retrieval processes in Auckland City Hospital, I refined the design of the document to incorporate all the clinician's touchpoints. Visual cueing of textual content, icons and colours were used to emphasise certain clinical procedures and actions for clinicians to systematically follow. Additional administrative content was supplied from the anaesthetists.

Employing graphic design techniques within the presentation of the document enabled the Idarucizumab approval criteria to be conveyed succinctly and systematically within its medical context. Once approved by the senior clinicians within the hospital, the final design was uploaded to the Auckland DHB intranet for clinicians to use (Figure 19)



Dabigatran Patient:
Consideration of Reversal with Idarucizumab

patient label here

Urgent APTT, TCT and (if available) a dabigatran level MUST be requested on a BLUE tube

1

Severity / Urgency

Inclusion: 1 box MUST be ticked

- Acute intracranial or spinal haemorrhage
- Chronic subdural haematoma with neurological impairment
- Immediate emergency surgery *
- GI bleed with significant haemodynamic instability OR an urgent procedure must be performed within 2-3 hours
- Major trauma
- Other massive bleed with immediate threat to life

Exclusion: Reversal NOT appropriate if any box ticked

- Elective surgery
- Surgery can be deferred with a conservative alternative strategy
- Surgery would be needed but not a candidate due to comorbidities
- Treatment likely futile / palliative
- Local measures to arrest bleeding could be undertaken while anticoagulated
- Last dose more than 24 hours prior unless CrCl < 30ml / min

* Surgery should be deferred as long as safely possible:

- The coagulation tests must be assessed for step 2 within 2 hours of the procedure to ensure that reversal is still necessary
- IV fluids should be given to enhance clearance
- Most surgical procedures can be undertaken with a dabigatran level of < 0.04ug / L (TCT should be normal for neuraxial anaesthesia to be considered)
- Consider intraoperative use of idarucizumab if bleeding occurs rather than upfront use

2

Evidence of Dabigatran Effect

Inclusion: 1 box MUST be ticked

- TCT > 80 seconds
- OR APTT > 40 seconds (no TCT available)
- OR Critical surgery with an admission to theatre time < 60 minutes

Exclusion: Reversal NOT appropriate

- TCT < 80 seconds
- No APTT or TCT (except critical surgery, see panel 3 Reversal)

3

Reversal

Criteria in 1 and 2 Definitely Met...
phone DHB specific panel - details attached
idarucizumab use authorised by:

- IV Idarucizumab 5g (2 x 2.5g vials)
- APTT / TCT immediately afterwards
- Print and complete this approval form and fax to the number on the attached sheet. This MUST be done following drug administration and will be audited for compliance
- Monitor APTT / TCT at 12h, 24h, and if more bleeding / surgery required
- Consider thrombotic potential / prophylaxis if appropriate
- Supportive care with fluids and RBC / plasma transfusion as indicated by the clinical situation

Criteria in steps 1 and / or 2 not met BUT clinical team prefer to reverse:
phone DHB specific panel - details attached
Considerations:

- APTT > 80 seconds } with major bleeding
- CrCl < 30ml / min } or needing surgery
- Surgery cannot be delayed more than 12 to 24 hours without high mortality risk
- Platelet count < 80 / anti-platelet agents might be relevant
- Significant post reversal rebound and surgery needed or bleeding

Fax completed form to extension 23557 (pharmacy)

Compassionate access to Idarucizumab (Praxbind) to reverse dabigatran at ADHB

Idarucizumab reverses the anticoagulant effects of dabigatran immediately after administration and is indicated in patients with recent dabigatran intake who have major bleeding or who require emergency surgery. It has been registered with Medsafe in NZ, but is not yet funded by Pharmac on the Hospital Medicines List. It has no efficacy for reversal of any other anticoagulant.

The criteria for reversal at Auckland DHB are shown on overleaf.

If your patient meets these criteria then phone one person on the panel below for approval.

If the criteria are not met but you are sure that reversal is required also please phone and discuss. Usage will be tracked and audited.

If reversal is approved by one member of the panel then:

1. The idarucizumab (2 vials, one box) can be taken from the fridge in the Medication room (81077), Post Anaesthetic Care Unit (PACU), level 8 Operating Rooms
2. A label with the patient's NHI must be entered into the log kept with the product
3. Both vials (2.5g each) should be charted and administered each by an intravenous push over 1 to 2 minutes, and the APTT / TCT measured after 15 minutes
4. The approval form must be printed, completed and faxed to Pharmacy (ext 23557)

Panel members are not necessarily on call so it may be necessary to try more than one person. Haematology on call services should be called if no one can be reached.

- Dr Laura Young (haematology)
- Dr Kerry Gunn (anaesthesia)
- Dr Nicola Eaddy (haematology)
- Dr Paul Ockelford (haematology)
- Dr Tim Short (anaesthesia)

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Figure 19. Thornhill, B. (2017). Approved administration criteria and guideline design by the Anaesthesia Department, Auckland City Hospital.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Clinical deployment: Idarucizumab: Drug prescribing guideline

The Idarucizumab guideline is used by clinicians only conducting emergency (acute) surgery, and is specific to patients taking Dabigatran (anti-blood clotting) medication. Designed as a single-page document, it functions as a criteria checklist for clinicians to follow and complete, aiding their decision as to whether the patient involved is suitable for the medication. Within the process, the practising clinician needs authorisation from a senior membership panel (comprised of specialist anaesthetists and haematologists within Auckland DHB) in order to administer the medicine.

Following the Idarucizumab guideline redesign and upload to Auckland DHB's intranet, more usability issues were noted. Although the redesign enhanced the overall readability of the document, particular facets of the design were overlooked by clinicians using the document within surgery. The archived guidelines faxed to the pharmacy department did not note who authorised or administered the medicine.

As this document was also used by the Auckland DHB to audit and stocktake the use of Idarucizumab, failing to record the clinician and date of administration would prove problematic. Furthermore, clinicians had failed to attach the patient information (in the form of a sticker) to the faxed guideline, further complicating the documentation process. Due to the stress within acute surgical settings, clinicians can often miss mundane tasks in procedures (Gawande, 2010). Although all of the clinicians accurately administered Idarucizumab to their patients, the guideline documentation aspects were not being adhered to. Thus, document design only went part way to improving the efficiency of clinical guideline use. It could not ensure that administrative actions and processes were being followed through.

Documentation of research

Capturing insights

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

At this point I realised that since guidelines were part of an overall system, where processes and action interacted within the system, I wanted to better understand how clinicians operated in surgical settings and how clinical guidelines were used generally at the hospital. This involved shadowing clinicians to understand their behaviour in surgical environments as well as conducting additional expert interviews.

Senior anaesthetists arranged a tour and introduction of the anaesthesia department including the perioperative environments where clinical guidelines are accessed and used. This provided a better understanding of the services and environments in the department. Progressing the study into a clinical setting allowed me to see how clinicians used information within surgical settings.

Shadowing clinicians at work in surgical settings revealed behaviours and activities necessary for their surgical processes. Within a designated operation room, two core teams are involved: surgeons and anaesthetists. In the surgical team, a lead doctor directs the surgical process by instructing the team of nurses through every step of the medical process. A surgical team consists of four clinicians.

The anaesthesia team focuses on the patient's level of consciousness throughout their operation and is also comprised of four individuals. Within perioperative environments, both teams work cooperatively and are always in communication. Each operating room has a designated desktop computer, enabling the accessibility of clinical guidelines and protocols. These are retrieved by registrars and nurses under instruction by the lead doctor (surgeon) or anaesthetist. Once guidelines are located and printed out, the same clinician would go to retrieve it from a separate room for hygiene purposes. Once brought back into the operating room it would then be followed by the surgical team. The guideline, being printed on multiple A4 size pieces of paper would quickly be scanned and flicked through.

I considered this process of retrieving clinical guidelines extremely cumbersome as clinicians in a surgical environment were not able to source the information immediately and 'on the spot'. The interruption to clinicians' workflow by having to source and print clinical information seemed unnecessarily difficult and impeded the operational process.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Expert interviews: Phase 2

I conducted a further round of interviews, this time extending the range of expert interviewees. I was aiming to understand how clinical guidelines are accessed and archived within Auckland DHB. Participants included senior house officers, anaesthetic registrars, specialist anaesthetists, haematologists, senior pharmacists, and a clinical director within Auckland City Hospital.

Clinicians described accessing guidelines at Auckland City Hospital as being 'laborious,' 'cumbersome' and a 'time-consuming' process. They rely on desktop computer access and the use of the Auckland DHB intranet. One clinician stated,

When you need the guideline you are not necessarily always in front of your computer and I might not be in the hospital – someone might phone me for advice, I might be talking about a patient at a meeting. So, what you want is a guideline that is on you instantly, so when you need it you don't need to leave your surroundings to go and find it on a computer.

This restricts 'on the fly' access of information. Although desktop computers are stationed in all operative environments within the hospital, various medical departments within the hospital have their own way of retrieving guideline information. This might involve uploading their own websites and pages that can be accessed and hyperlinked within the Auckland DHB's intranet. This has now caused the Auckland DHB intranet to become a maze of hard to find content with hyperlinks linking clinicians to various web pages and sites. This frustrates clinicians:

I find the guidelines within the hospital hard to get to—the subject lists aren't easy to find as there are so many—you have to scroll through a lot of them.

Clinicians don't know which guideline is the up-to-date and trusted version. Accordingly, websites are continuously created and uploaded by various departments to try and ensure clinicians are using up-to-date and trustworthy content. Keeping guidelines up-to-date is difficult since there is always new information as medical science advances. Guidelines need to be reviewed by the DHBs annually to ensure accurate real-time information.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

As each DHB within New Zealand hosts their own intranet sites, clinicians moving from another DHB tend to retrieve guidelines from their previous districts, not the Auckland database. A clinician admitted, "I use my old DHB's intranet to find guidelines." This seems counterproductive as it complicates the process of retrieving guidelines. Another clinician suggested that "it would be good having an app" as they thought it would eliminate the time-consuming process of having to retrieve guidelines on a desktop computer.

Archiving Guidelines within Auckland City Hospital

Guidelines that 'gate keep' certain medicines engage multiple medical departments within the hospital. In the case of the Idarucizumab guideline at Auckland City Hospital, the anaesthesia and pharmacy departments were involved. Senior pharmacists felt that having the guideline process administered across both departments was not reliable, since data was recorded manually by clinicians and sent using dated technology (facsimile). In the operating rooms, clinicians send the completed guideline by fax to the pharmacists where it is then manually documented and filed at the pharmacy.

Due to the unreliability of manually recorded data in perioperative environments, vital information was often missed, including the date of medicine administration, who authorised its use, and patient details.

Engaging multiple departments to work across a specific administrative process demands systems thinking. While both the anaesthesia and pharmacy departments operated within a single organisation, they functioned differently. By gaining a holistic perspective of how each department functions, critical relationships and connections that are often missed or unvalued can be identified that are pivotal to successful implementation efforts (Trbovich, 2014). This helps in recognising how to intervene (e.g. focusing on changes of technology, clinician training and clinical practice) in the healthcare system successfully (ibid.). By investigating the needs of stakeholders from both departments, designs and interventions were able to be explored and evaluated in concert. This enabled me to recognise and unpack the complexities involving clinical guideline retrieval and archiving within the organisation, and the processes involved between both departments.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Implications for guideline design

At Auckland City Hospital, surgery is often interrupted by clinicians searching and retrieving medical information. Once the A4 paper guideline is printed and retrieved, using the guidelines involves close reading, tests, and calculations; where the content doesn't align with the surgical process at hand. Due to the time pressures of surgical practice, every moment saved enables work processes to flow smoothly between the surgical teams. If the process is interrupted (e.g. searching and retrieving clinical guidelines), time is wasted, accelerating pressure on the surgical team, and potentially risking rushed decisions and errors in the operating room.

The process of clinicians having to retrieve and archive guidelines for administration purposes connects both the anaesthesia and pharmacy departments within Auckland City Hospital. Rather than being a problem for guideline design, this situation offers further possibilities for a systems-based approach; system where clinical guideline administration and archiving could be automated and digital, meaning both time saving and error minimisation for both departments.

Documentation of research

Reframing the project: 1

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Until this point, the focus of this research was on how visual information design could enhance clinical guidelines, enabling efficient and accurate decision-making amongst clinicians in perioperative settings. After exploring ways in which information design could improve guideline efficiency and accuracy of clinical decisions, an additional inefficiency was noted; that the system administering and delivering guidelines was seriously flawed. It was at this point that my research focus shifted. I had identified that the problem with effective use of clinical guidelines at Auckland DHB involved more than the documents' visual design.

In order to clarify how each affiliated department operated within Auckland DHB and thereby confirm my assumptions around the guideline redesign, I consulted with senior members from each department. I then proposed that in order to improve clinical guideline use, the retrieval processes needed to become more efficient in perioperative settings. Furthermore, as particular guidelines used by clinicians require archiving for auditing and stocktake purposes, the system that brings both the anaesthesia and pharmacy departments together needed to be considered in the redesign. I suggested that if the processes of guideline retrieval and documentation saved time, clinician stress and interruption within practice would be reduced, allowing the guideline's content to become the clinicians' focal point.

Documentation of research

Prototyping: 1

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Anticoagulation bridging guideline

The document was collated by the anaesthetists into five determinants of information, each represented and titled as a separate medical enquiry. Blue boxes were used throughout the document to establish hierarchy, emphasising medical considerations, risks, and protocols. Blank data tables were also incorporated, enabling clinicians to manually record medical calculations within the guidelines process. Five medical enquires, although needing to be formulated separately by the clinician, amalgamate to accurately conclude the patients' medical outcome. The five medical enquiries included the following;

1. Is the surgery minor?
2. What is the indication for anticoagulation?
3. Is the patient taking Warfarin?
4. Is the patient taking a Non-Vitamin K Oral Anticoagulant?
5. Is your patient taking antiplatelet agents?

As with the Idarucizumab guideline previously, the content of the guideline was an unformatted working draft being refined by the specialist anaesthetists within the department. The medical information was listed consecutively across multiple pages (Figure 8). As a result, the guideline's information was difficult to navigate and comprehend efficiently. A clinician, while pre-examining a patient before surgery, would be perplexed trying to accurately decipher and calculate all the medical considerations within the guideline. It was difficult for me to digest/consume the information in its current form.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

ADHB Elective Surgery: bridging guideline in perioperative anticoagulated patients

Note: this is a GUIDELINE and may not encompass unusually high risk situations for bleeding or thrombosis. Clinical discretion is needed followed by specialist discussion if uncertain. In general, the literature in this area suggests that bleeding is a greater risk than thrombosis for these perioperative patients.

Overview: Elective surgery:

- 1 Procedures where anticoagulants can be continued
- 2 Thrombotic risk
- 3 Warfarin and bridging guidelines
- 4 Non vitamin K oral anticoagulants (NOAC)
- 5 Antiplatelet agents

For emergency surgery the reversal of warfarin or NOAC guideline should be consulted.

1. Is the surgery minor?

If the surgery is one of the following then anticoagulants can generally be continued. Note if the patient is taking antiplatelet agents *as well* then these would generally be stopped for 7 days prior (discuss with surgeon/relevant departments if unsure)

Warfarin: an INR should be checked on the day of surgery and ideally be ≤ 2.5 .

NOAC: Omit the dose(s) on the day of the procedure with restart the following day

- Dental procedures [see appendices]
- Bone marrow biopsy [see haematology guideline]
- Venous interventional radiology procedures
- Gastrointestinal endoscopy without biopsy
- Skin biopsy or superficial excisions
- Minor procedures such as some superficial hernias (procedure specific)
- Cataract surgery [note non-cataract ocular procedures vary: see appendices]
- Joint aspirations

Comment [LY(1)]: Confirming preferred details for anticoagulation continuation with interventional radiology and gastro

2. What is the indication for anticoagulation?

(i) **Prosthetic heart valve¹**

Does the patient with prosthetic valve(s) meet the following criteria:

- Prosthetic valve in mitral position
- OR CVA or TIA in the past
- OR More than one prosthetic valve
- OR EITHER tilting disc OR ball and cage valve²
- OR Rheumatic Heart Disease
- OR LVEF of $< 40\%$
- OR Atrial fibrillation

if YES the patient is HIGH RISK³.

YES: High Risk Protocol²

¹ Patients with an aortic bileaflet mechanical valve alone are LOW RISK if there are no other risk factors for thromboembolism/stroke. The 3 current brands are Onyx, St Jude, Medtronic AFS. Please check with either: patient records, a cardiac surgeon/ardiologist, or with echocardiography if you are uncertain what kind of valve is in a patient, before you assign LOW RISK.

² The high risk protocol uses once daily enoxaparin to allow district nurse administration. There is no published data regarding therapeutic once daily enoxaparin in prosthetic valve patients. If the patient is very high risk, for example recent valve thrombosis/stroke then discuss with cardiology/review indications for interruption of warfarin. The length of time without warfarin should be minimised. Post-operatively twice daily may be preferred once haemostasis is secured as per the guideline.

(ii) **Prior Venous Thromboembolism (VTE, currently on anticoagulants)**

Does the patient with VTE meet any of the following criteria:

- Active cancer
- OR Antiphospholipid syndrome
- OR Deficiencies of antithrombin, protein C or protein S
- OR multiple thrombophilias
- OR Any VTE within 3 months
- OR VTE within 6 months with a high thrombotic load⁴
- OR Recurrent VTE including proximal DVTs or PEs

if YES the patient is HIGH RISK for thromboembolic events

YES: High Risk Protocol

(i) **High thrombotic risk:**

CrCl > 50 ml/min [calculator]

Day -6 Last dose of warfarin

Day -3 Start enoxaparin 1.5mg/kg once daily in the morning (rounded to 10mg)

Day -1 Half the current dose of enoxaparin should be given, at least 24 hours preoperatively

Day 0 Check INR preoperatively to ensure $< 1.5^5$
No enoxaparin; consider restarting warfarin in the evening²

Day +1-3 When haemostasis is secured restart enoxaparin at 1mg/kg daily. Increase to 1.5mg/kg daily OR 1 mg/kg twice daily as able depending on the surgery type and bleeding¹⁴
Warfarin should be restarted by Day 1²

Continue enoxaparin until INR > 2.0

CrCl 30-50 ml/min [calculator]

(NB enoxaparin should be avoided when CrCl < 30 ml/min)

Day -6 Last dose of warfarin

Day -3 Start enoxaparin 1mg/kg rounded to the nearest 10mg

Day -1 Enoxaparin 40mg in the morning/24 hours preoperatively (or 20mg if < 60 kg)

Day 0 Check INR preoperatively to ensure $< 1.5^5$
No enoxaparin; consider restarting warfarin in the evening²

Day +1-3 When haemostasis is secured restart enoxaparin at 1mg/kg daily. Prophylactic regimens (enoxaparin 20-40mg daily) can be considered with a dose escalation¹⁴
Warfarin should be restarted by Day 1²

Continue enoxaparin until INR > 2.0

(ii) **Non-high thrombotic risk patients taking warfarin**

Day -6 Last dose of warfarin

Day 0 Check INR preoperatively to ensure $< 1.5^5$
In the evening consider restarting warfarin² (aim to minimise number of days with an INR of < 2)

(ii) **Atrial fibrillation**

Does the patient with atrial fibrillation meet any of the following criteria:

- OR CHADS₂ score of 5-6 [calculator]
- OR CHA₂DS₂-VASc score of ≥ 3 [calculator]
- OR Severe mitral stenosis
- OR CVA or TIA within 6 months:

if YES the patient is HIGH RISK for thromboembolic events ($> 10\%$ annual risk)

YES: High Risk Protocol

3. Is the patient taking warfarin? If yes follow this guideline

The following is likely to be helpful and should be collected:

Age	
(gender)	
Weight	
Serum creatinine	
Maintenance warfarin dose	

In general the bleeding risk estimate of the surgical procedure, and the presence or absence of bleeding complications will determine when anticoagulants can be restarted. The HAS-BLED score [calculator] provides an indication of overall bleeding risk HOWEVER this evaluates risk of bleeding on therapeutic anticoagulants rather than specifically perioperative.

Bridging unfractionated heparin at therapeutic doses should generally be avoided (with occasional exceptions – consult with cardiology/haematology).

IMPORTANT: PLEASE READ THE FOOTNOTES AT THE END OF THE PROTOCOLS

High risk procedures would include any other major surgery, pacemaker or ICD implantation, colonoscopy with significant polyp resection, ERCP with sphincterotomy, neuraxial anaesthesia.

(a) **Dabigatran**

A normal thrombin clotting time preoperatively completely excludes any residual dabigatran effect. This should be requested a separate test to the coagulation screen along with a dabigatran level if there are particular concerns regarding bleeding risk. The drug level should be below the limit of detection ($< 0.03 \mu\text{g/ml}$) with a normal TCT to consider elective neuraxial anaesthesia.

Preoperative management (no bridging)

Creatinine clearance ≥ 50 ml/min:

LOW risk procedure: Last dose 24 hours prior to surgery
HIGH risk procedure: Last dose 72 hours prior to surgery

Creatinine clearance 30 to 49 ml/min:

LOW risk procedure: Last dose 72 hours prior to surgery
HIGH risk procedure: Last dose 96 hours prior to surgery

Postoperative management

Low bleeding risk procedure: restart 24 to 48 hours postoperatively

High bleeding risk procedure:

Ascertain the thrombotic risk as per section 2:

High thrombotic risk:

1. Follow the enoxaparin guideline in section 3
2. Restart dabigatran at day 3 to 5 depending on haemostasis (24 hours after enoxaparin)

Non-high thrombotic risk:

- Restart dabigatran at day 3 to 5 depending on haemostasis (consider interval VTE prophylaxis)

(b) **Rivaroxaban/apixaban**

A normal prothrombin ratio suggests that only low levels of rivaroxaban are present. Therapeutic levels of apixaban do not prolong the prothrombin ratio. If the drug level of either medication is below the limit of detection (0 ng/ml) then a minimal

Figure 20. Auckland DHB. (2016). Anticoagulation bridging guideline.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Expert interviews: Phase 3

For the next phase of the research, another guideline was supplied by the anaesthesia and haematology departments within Auckland City Hospital. The bridging anticoagulation guideline relates to patient blood treatment within surgery, but is used in a different perioperative context: elective surgery.

Even though used in a different medical context than the Idarucizumab guideline, the bridging guideline has a similar intention; to function as an efficient step by step process enabling accurate decision-making amongst clinicians. The bridging guideline was more complex than the Idarucizumab guideline and had multiple A4 sized pages. The document contained more information and had more highly specialised content (e.g. medical abbreviations, calculators, and protocols). Additional interviews were conducted with stakeholders (specialist anaesthetists) authoring the anticoagulation bridging guideline to help contextualise the guideline medical terminology, algorithms and outcomes.

The bridging guideline was described by the specialist anaesthetists (interviewed) as being complex and confusing to understand. Having dedicated months to collating the guideline's content, the anaesthetists recognised the difficulty of succinctly communicating multiple algorithms using single pieces

of paper. There was a desire for the guideline to be more adaptive to clinicians' needs. To enable clinicians to access the information from multiple medical perspectives, three entry points were identified within the guideline's content to initiate the guideline's adoption, helping to restructure the design and hierarchy of information. These included the following;

- What is the intensity of the patients' surgery?
- What medication is the patient taking?
- What is the reason the patient is taking the medication?

Each question required its own information stream, and would need to incorporate additional questions within its decision pathway to determine the medical outcome. In order to adapt the guideline's information to cater for multiple medical perspectives and entry points, its content needed to be visualised (Figure 21). For me to understand its complex decision pathways and processes, the information needed to be divided into stand alone modules of content. Once visualised, connections within the content were identified and interlinked accordingly to eliminate duplication within the three separate information streams. This enabled a distinct and systematic decision pathway to be created within the guideline's content.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

The complexities of compiling and presenting multiple facets of medical content into an adaptive information structure meant it was likely the adaptive structure couldn't be effectively communicated two dimensionally on paper. It required an integrated digital solution; one that clinicians could use in perioperative settings. Remembering that clinicians routinely carry personal smartphone devices and use them constantly, I proposed that a mobile app-based solution might be an integral part of the redesign strategy.

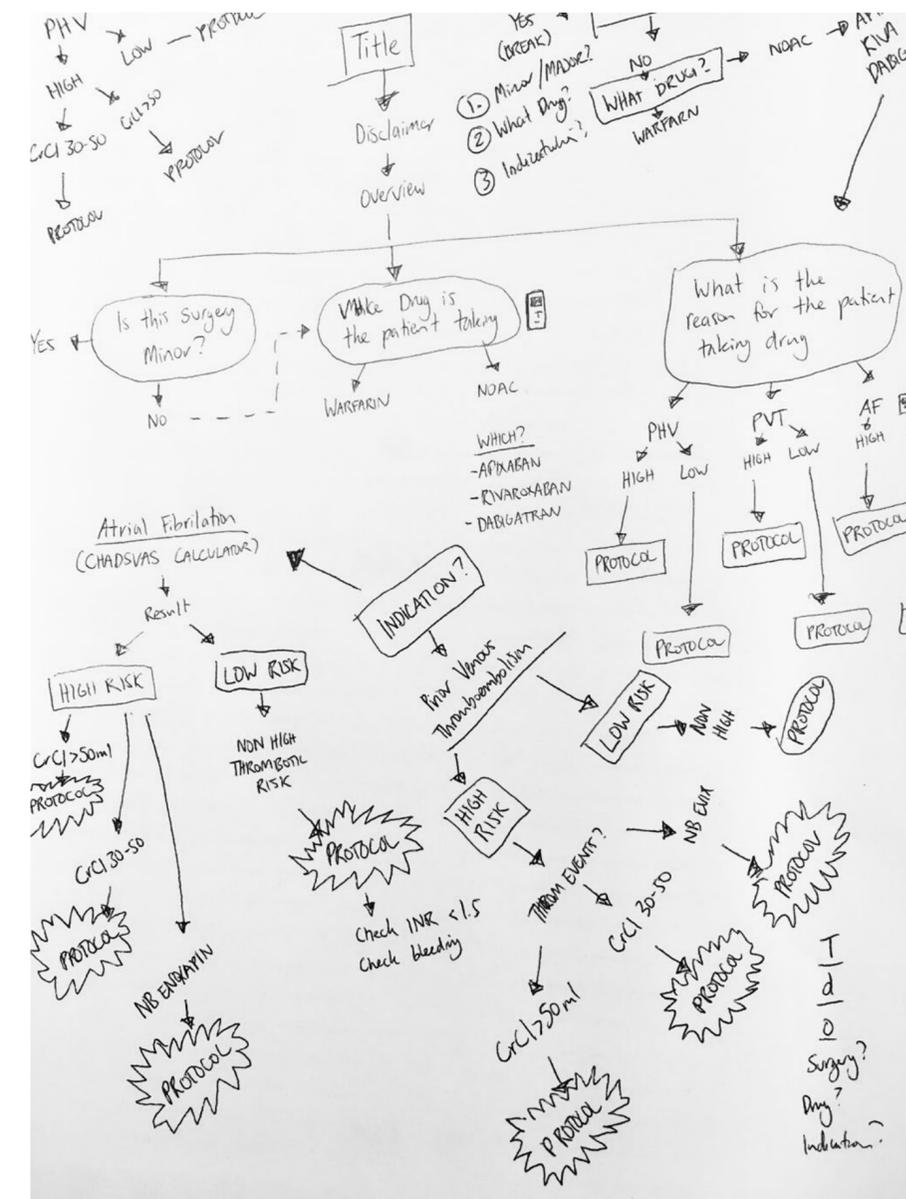


Figure 21. Thornhill, B. (2017). Initial anticoagulation bridging guideline algorithm concepts.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Wireframes and decision pathways

To ensure the complexity of medical information would accurately function in the bridging guideline, a software developer was recruited to work alongside me. Together we re-evaluated the information given to us by the anaesthetists and explored digital and web-based platforms, looking for digital opportunities to further refine and prototype the information.

The bridging guideline's contents were divided into independent categories; this helped me to understand the information complexity. Placing the content under simplified headings (categories) enabled me to arrange the information into basic structural skeletons. Hand drawn algorithms were used to sequence information, before being developed into digitally constructed wireframes and decision trees enabling me to visualise and compare different medical decision pathways and outcomes (Figure 22). Graphical arrows and colour boxes enabled me to reconnect content and restructure information into various decision pathways (Figure 23).

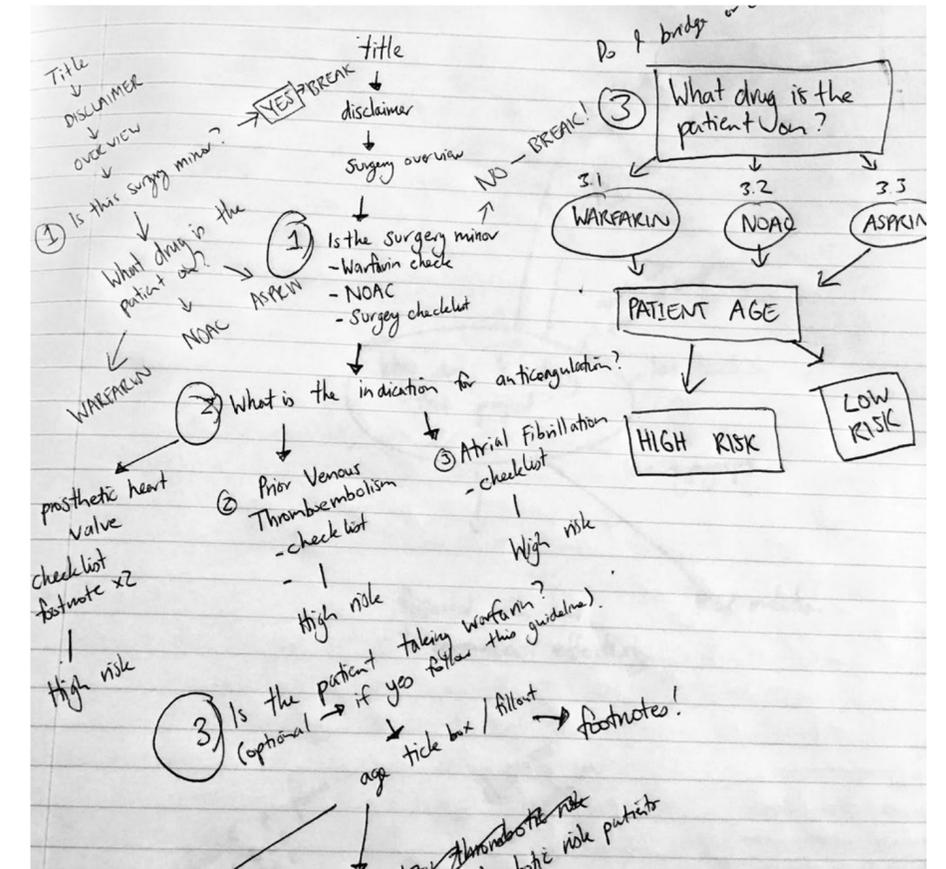


Figure 22. Thornhill, B. (2017). Hand drawn algorithms used to sequence the bridging guidelines information.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

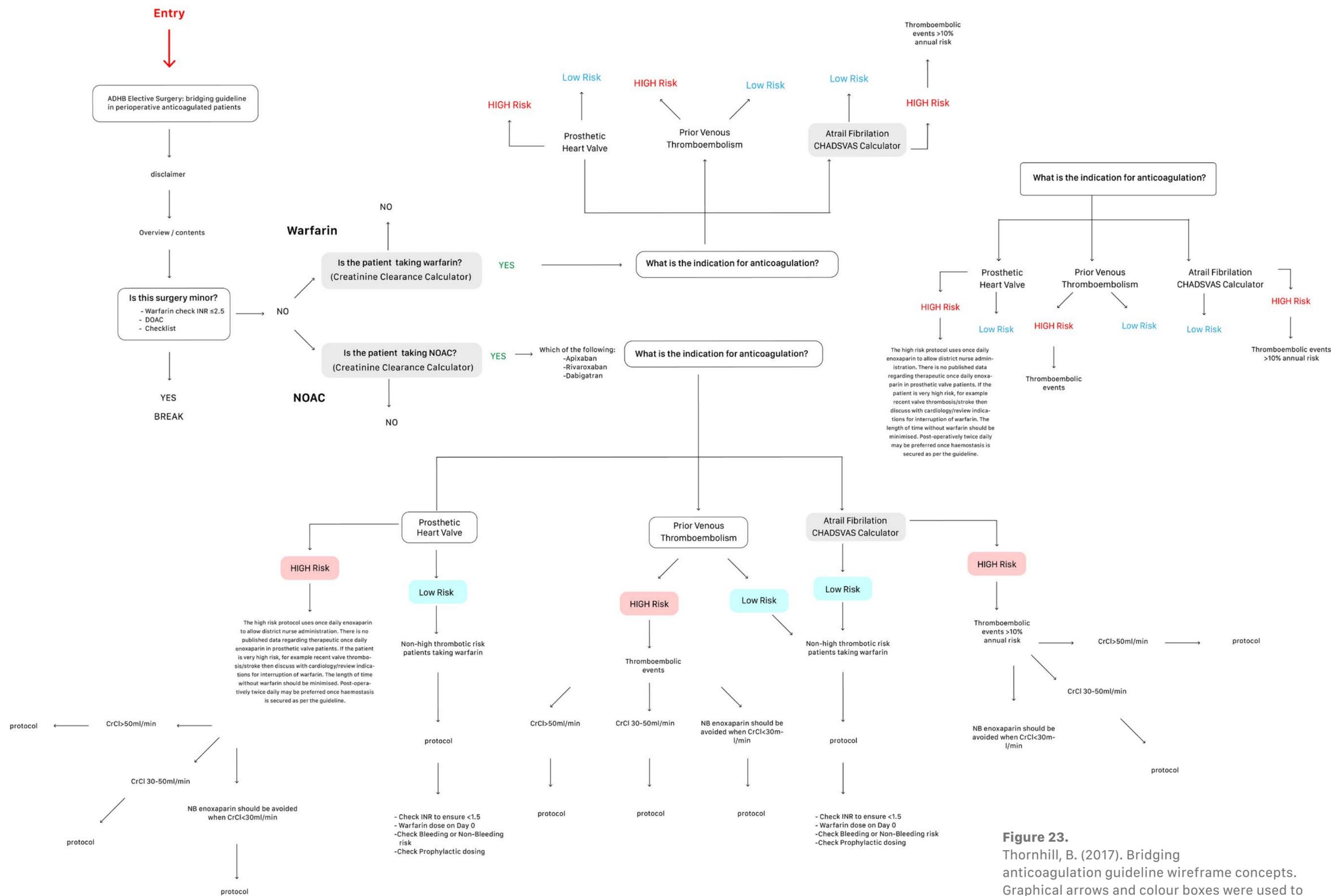


Figure 23. Thornhill, B. (2017). Bridging anticoagulation guideline wireframe concepts. Graphical arrows and colour boxes were used to reconnect content and restructure into various information pathways.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Multiple concepts and iterations were prototyped to develop an adaptable information structure within the guideline. Consultations with a board of anaesthetists informed the guidelines logic by aligning its functions to its clinical processes. This involved user testing the wireframe information structure and identifying issues with its functionality. Through iteration, the guideline's content was accurately restructured into three information streams (Figure 24). We conducted workshops with a focus group of senior clinicians; this finalised the guideline decision pathway (Figures 25 & 26).

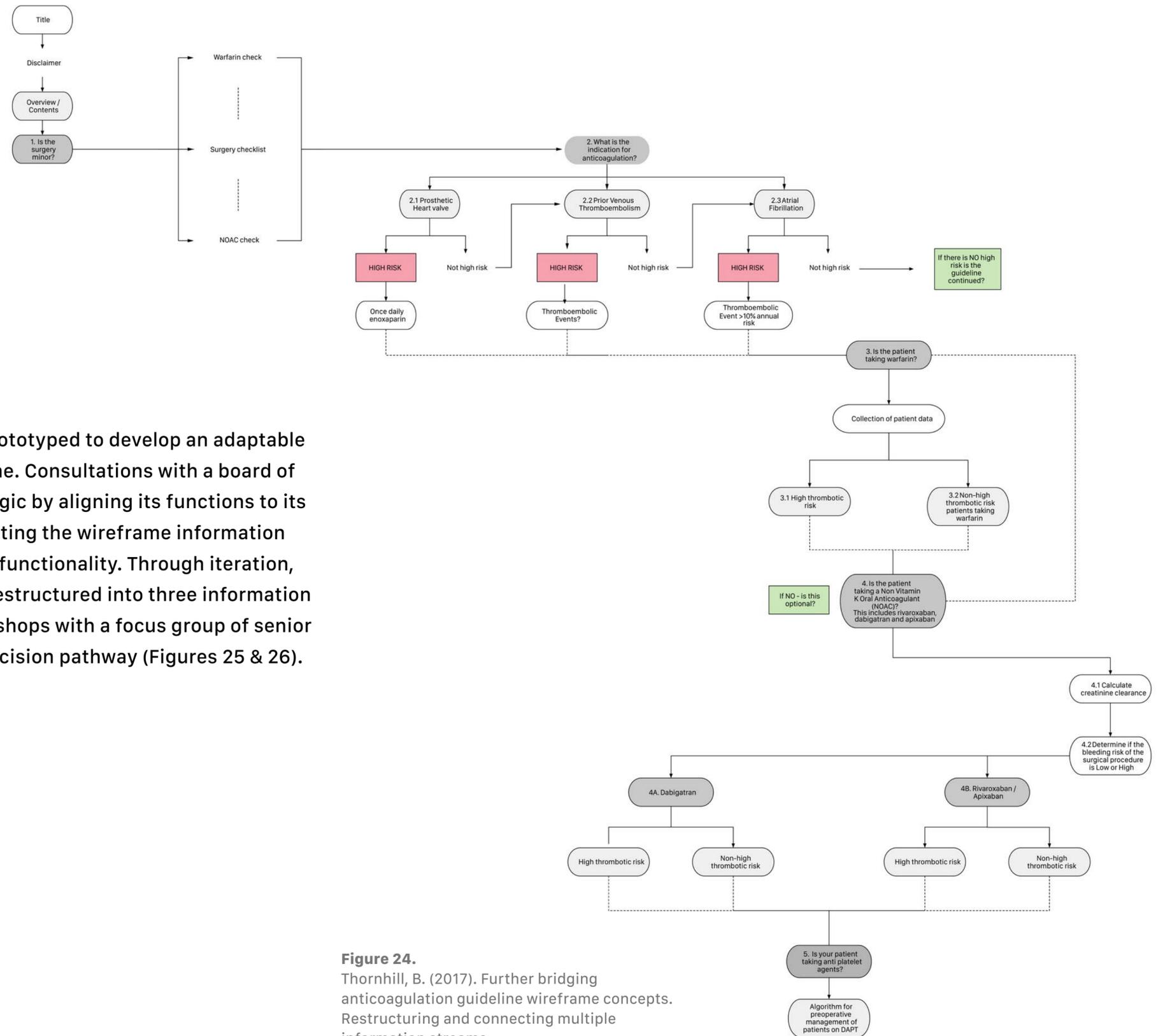


Figure 24. Thornhill, B. (2017). Further bridging anticoagulation guideline wireframe concepts. Restructuring and connecting multiple information streams.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements



Figure 25. Thornhill, B. (2017). Wireframe workshops with a focus group of senior clinicians finalised the guideline decision pathway no.1.

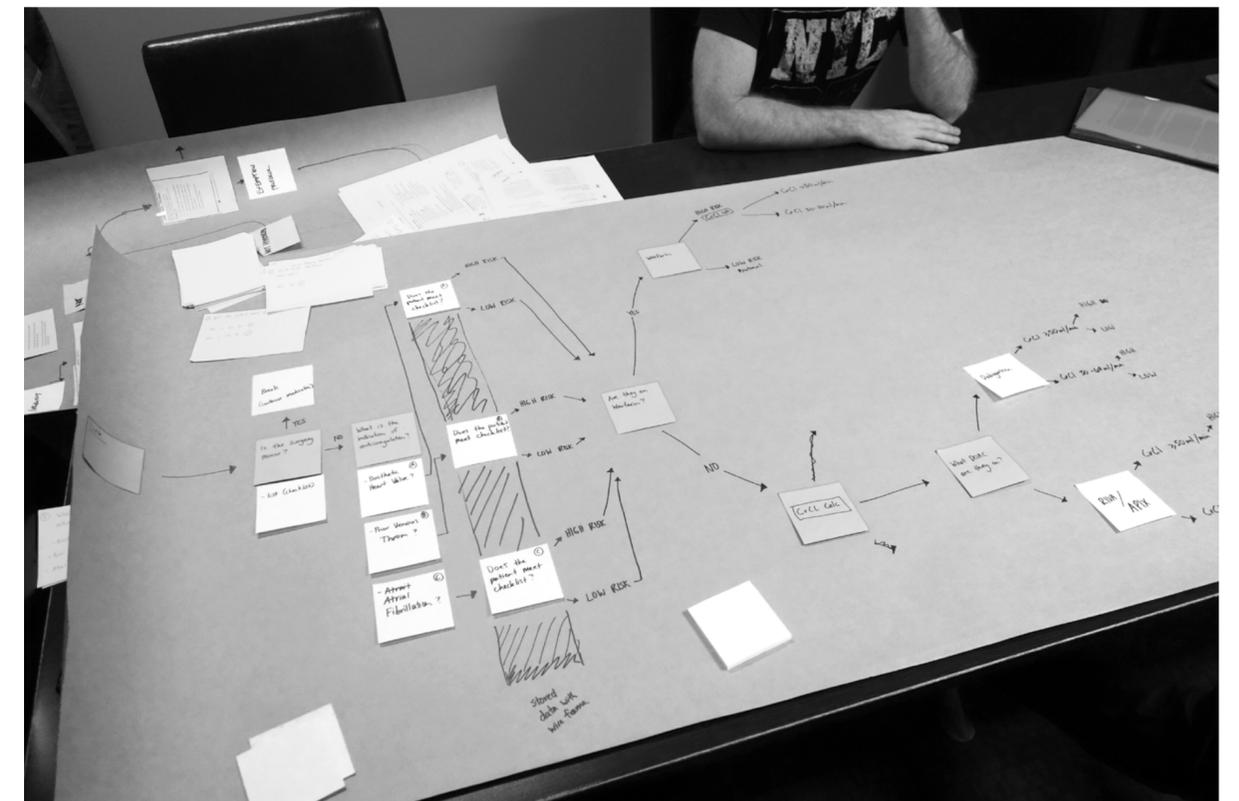


Figure 26. Thornhill, B. (2017). Wireframe workshops with a focus group of senior clinicians finalised the guideline decision pathway no.2.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Paper prototyping

Paper prototyping allowed us to arrange the guideline information into systematic processes that accommodated the clinician's experience and needs. Our process consisted of multiple paper cards containing a rough sketch, with each card representing a basic action in the guideline. As actions correlated to additional actions, the affiliated cards interlinked, forming an information structure of multiple decisions and outcomes (Figure 27). Any duplications of content were identified and eliminated from the information architecture, simplifying the information's functionality. This was a powerful prototyping tool. It enabled us to develop an adaptive information structure that would map on to various clinical decisions.



Figure 27.
Thornhill, B. (2017). Paper prototypes interlinked and formed an information structure.

¹⁷ Defined by Budi (2013), “**Native and hybrid apps** are installed in an app store, whereas web apps are mobile-optimized webpages that look like an app. Both hybrid and web apps render HTML web pages, but hybrid apps use app-embedded browsers to do that.”

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

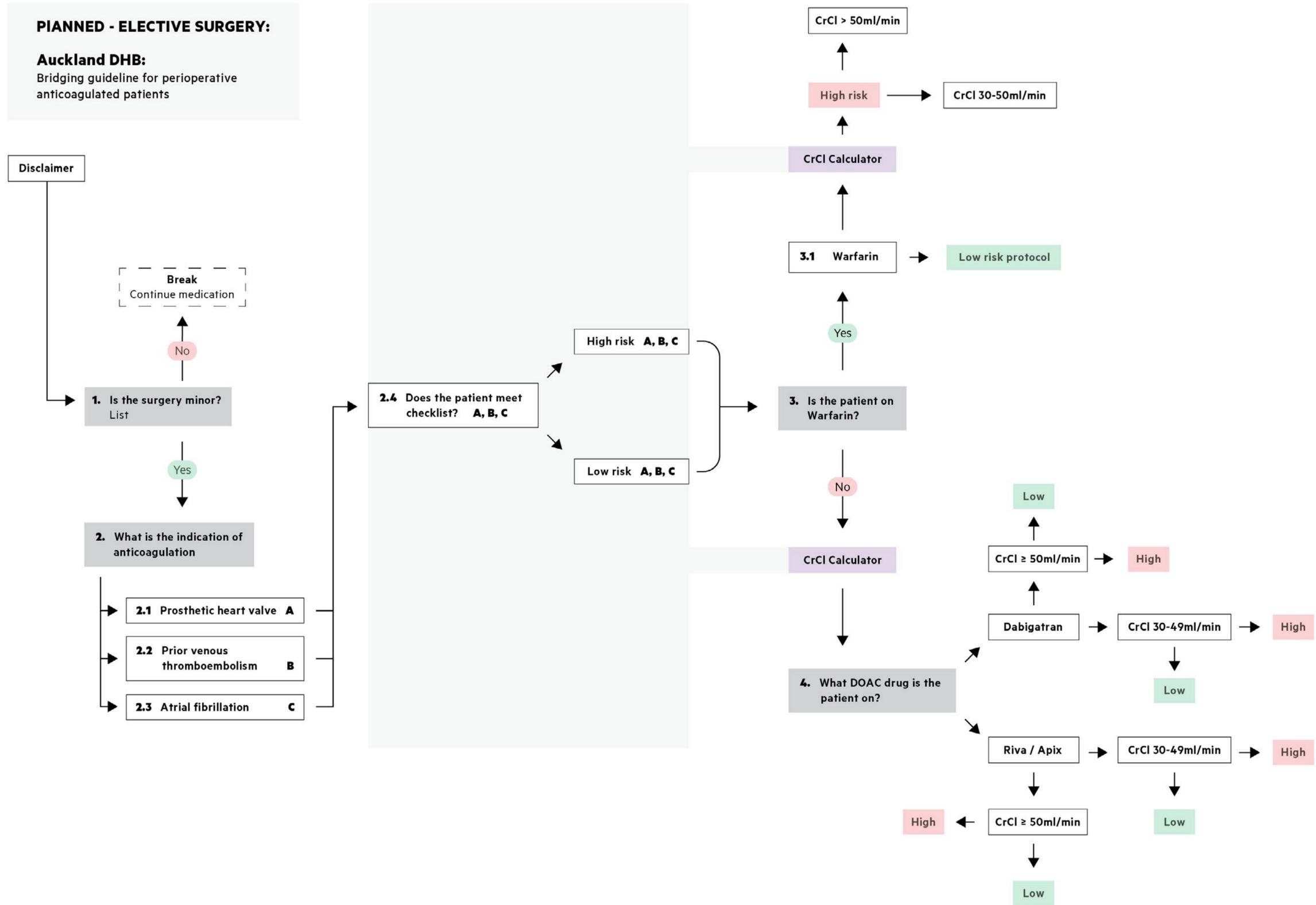
User interface refinements

Digital prototyping

Paper prototyping enabled the discovery of the bridging guideline wireframe. Next we explored other prototyping methods to recreate the guideline structure and contents digitally (Figure 28). Combining three streams of information was so complex that the guideline's architecture couldn't be easily realised on a single piece of paper. At this point, digital prototyping techniques were employed to systematically construct the information three dimensionally into a computer program. The information could then be crafted, tested and maintained virtually into a computer system/device, accurately assisting the clinician's decision-making while performing the medical task.

This involved investigating various web-based applications, comparing their prototyping capabilities and interactions before deciding on UX Pin as a prototyping tool. UX Pin worked well for our purposes because it enabled us to dynamically network multiple screens into a interactive information stream. Digital prototyping enabled the information to be constantly tested and refined throughout its development and realisation. The guideline's wireframe was developed into a user interface, linking digital content through a network of interactive buttons and web pages (Figure 29).

Assembled using basic headings and blue buttons, regular usability tests were conducted with specialist anaesthetists for us to gain further insights into the interface's wireframe and decision-making process. Through multiple refinements and consultations with the anaesthetists, an adaptive digital interface was developed. The interface was still a basic wireframe consisting of headings and interactive buttons, and the web-based application lacked versatility to incorporate all the guideline's content, excluding medical features, calculators and algorithms. In order for all the information to be adaptive within a complex user interface, the software developer had to program a native application¹⁷.



Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

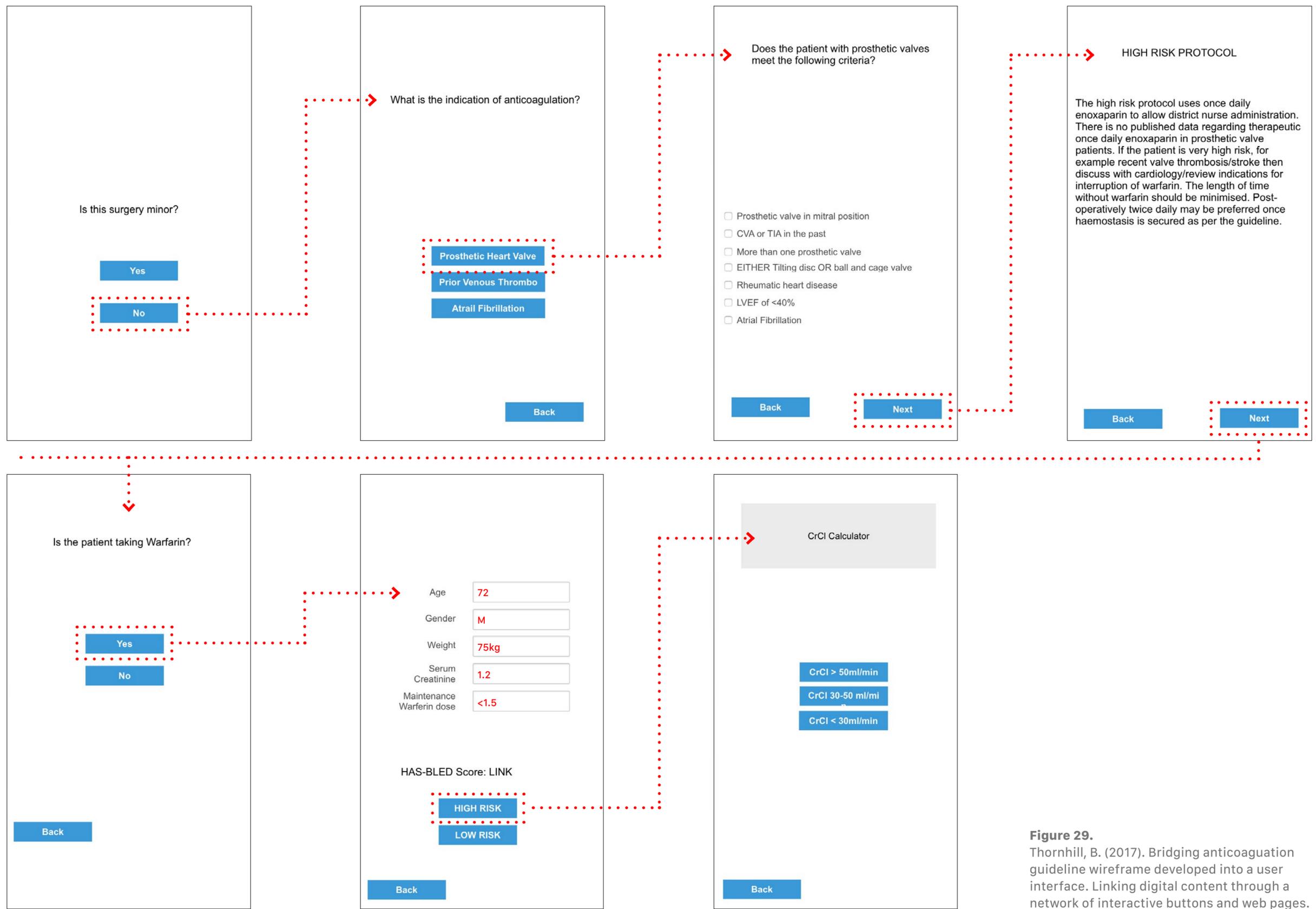
Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Figure 28. Thornhill, B. (2017). Bridging anticoagulation guideline information streams sequenced.



Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Figure 29. Thornhill, B. (2017). Bridging anticoagulation guideline wireframe developed into a user interface. Linking digital content through a network of interactive buttons and web pages.

Documentation of research

Reframing the project: 2

Documentation of research

Explorative design phase

Alongside developing wireframes and digital prototypes for the bridging guideline, the Idarucizumab guideline was also regenerated using a similar approach to the development of a digital solution tools and methods.

Although the Idarucizumab guideline had been redesigned to enable efficient and accurate decision-making for the clinicians using it, as a paper document, its retrieval and documentation processes were still problematic. Digital prototyping was identified as potentially being able to enhance the guideline's retrieval and documentation processes.

Capturing insights

Reframing the project: 1

Although the redesigned Idarucizumab guideline developed in the exploration phase of this project was currently archived at Auckland City Hospital; it was clear after I completed the information architecture and digital prototyping of the bridging guideline that the Idarucizumab printed guideline misinterpreted certain decision outputs, which compromised its accuracy. Accordingly, the Idarucizumab guideline's document's information design was refined using the same wireframing and paper prototyping methods as used for the bridging guidelines (Figure 30). These had proved effective, so I was confident of good results when applying them to the Idarucizumab guideline. The refined Idarucizumab guideline was rereleased and archived on the Auckland DHB intranet (Figure 31).

Due to the timeframe of this research, it was not feasible to develop both the anticoagulation bridging and the Idarucizumab guidelines into digital applications complete with user interfaces. The project's stakeholders (anaesthetists, software developer) made a collective decision to develop the Idarucizumab guideline into a digital prototype and application.

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

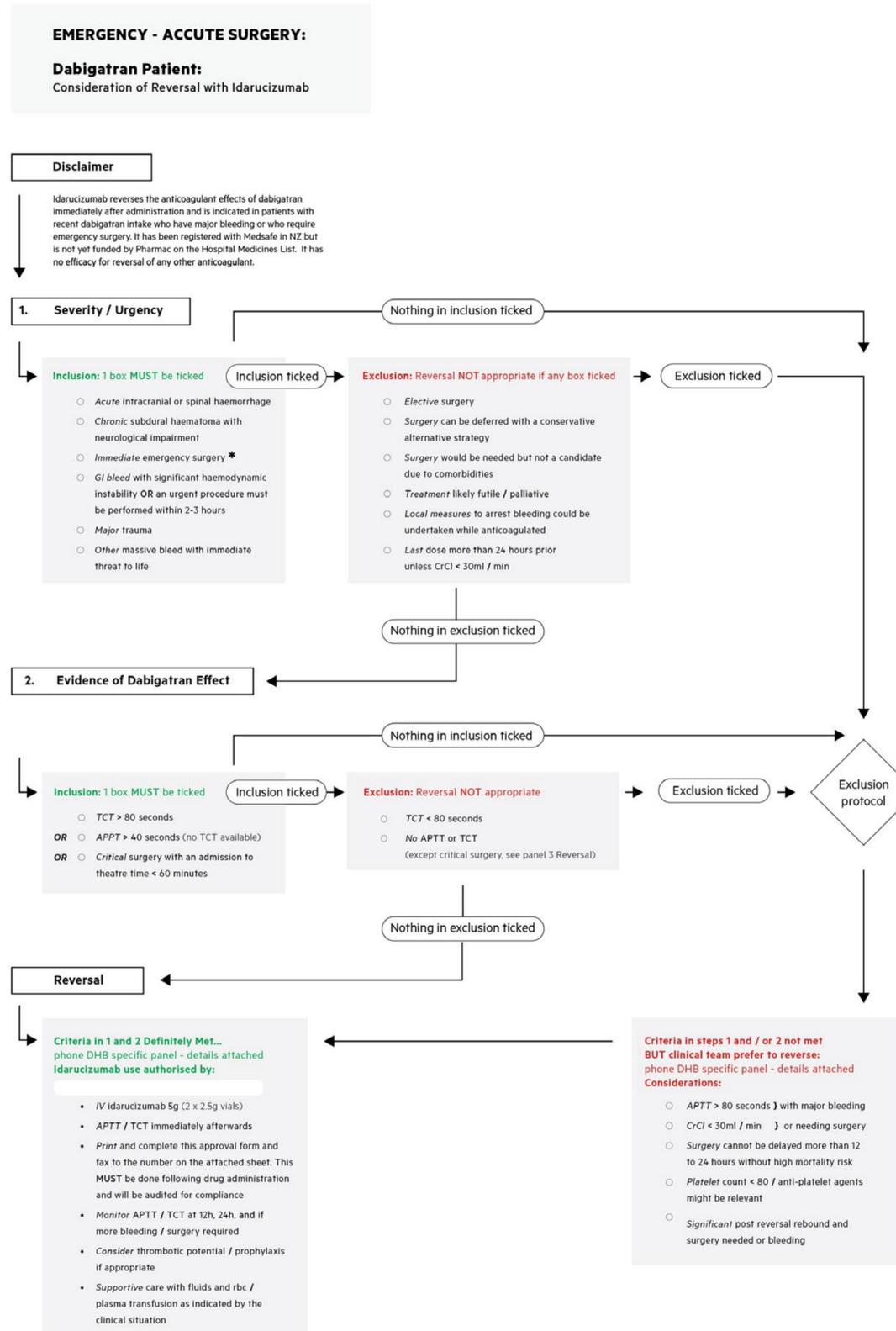


Figure 30. Thornhill, B. (2017). Idarucizumab guideline information restructured into a wireframe.



patient label here

Dabigatran Patient:
Consideration of Reversal with Idarucizumab

Urgent APTT, TCT and (if available) a dabigatran level MUST be requested on a BLUE tube

1

Severity / Urgency

Inclusion: 1 box MUST be ticked

- Acute intracranial or spinal haemorrhage
- Chronic subdural haematoma with neurological impairment
- Immediate emergency surgery*
- GI bleed with significant haemodynamic instability OR an urgent procedure must be performed within 2-3 hours
- Major trauma
- Other massive bleed with immediate threat to life

Exclusion: Reversal NOT appropriate if any box ticked

- Elective surgery
- Surgery can be deferred with a conservative alternative strategy
- Treatment likely futile / palliative
- Local measures to arrest bleeding could be undertaken while anticoagulated

*** Surgery should be deferred as long as safely possible:**

- The coagulation tests must be assessed for step 2 within 2 hours of the procedure to ensure that reversal is still necessary
- IV fluids should be given to enhance clearance
- Most surgical procedures can be undertaken with a dabigatran level of < 40ng / L (TCT should be normal for neuraxial anaesthesia to be considered)
- Consider intraoperative use of idarucizumab if bleeding occurs rather than upfront use

2

Evidence of Dabigatran Effect

Inclusion: 1 box MUST be ticked

- TCT > 80 seconds
- OR APTT > 40 seconds (no TCT available)
- OR Emergency with an admission to theatre time < 60 minutes

Exclusion: Reversal NOT appropriate

- TCT < 80 seconds
- No APTT or TCT (except critical surgery, see panel 3 Reversal)

3

Reversal

Criteria in 1 and 2 Definitely Met
phone DHB specific panel – overleaf

- IV idarucizumab 5g (2 x 2.5g vials)
- APTT / TCT immediately afterwards
- Print and complete this approval form and fax to the number on the attached sheet. This MUST be done following drug administration and will be audited for compliance
- Monitor APTT / TCT at 12h, 24h, and if more bleeding / surgery required
- Consider thrombotic potential / prophylaxis if appropriate
- Supportive care with fluids and RBC / plasma transfusion as indicated by the clinical situationminutes

Criteria in steps 1 and / or 2 not met BUT clinical team prefer to reverse:
phone DHB specific panel - overleaf

Considerations:

- APTT > 80 seconds } with major bleeding
- CrCl < 30ml / min } or needing surgery
- Surgery cannot be delayed more than 12 to 24 hours without high mortality risk
- Platelet count < 80 / anti-platelet agents might be relevant
- Significant post reversal rebound and surgery needed or bleeding

Authorised by: _____

Fax completed form to extension 23557 pharmacy

Compassionate access to Idarucizumab (Praxbind) to reverse dabigatran at ADHB

If reversal is approved by one member of the panel then:

1. The idarucizumab (2 vials, one box) can be taken from the fridge in the Medication room (81077), Post Anaesthetic Care Unit (PACU), level 8 Operating Rooms
2. A label with the patient's NHI must be entered into the log kept with the product
3. Both vials (2.5g each) should be charted and administered each by an intravenous push over 1 to 2 minutes, and the APTT / TCT measured after 15 minutes
4. The approval form must be printed, completed and faxed to Pharmacy (ext 23557)

Idarucizumab reverses the anticoagulant effects of dabigatran immediately after administration and is indicated in patients with recent dabigatran intake who have major bleeding or who require emergency surgery. It has been registered with Medsafe in NZ but is not yet funded by Pharmac on the Hospital Medicines List. It has no efficacy for reversal of any other anticoagulant.

The criteria for reversal at Auckland DHB are shown on overleaf.

If your patient meets these criteria then phone one person on the panel below for approval.

If the criteria are not met but you are sure that reversal is required also please phone and discuss. Usage will be tracked and audited.

Panel members are not necessarily on call so it may be necessary to try more than one person. Haematology on call services should be called if no one can be reached.

Dr William Smith	021 111 2222
Dr Dora Clinton	021 222 3333
Dr Nicola Wilson	021 333 4444
Dr Dennis Donor	021 444 5555
Dr John Smith	021 555 6666

ext 23557

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Figure 31. Thornhill, B. (2017). Refined Idarucizumab guideline document.

Documentation of research

Prototyping: 2

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Android native application prototype

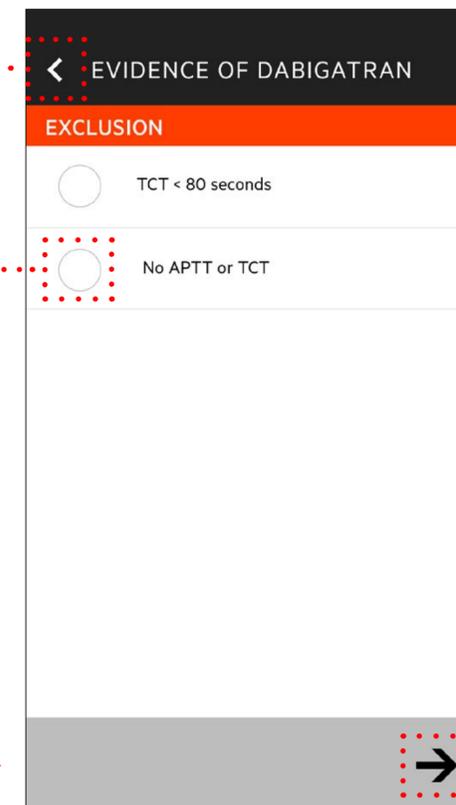
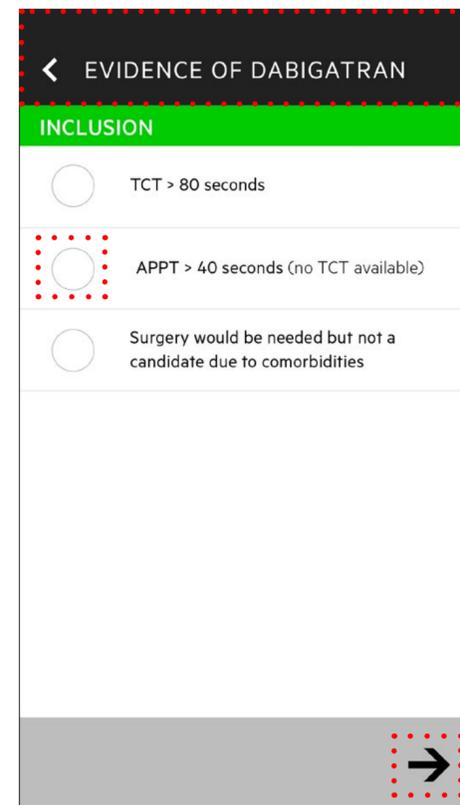
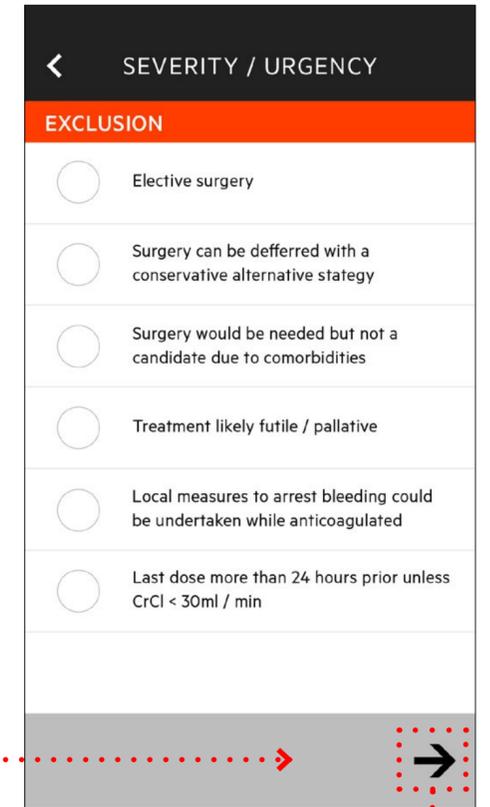
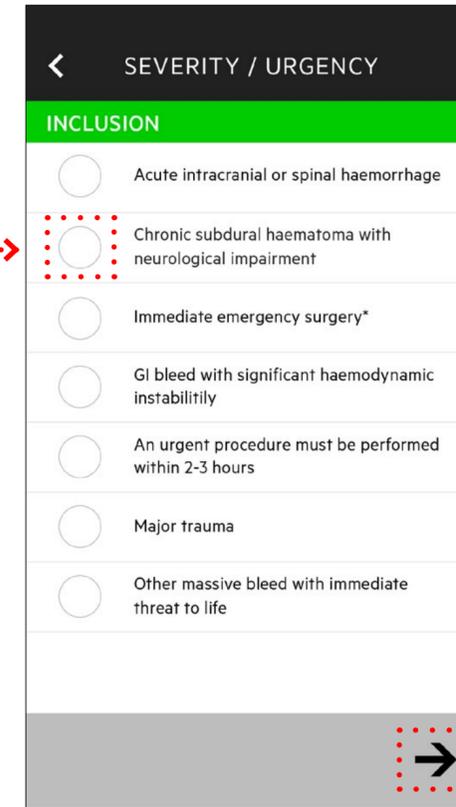
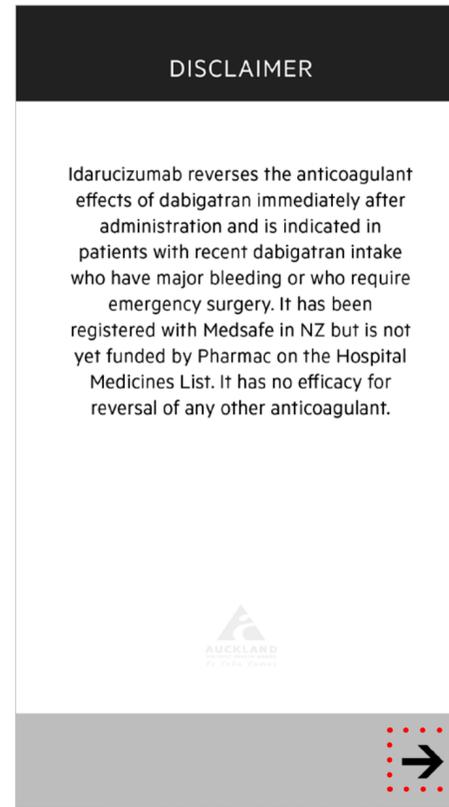
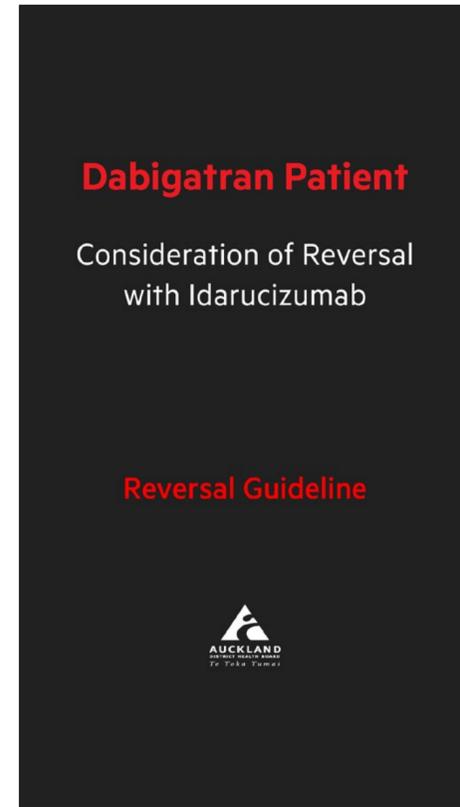
The Idarucizumab guideline was collaboratively developed by me and the software developer into an application program for android smartphone devices.

Initially, the guideline's information architecture was programmed into an adaptive interface, establishing a network of screen-based pages and was coded using Java (Figure 32). As an internal structure of the guideline information (Lupton & Cunningham, 2014), the interface consisted of basic headings and buttons linking the pages to organise the guideline's content into systematic and interactive decision pathways (Figure 33). Included within the prototypes development, an android smartphone device was used to test and refine the guideline's decision processes within its interface, enabling the live testing of each iteration (Figure 34).



Figure 32. Thornhill, B. (2017). The guideline's information architecture was coded using Java into an adaptive interface.

Figure 33. Thornhill, B. (2017). Basic headings and buttons designed and arranged into a user interface.



Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

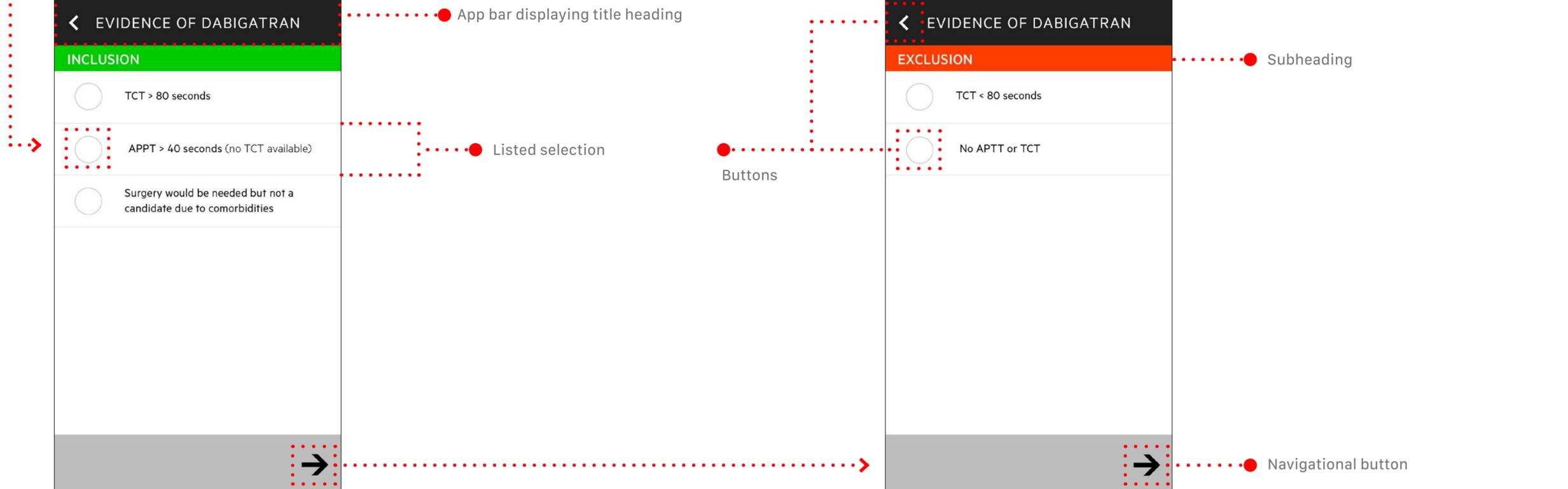
Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements



Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements



Figure 34.
Thornhill, B. (2017). An Android smartphone device was used to test and refine the guideline's decision processes within its interface.

Figure 35.
Thornhill, B (2017). Design concepts of the user interface incorporating icons, dialog boxes and windows.

18 Google's material design guidelines:
<https://material.io/guidelines/>

Drop down menus and dialogue boxes

Icons and pictograms

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

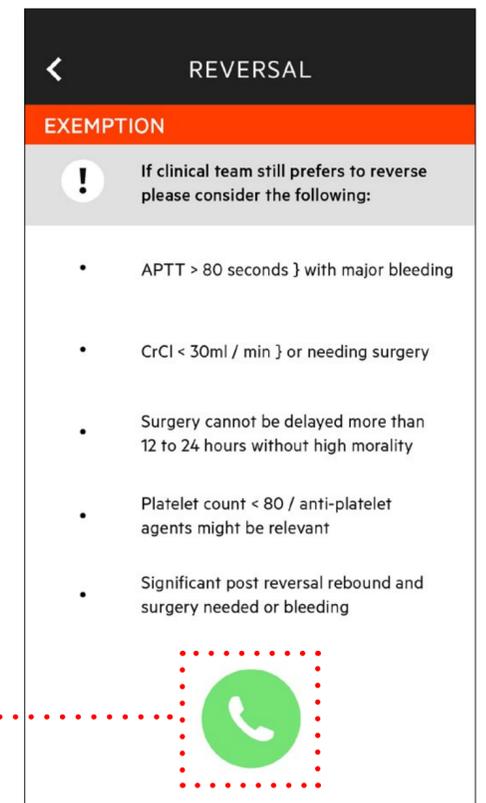
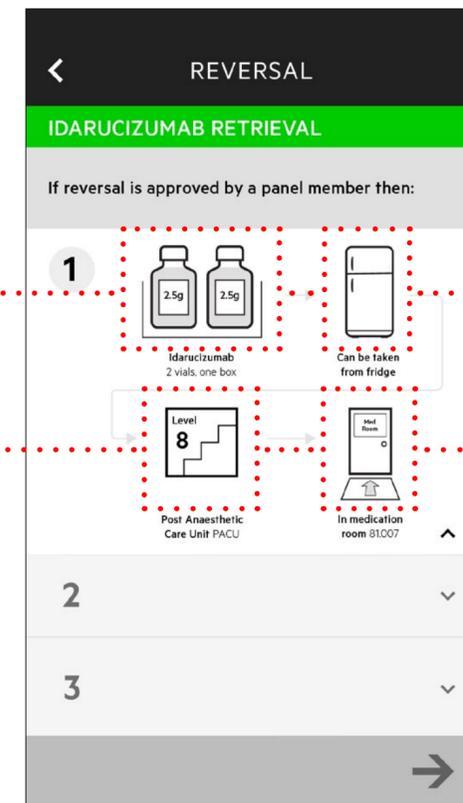
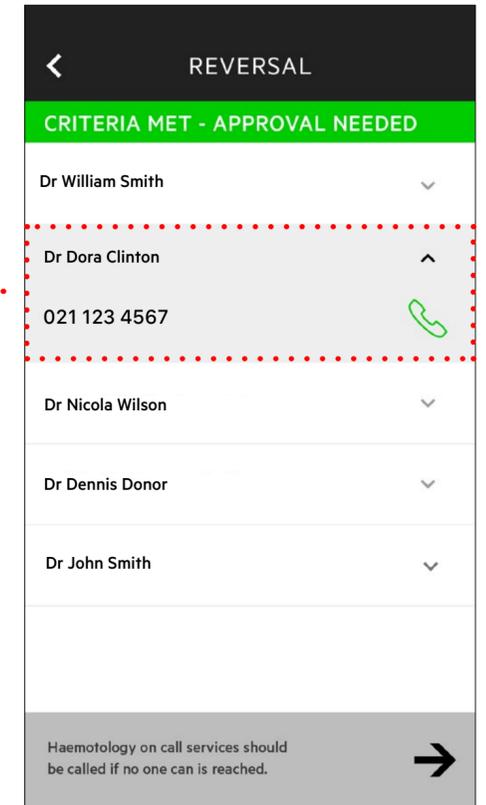
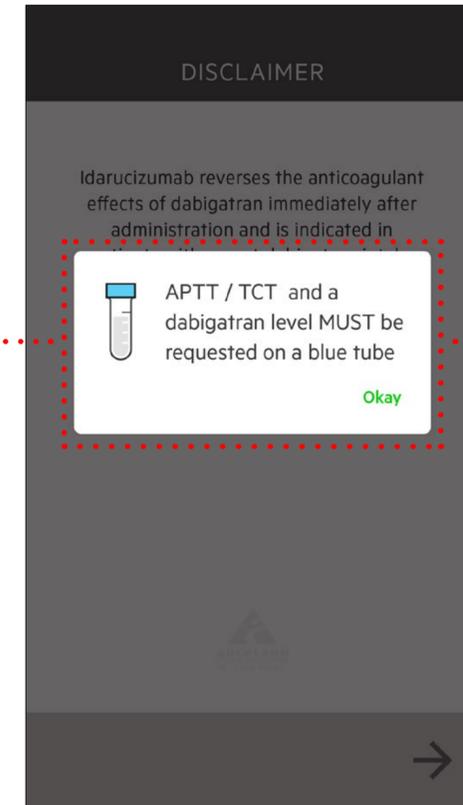
Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

At the user interface (UI) stage, graphic design principles, including typography, page layout and iconography, were applied. Focusing on the graphical appearance of the application, windows, icons and menus were designed and programmed to enhance the interface's usability and the user's experience (Figure 35). As the application's interface was programmed for a specific platform (Android), we referred to Google's online material design guidelines¹⁸; this influenced the design of the visual language and synthesised the user interface to be adaptable across the android platform. In order to design an underlying system to unify clinician's experiences when adopting the Idarucizumab guideline, the interfaces style, layout and components were prototyped digitally using Adobe's Creative Suite (Figure 36). Multiple concepts exploring colour palettes, icons and layout grids arranging the guideline's textual content were prototyped on device-sized screens within the computer software. As an iterative production process between myself and the software developer; the ability to co-design and assist each other throughout the prototypes production enabled an efficient process.



Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

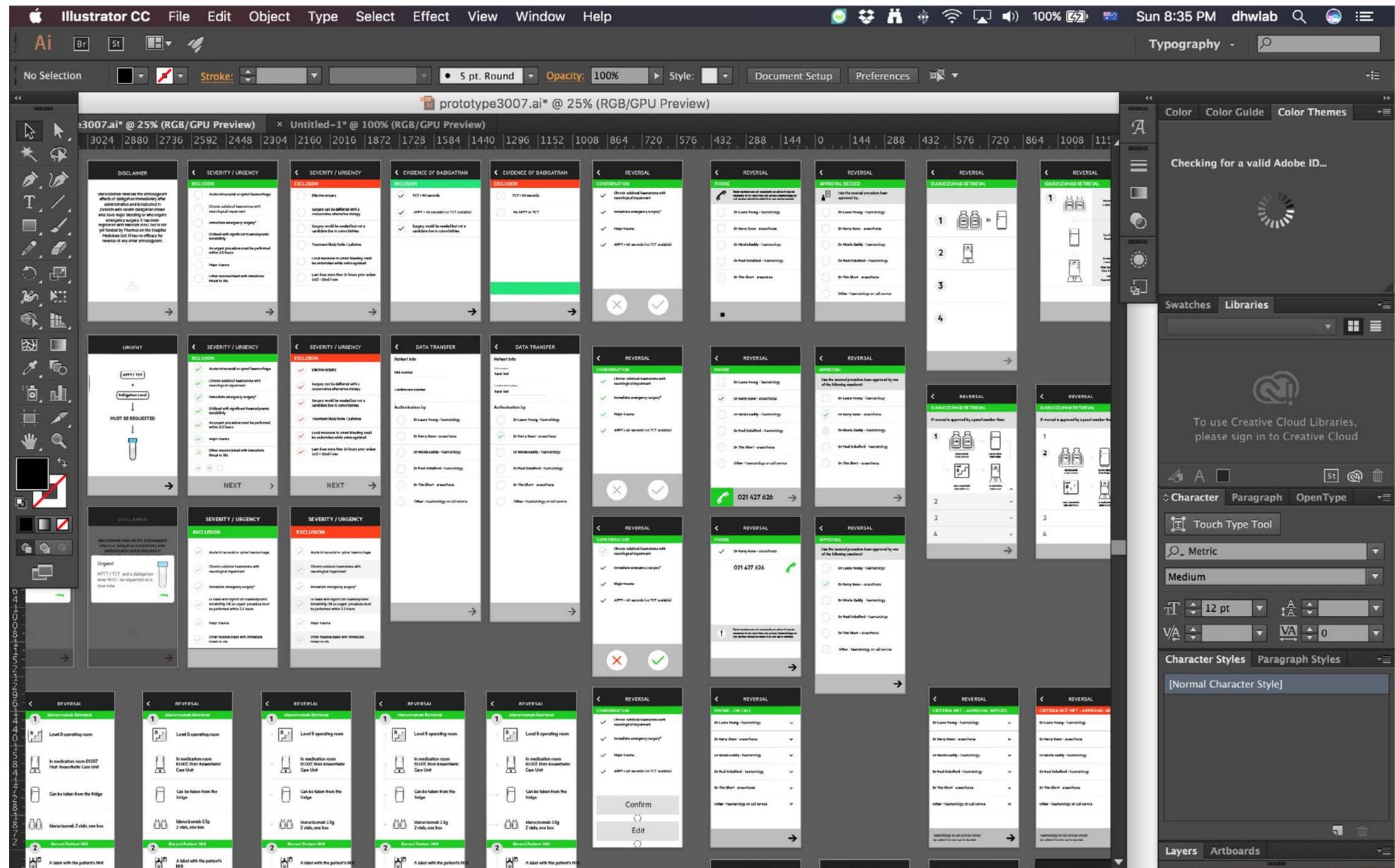


Figure 36. Thornhill, B. (2017). Interface style, layout and components prototyped using Adobe's Creative Suite.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Digitally designed material was supplied to the developer using precise pixel metrics administered within the applications programming. To act as visual shortcuts in perioperative environments where time is at a premium, icons were designed (Figures 37 & 38) to enhance functionality and navigation within the interface. Using the typographic knowledge gained during the explorative design phase earlier, I typeset text to enhance readability at small sizes, employing various font weights to establish hierarchy. The font Metric was compatible across multiple devices using the android platform. The existing processes for clinicians adopting the Idarucizumab guideline were incorporated into the application’s functionality, enabling the touchpoints within its administration to be sequenced and automated actually within the interface to save clinicians time in retrieving and documenting information. Interactive components (e.g. check boxes) in the user interface’s design were added to enable clinicians to physically interact with the information. Clinical actions and tests within the guideline administration could be emphasised and communicated incorporating ‘popup’ dialogue boxes, alerting and informing the clinician systematically as they progress through the app/content/guideline (Figure 35).

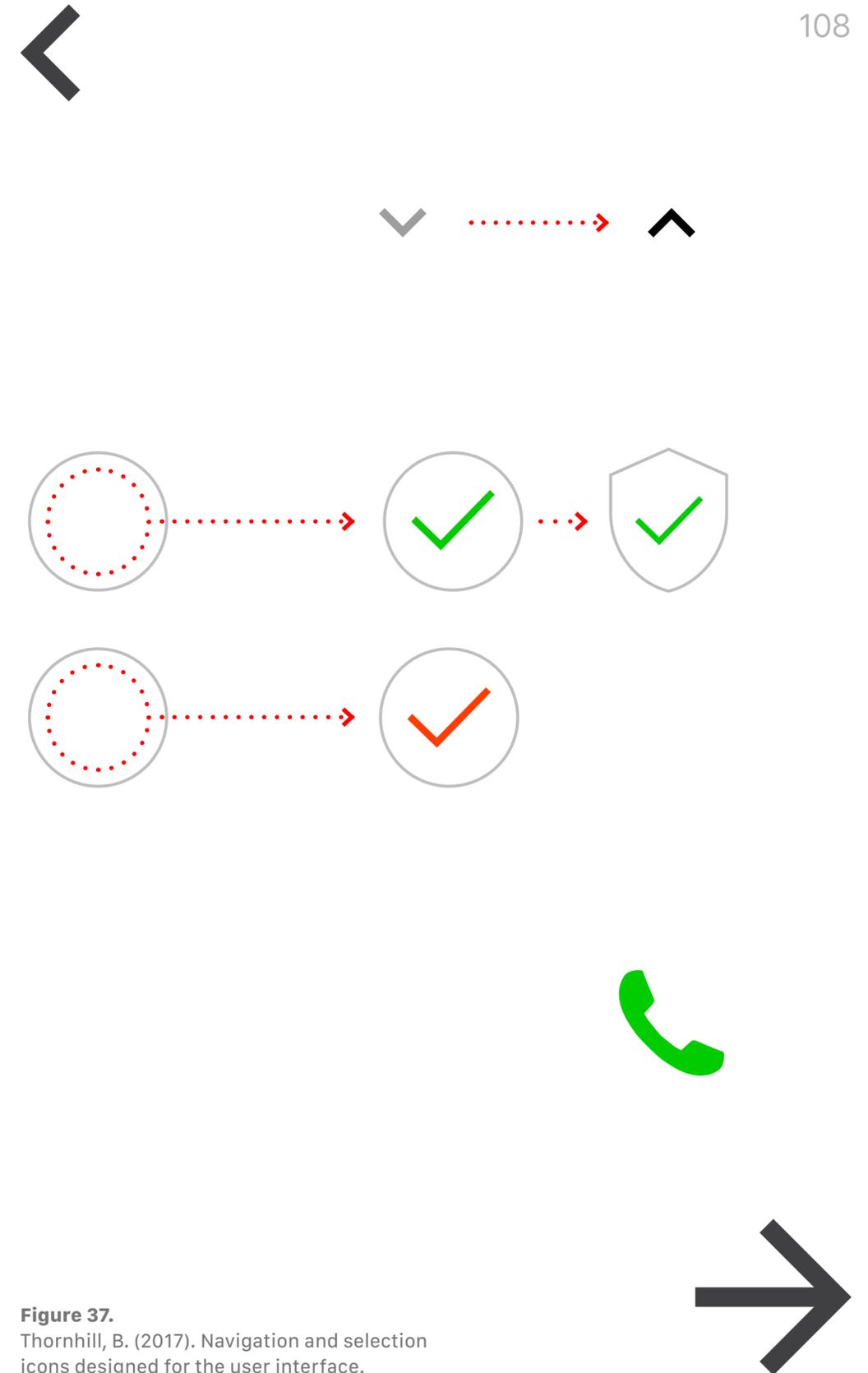


Figure 37.
 Thornhill, B. (2017). Navigation and selection icons designed for the user interface.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

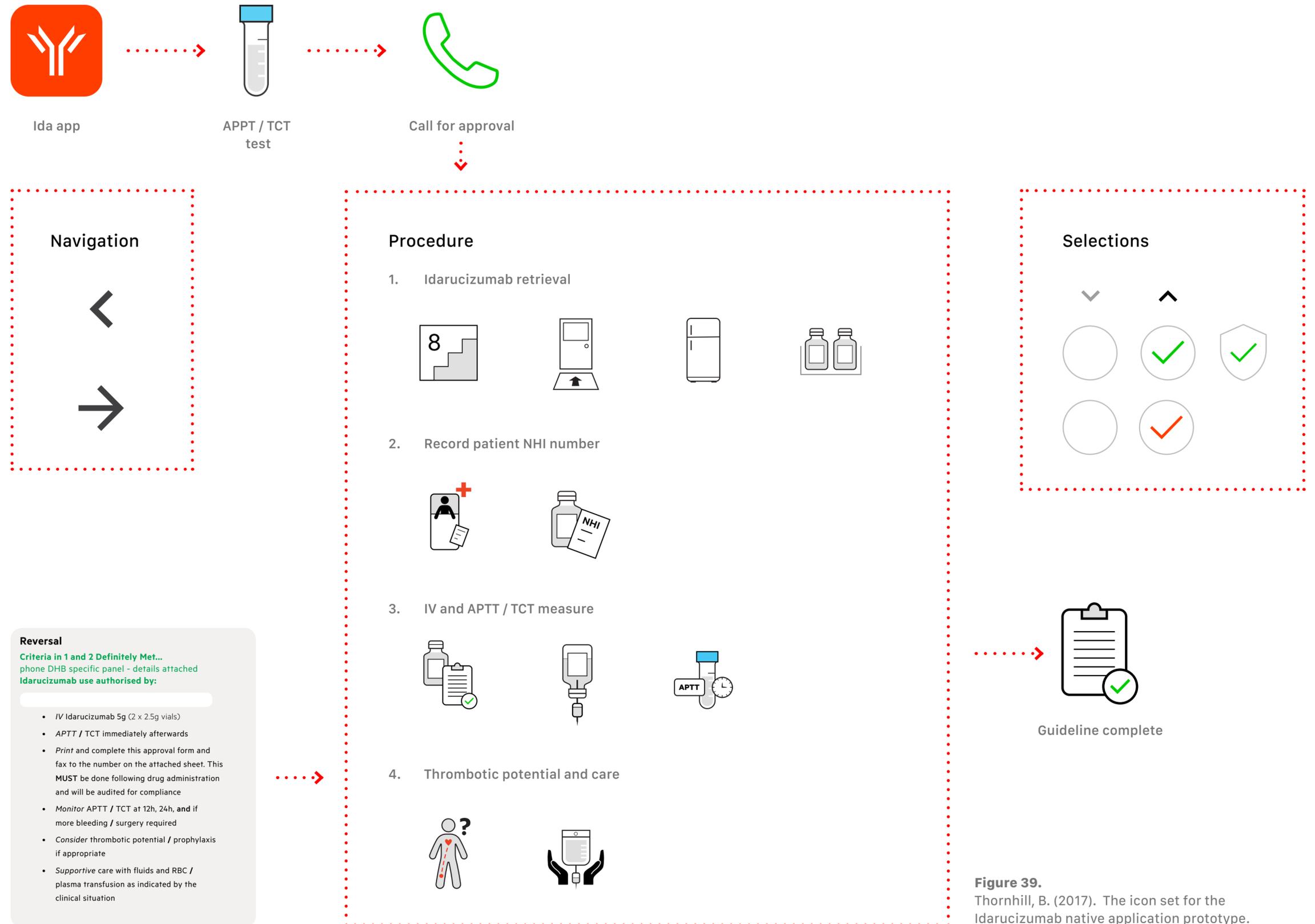


Figure 39. Thornhill, B. (2017). The icon set for the Idarucizumab native application prototype.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

As an application designed to be used on pocketable smartphone devices, the Idarucizumab guideline's interface was intended to enable 'anytime, anywhere' accessibility for clinicians. Being a smartphone application, phone call functionality was programmed into the interface so clinicians could easily contact the specific authorisation panel for the medication's approval. Also, the data from the clinician's selections could be aggregated and automated into email form at the end of the guideline completion process, enabling the recorded data to be electronically sent to the pharmacy department for archival purposes.

Subsequently, a working digital prototype was produced. The application was named "Ida" because this is what clinicians at Auckland DHBs nicknamed the Idarucizumab drug. The app prototype was user tested at Auckland City Hospital; results are discussed below.

Documentation of research

Ida: Smartphone prototype

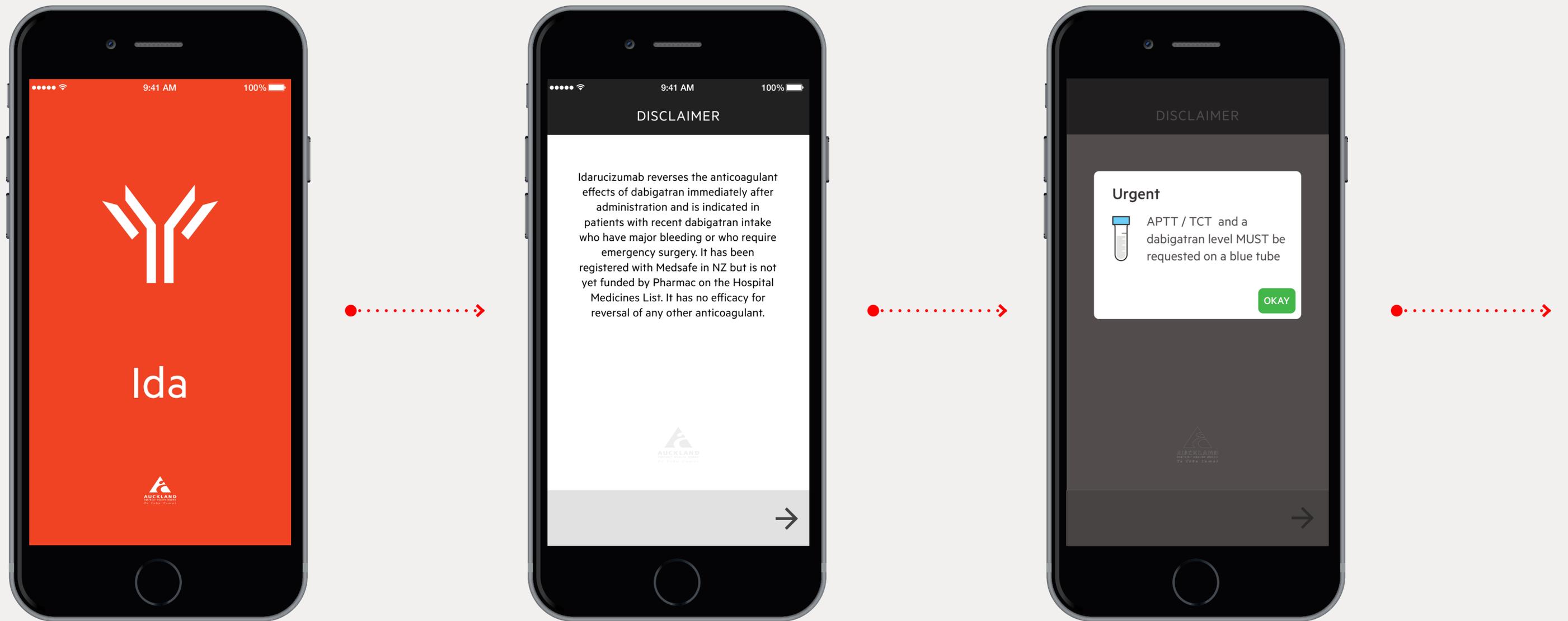
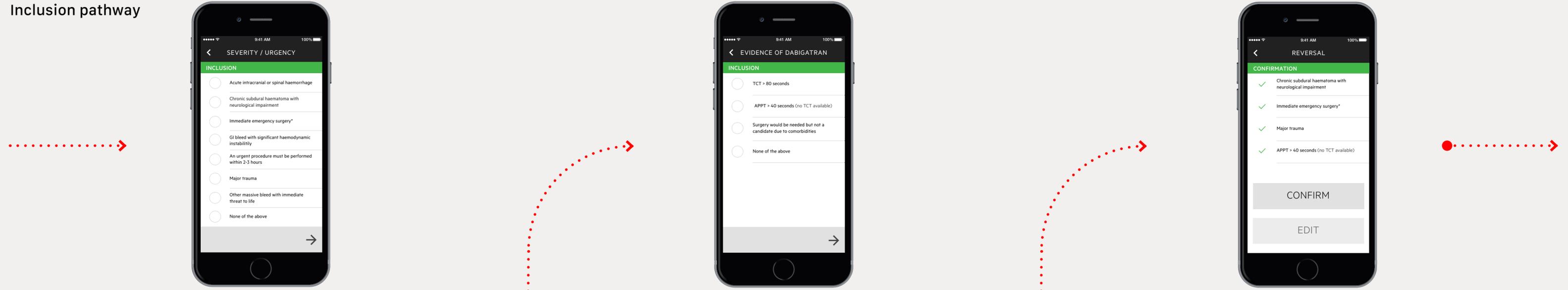


Figure 40.
Thornhill, B. (2017). Idarucizumab guideline application prototype no.1.

Inclusion pathway



Exclusion pathway

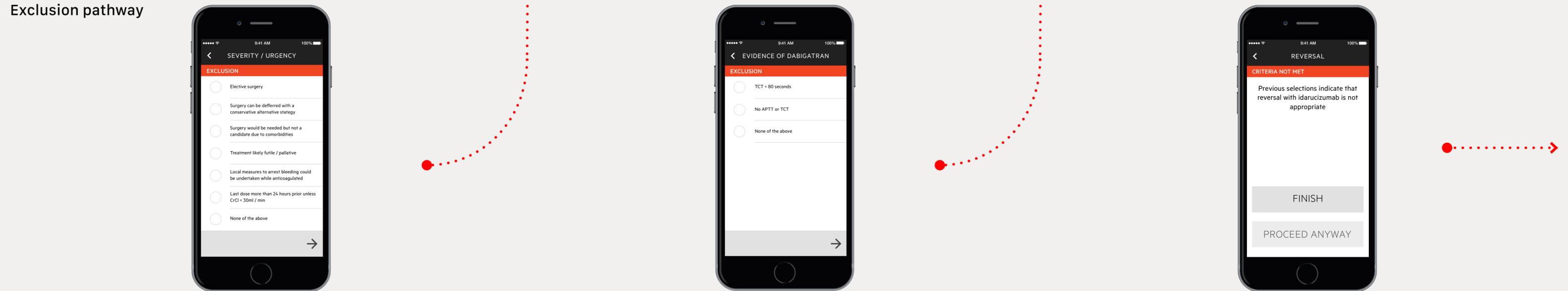
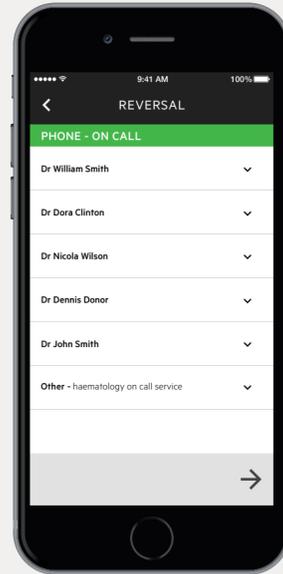
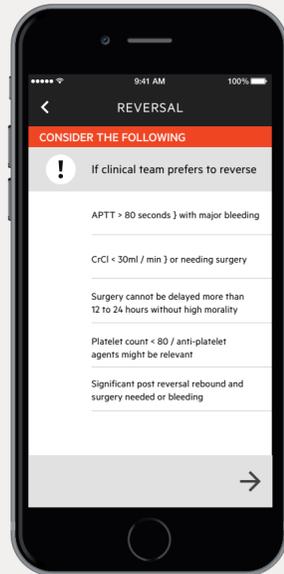


Figure 41.
Thornhill, B. (2017). Idarucizumab guideline application prototype no.2.

Phone for approval



Exclusion considerations



Phone for advice

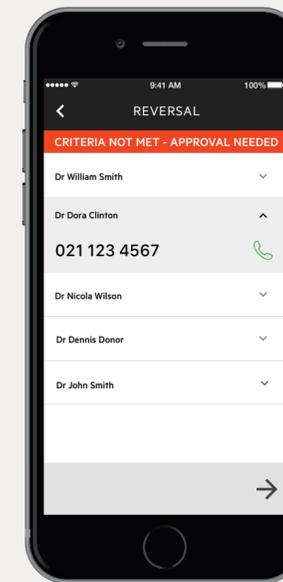
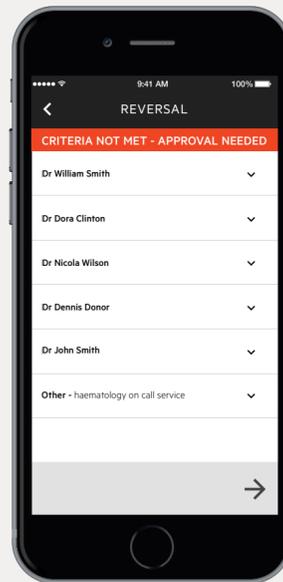


Figure 42.
Thornhill, B. (2017). Idarucizumab guideline application prototype no.3.

Idarucizumab Procedure

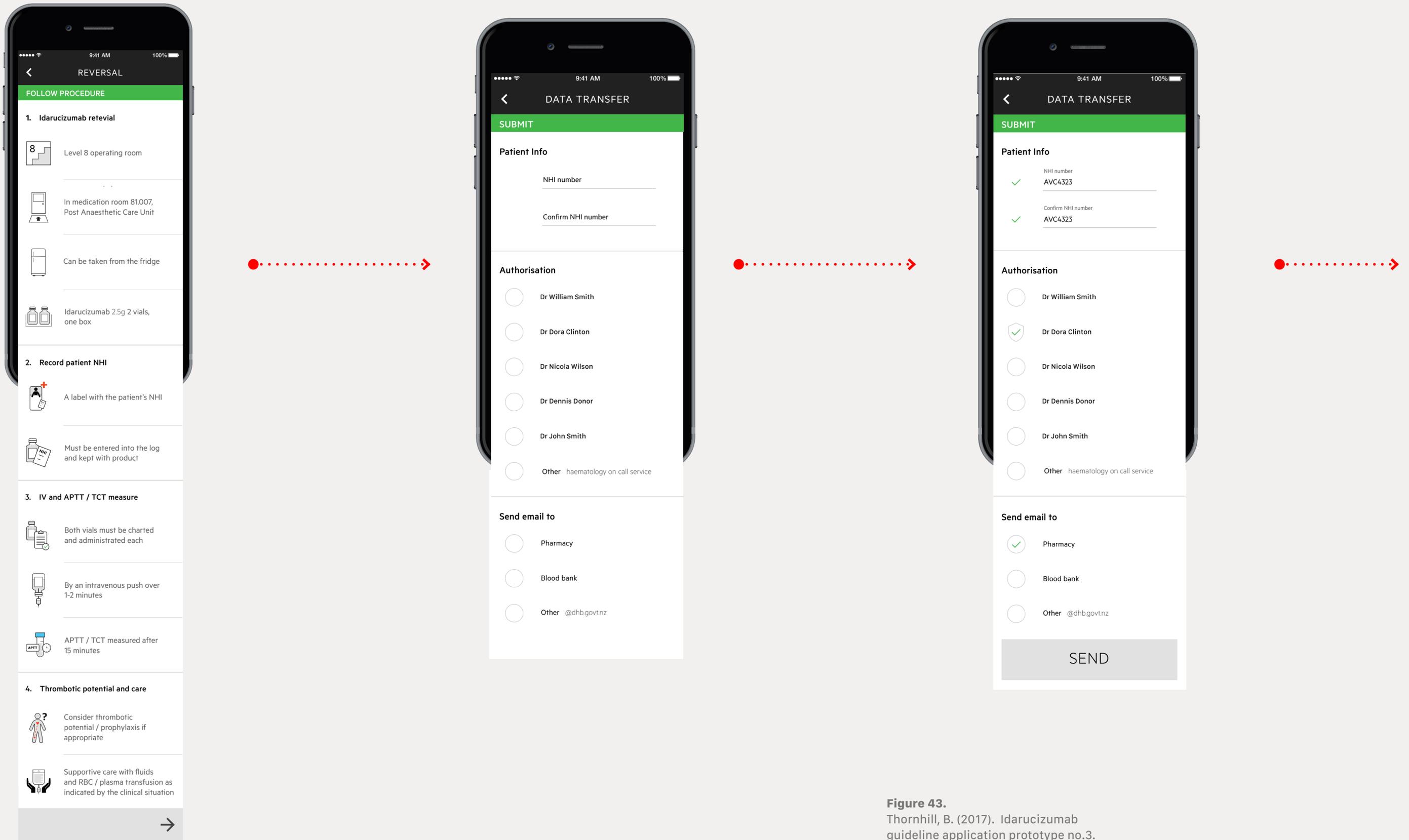


Figure 43. Thornhill, B. (2017). Idarucizumab guideline application prototype no.3.

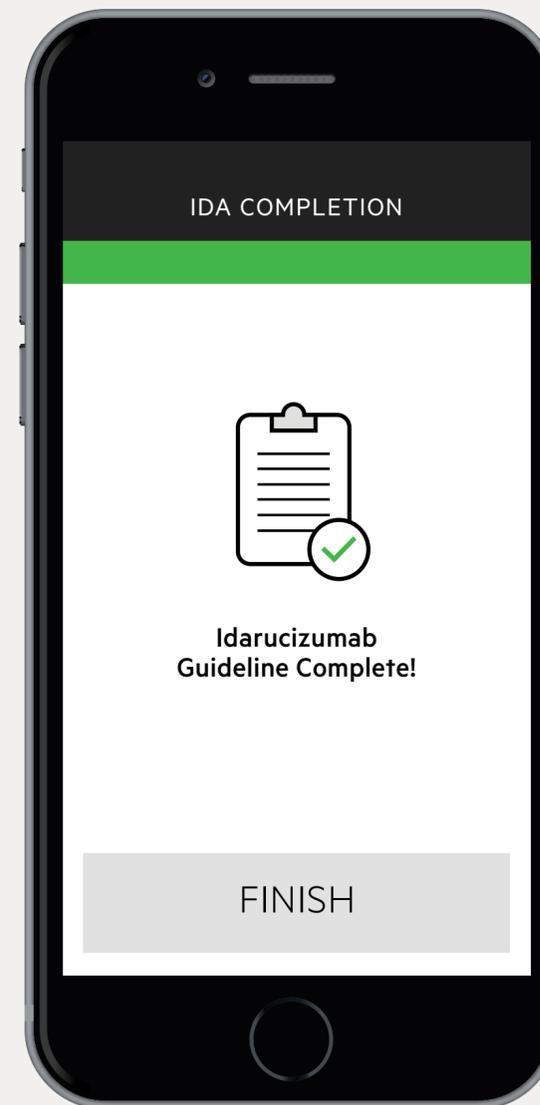
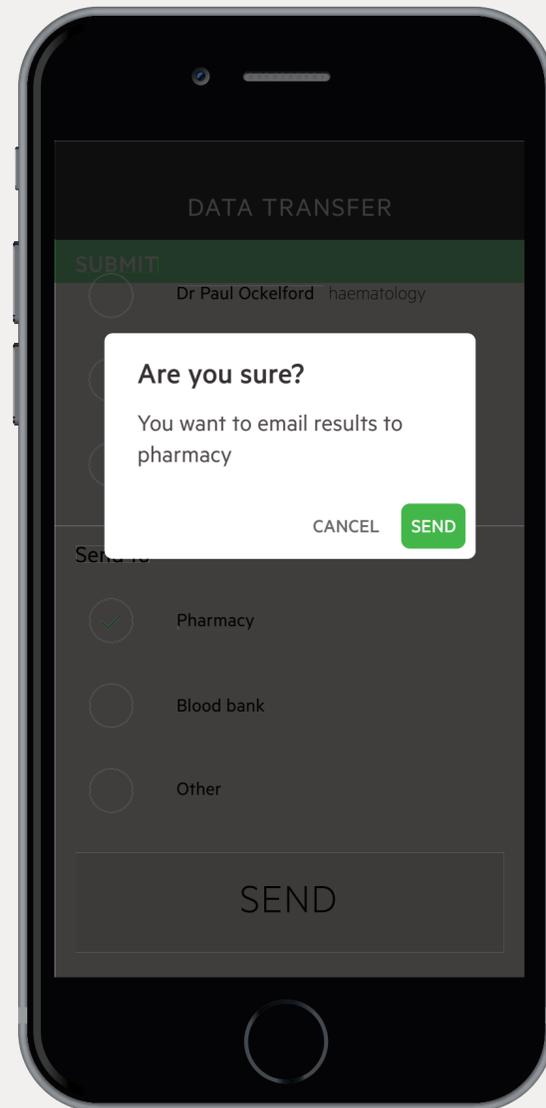


Figure 44.
Thornhill, B. (2017). Idarucizumab guideline application prototype no.4.

Documentation of research

User tests

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

To test the usability of the digital prototype, a series of user tests were conducted with Auckland City Hospital clinicians (Figure 45). The user tests incorporated pre-test and post-test questions to gain further insights on the participating clinicians' profile (job title, age), smartphone use, and evaluation of the application's interface and decision pathway. All user tests were recorded on a video camera capturing the clinicians' interactions, body language and comments as they used the guideline application. Reviewing the footage, I gained further understanding about the clinicians' reactions and interactions using the applications interface. These findings were noted and arranged into a data table¹⁹; this meant I could identify and compare clinicians' behavioural patterns. I summarised my findings and evaluations into two Acrobat pdf documents; one for novice and one for advanced users²⁰. From this I could identify the common issues faced by clinicians who tested the application's interface. The key insights gained from the analysis of these user tests are as follows.



Figure 45.
Thornhill, B. (2017). User testing clinicians.

21 MedCalcX (Pfiffner & Tschopp, 2016) application:
<http://medcalx.ch/>

22 Pedi Safe (iAnesthesia, 2017) application:
<http://www.ianesthesia.org/apps/pedi-safe/>

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Novice users



Anaesthetic Registrar x5

Male

Ages: 29, 30, 31, 31, 32



Senior House Officer x2

Male

Age: 26

Female

Age: 27



Anaesthetic Fellow

Female

Age: 33

Average age: 30

Smartphone device use amongst clinicians

All the clinicians tested used and owned an iOS device. All iPhone models were sixth generation or later and all the clinicians used medical applications on their iPhone device. Six out of the eight clinicians tested use the MEDcalcX²¹ application. Three out of eight clinicians tested use the PediSafe²² application.

Idarucizumab familiarisation

One out of eight clinicians was familiar with the Idarucizumab medicine. Five clinicians were not familiar, and two reported having "vaguely heard of the drug".

23 Reversing Warfarin (HealthObs, 2017)
application:
<https://itunes.apple.com/nz/app/reversing-warfarin/id641461083?mt=8>

24 Managing Dabigatran (HealthObs, 2017)
application:
<https://itunes.apple.com/nz/app/managing-Dabigatran/id498413737?mt=8>

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Advanced users



Specialist Anaesthetist x2

Male

Female

Age: 56

Age: 59



Clinical Director

Male

Age: 57



Haematologist

Female

Age: 42

Average age: 53.5

Smartphone device use amongst clinicians

The clinicians tested all owned an iOS device and personally carried their iPhone within surgical environments. All the iPhone models owned were sixth generation or later. There was a comment made by one clinician that around 10% of his department were "die hard anti iOS" and use android devices / phones. The clinicians all reported using medical applications on their iPhone device. All of the clinicians tested, download and use the NZ Blood Warfarin²³ application and three out of four use the Managing Dabigatran²⁴ application. There was a comment made by a clinician, "These things [applications] you don't normally refer to; they are there just in case."

Idarucizumab familiarisation

Three out of four are familiar with the Idarucizumab medicine.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Task scenario testing

To gain an understanding of how clinicians use the interface I needed to observe them using the application practically. Four realistic task scenarios²⁵ were created by the specialist anaesthetists enabling me to test the clinicians attempting to administrate Idarucizumab. Nielsen Norman Group (2014) suggests, "When the right participants attempt realistic activities, you gain qualitative insights into what is causing the user to have trouble ... helping you determine how to improve the design." I was able to measure the percentage of the tasks clinicians completed correctly while using the interface, communicating its overall usability.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Scenario 1

Novice users

Seven out of eight clinicians completed the scenario with the correct outcome. The one clinician who didn't reach the desired outcome admitted being new to Auckland DHB and has only been on the job for two months.

Advanced users

All clinicians completed the scenario to the correct outcome. Two clinicians initially overlooked the second inclusion selection within the guideline, calling into question the effectiveness of the application's decision pathway. The footage depicts both users skimming hastily through the guideline's selection screens. Once the scenario was restarted they both completed the scenario tasks successfully.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Scenario 2

Novice users

Six out of eight clinicians completed the scenario to the correct outcome. The one clinician who didn't was new to Auckland DHB and didn't understand the clinical scenario put forward. The second clinician seemed very frazzled with the scenario but also the functionality of the application as he skipped screens and didn't read the content correctly. As the clinician is excluded from the guideline, the clinician states, "I think I've missed something." The 'further considerations' screen was identified by the clinician as needing to be incorporated within the inclusion and exclusion decision pathways rather than after the clinician is excluded from the guideline.

As the clinicians successfully reached the 'not appropriate' screen within the application they were presented with two buttons; 'finish' and 'proceed anyway.' Two clinicians understood that the patient in the scenario was 'not appropriate' for the administration of Idarucizumab. They also mentioned wanting to get in contact with the member panel if they were unsure whether the drug should be approved. It was suggested by a clinician to include a contact list within this aspect of the application as then clinicians can call for advice.

Advanced users

All clinicians completed this scenario to the correct outcome with ease as the functionality of the application was clear after initially going through it. One clinician stated, "I like this a lot."

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Scenario 3

Novice users

Six out of eight clinicians reached the desired outcome but did so through the inclusion decision pathway. Although this would successfully administrate the medicine to the patient, the correct decision pathway was not achieved. Clinicians needed to proceed through the exclusion decision pathway where the 'proceed anyway' button would be presented and pressed. This would enable the clinician to gain approval via calling the medicines member panel. Only one clinician picked up on this function within the scenario. The same clinician stated, "even though the patient doesn't meet any of the criteria I would further discuss this situation with the haematology department." The clinician defined this scenario as a "grey area" and stated personally wanting to reverse the patient even though they didn't meet the criteria. It was here that seeking further advice from the member panel was necessary.

Advanced users

All clinicians met the desired outcome within this scenario but only one clinician did so through the correct decision pathway. This clinical scenario was described as being a "grey zone" where no inclusion within the guideline meets the patient diagnosis. Although no inclusions are appropriate, there is functionality within the application to bypass this and still gain administration of the drug through the 'not appropriate' selection screen. There are two buttons presented on this screen. First, a 'finish' button that when pressed sends the clinician to the disclaimer screen (start). A clinician said, "Once [the] application prompts 'finish' — advice is needed to be given regarding where or what to do next." Second, there is a 'proceed anyway' button that when pressed leads the clinician to a 'further considerations' screen before then allowing them to call the member panel to gain approval for the medicine. This 'proceed anyway' functionality caused hesitation and confusion for the clinicians. Two clinicians mentioned the 'proceed anyway' decision pathway needs more clarity regarding the protocol conditions that are included going forward. They felt it was not clear enough.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Scenario 4

Novice users

All clinicians reached the desired outcome for this scenario.

Advanced users

All clinicians finished the scenario tasks to the desired outcome with ease.

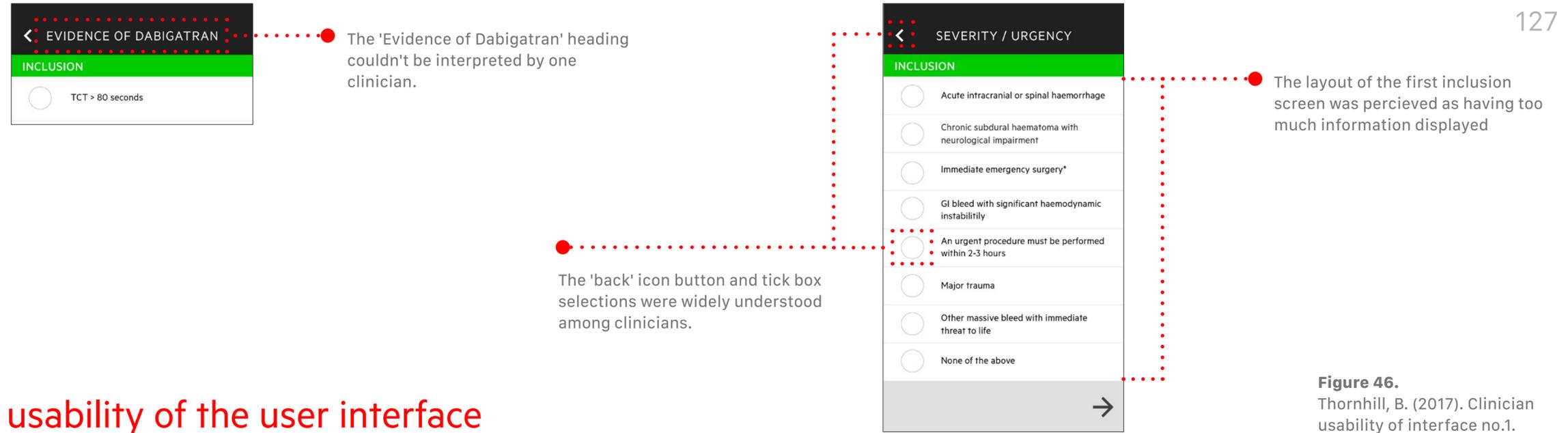


Figure 46. Thornhill, B. (2017). Clinician usability of interface no.1.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Clinician usability of the user interface

Novice users

The taps and buttons within the user interface were described by the clinicians as being easy and straightforward to use. One clinician stated, "It's easy to select what I want." All the clinicians identified a problem regarding the patient's NHI number input. There were a number of cases where clinicians had to re-enter the data as the keyboard component didn't collapse within the application. A clinician also asked whether the data input was case sensitive as NHI numbers always involve all capital letters. The icons were described as useful and clear. The 'back' icon within the application was also widely understood. One clinician suggested that two icons within the procedure screen could be further refined, as its communication was unclear. Another clinician mentioned that "simple tick and tap boxes are far superior as it's easily followed and understood. One clinician described the icons as being 'pretty' and didn't look at their function. It was also mentioned that the icons looked 'very cartoony' for a medical application. Only one clinician stated this as being a negative aspect of the designed icons.

The use of language and medical terminology throughout the guideline's content was clearly understood by five of the eight clinicians, although one clinician was unfamiliar with the medical abbreviation 'TCT'.

Another claimed the 'Dabigatran Evidence' heading presented in the inclusion and exclusion screens was problematic as the clinician couldn't interpret what it meant. The layout of the first inclusion screen was perceived as having too much information, with clinicians questioning whether all its selections were needed. After this first inclusion screen, the user interface was described as "flowing nicely". The readability and legibility of the font used (Metric) to display the applications information was described as being "easy to read," "clear" and "friendly." One clinician commented "I could read it clearly and I didn't even have my glasses on." Labels were regarded as being easy to read.

A software glitch was discovered by one of the clinicians where selections were not saved when trailing 'back' through the application to double check decisions. All clinicians responded positively to the procedure screen and followed the content with ease. A clinician stated "Direct steps help with process as a lot of the time when searching for the correct drug it is spent looking through a room filled with them. They are always looking around in a giant room full of drugs."

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

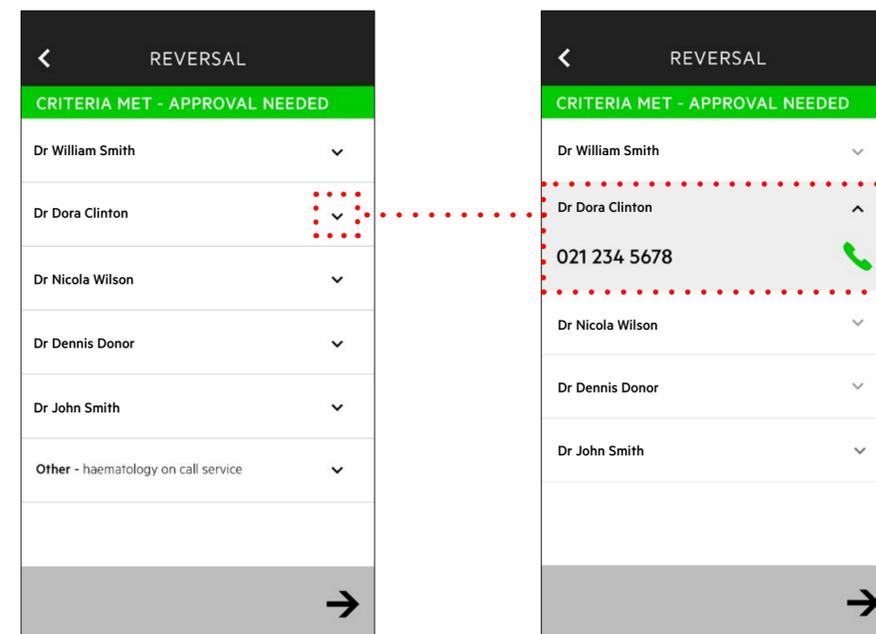
Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Four out of eight clinicians were confused when reaching the call screen within the application. Although all clinicians acknowledged the need to call the member panel to gain approval, when six different contacts are listed within the same screen there was hesitation about which contact to call. A clinician stated, "I would always call the Haematology Department as I have in the past." Regarding the usability of the call screen, clinicians hesitated when interacting with the dropdown menu. At first glance this screen was problematic as clinicians didn't know how to engage with the content within the screen. In the recorded footage, clinician's fingers hovered over different aspects of the 'Call' screen. One clinician was not able to make a decisive decision and interact intuitively with the screen. This caused an interruption of flow to decision-making. A clinician expressed the calling procedure as "hard to understand" and even questioned whether it was necessary to call a member from the approval panel.

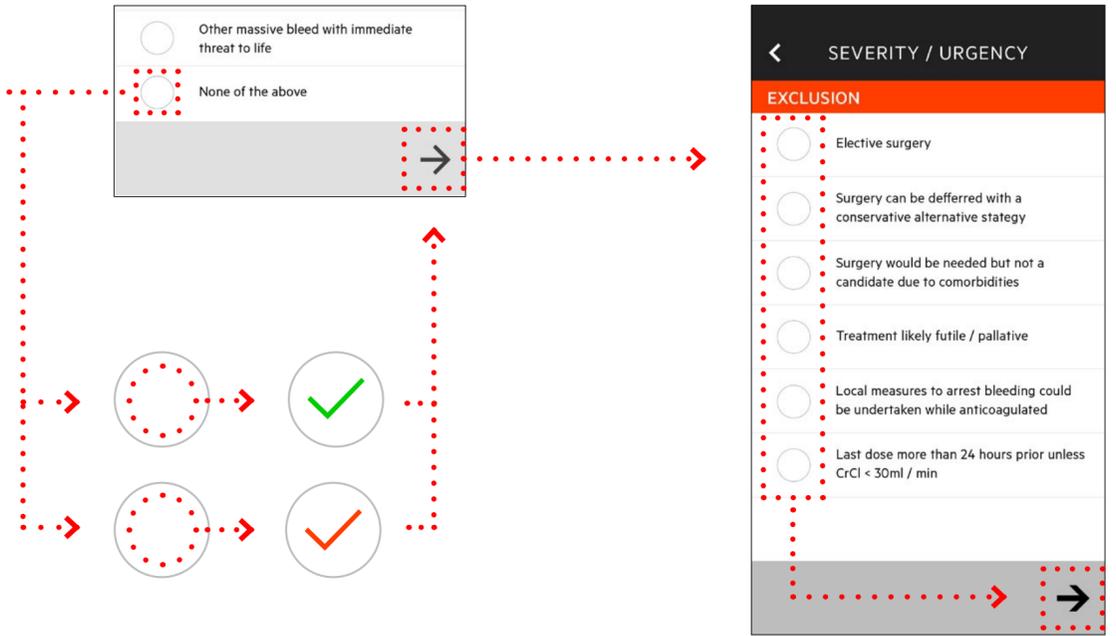


● The drop down menu on the call screen caused confusion among clinicians as they didn't know how to intuitively interact with the content on the screen

Figure 47.
Thornhill, B. (2017). Clinician usability of interface no.2.

Manual input of the selections needed to be compulsory. Pre-ticked selections caused clinicians to overlook vital information while skimming through the application.

Only when a selection is made should the clinician be able to proceed to the next screen.



Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Advanced users

Regarding the usability of the taps and buttons within the application, clinicians stated how easy and functional it was to use. Two clinicians expressed the need for a 'start over' button. It was stated "there needs to be a 'back to home' screen. If there is confusion caused, a restart button needs to be easily accessible." This also reflects advice on practice given by Anaesthesia Department specialist clinicians; "if you [accidentally] ignore the software or if you feel your outcome is not right then have another look at it. Check your decisions or start from the beginning."

The readability and legibility of the text within the application was described as being easy to read and clear. Clinicians suggested the dialog box within the 'immediate emergency surgery' selection (inclusion 1) needed refinement as there was too much information presented at once. The content needed to be simplified for its information to become more approachable.

The inclusion and exclusion selection screens incorporated preticked selections that enabled the clinician to skip vital steps within the guideline. A clinician stated "preticked selections influence bad habits" as content can easily be missed or overlooked. A selection must be manually ticked before the

user is able to proceed to the next screen within the decision pathway. Manual input of the selections needed to be compulsory. Only when a selection is made should the clinician be able to proceed to the next screen. This influences the clinician to read each step rigorously, reducing the risk of bad decision-making. As this application will be used in emergency settings, this step by step process where content is engaged is vital. Regarding the content of the inclusion and exclusion selections, as some selections are internally linked to each other—depending on what's selected—some become redundant. These selections needed to be removed within the application's decision pathway to reduce further confusion by the clinician.

Figure 48. Thornhill, B. (2017). Clinician usability of interface no.3.

Documentation of research

Explorative design phase

The inclusion of the contact list within the guideline was noted as being “very cool” as it streamlines the guideline's process without any interruptions. It also enforced calling the member panel who then ‘deny’ or ‘grant’ approval before the drug can be administrated. Although the contacts’ names were clearly listed within the design of the screen, it took the clinicians time to understand how to engage with the selection panel. This was because the phone numbers and icons were hidden by a drop-down menu. The displayed contact name needed to be touched to present the number. The functionality of this screen needed to be more obvious as a call screen.

The language and medical terminology in the application was described by three clinicians as being clear. The ‘proceed anyway’ button was identified as a poor term and could influence bad practice amongst clinicians as it can “encourage careless decision-making amongst clinicians.” Throughout the user tests all clinicians voiced concern over this label. Clinicians suggested additional content needed to be incorporated to clarify the exclusion decision pathway. Once reaching this outcome the clinicians were unsure of the next steps forward within the application.

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

NHI patient input within the application caused frustration. Firstly, the double input of the patient's NHI number seemed tedious. A clinician stated, “the double inputted of the NHI number will drive me mad!” This function was to enforce correct data being logged. Once both numbers were input there was a further issue regarding the application's keyboard. It wouldn't collapse or finalise the data added by the clinician, causing confusion as the clinicians didn't know what to do next. There were further issues regarding the interaction of the NHI patient number and keyboard. This stopped the flow of the interaction between the clinician and the application.

The legibility of the icons within the user interface was also described as useful and clear. All clinicians stated that the icons didn't need any refinements. One clinician commented, “the icons are there to embellish the idea, helping transfer and replacing a textual basis ... [it's] nice to have something that breaks up information, but adds to functionality, too.” Another comment was made regarding the design of the ‘Ida’ logo and it being “very cool.”

User tests

User interface refinements

“easy to use”

“I would use this”

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Clinical evaluation of the Ida guideline application

Novice users

The clinicians' general impression after using the application was positive as they commented on the user interface as being “easy to use” and “self-explanatory.” Another clinician said “I would use this” while user testing the prototype. Although comments were made on how easy the ‘Ida’ application was to use, some clinicians needed more time to familiarise themselves with the user interface. After all the clinicians had used the application the first time around, the user interface was easily understood and followed. One clinician stated, “It would be good if you had prior knowledge of the drug or procedure, the application wouldn’t be satisfactory enough otherwise.” This was contrasted by another saying how useful the application was as it saved time by not involving searching, finding and reading protocols. This clinician said “normally I have no idea where the protocols are and I don’t always have time to read through them (e.g. eight-page pdf.)” The application’s content was described as being cleanly laid out especially for high acuity situations. Another clinician mentioned, “I like once you’re prompted to reverse (entering the procedure screen) the simple steps streamline the process and help focus your decision.” Regarding the functionality within the application, the incorporation of the call feature was received positively by clinicians as it influences communication between ‘first time users’ and ‘professionals.’

After finishing the task scenario user tests, the clinicians commented that no content was missing within the application. Although this was stated within the user tests, comments were made about needing to include further information about the Dabigatran reversal within the application. There were split views between the clinicians on this topic. Firstly, one clinician stated “the purpose of this application is for somebody on the run to correctly decide whether to give Idarucizumab or not— so from that point of view I think the application does exactly what its advertised as doing within the package and any more complicated than that it’s probably going to be unnecessary and cumbersome.” The clinician openly states “those who would want to look at the literature to fulfil their intellectual curiosity I’m sure would be able to find it easily on the internet as well as on Auckland DHB intranet in their own time.”

“For our generation it’s definitely more helpful to have an application [as] pocketable information is much more preferred than having to find and search for information.”

Documentation of research

This was contrasted by another clinician stating the application wouldn’t be satisfactory without background information about its process and drug application and states, “having literature within the app would be useful as it educates you more especially if it’s a new drug. I actually don’t know much about this drug, would like to know how to use it.” The same clinician suggested including evidence-based content within the application to determine whether the drug is safe. Another contrast in clinician opinion was whether to include a flowchart / decision pathway at the end of the application to see if the decisions made are correct – “just to make sure you selected the right things.” When asked whether to include a decision pathway within the application another clinician stated, “No the current application where I choose a selection and it automatically directs me to the correct option is much better than a decision tree because it simplifies the decision-making process one step further than a decision tree—I think it is very good as it is!”

When the digital guideline application was compared to the original paper form, six out of the eight clinicians preferred the digital application. The clinicians mentioned how the paper form presenting all its content at once is confusing to follow as there were too many words.

It was further acknowledged that breaking up the information enables clearer understanding when making decisions within the application, making it a lot easier to follow. The incorporation of selection controls within the application enabled clinicians to engage and interact with the information through a step by step process, proceeding through the decision tree. This component within the application fulfilled its designed purpose to influence clinicians to interact with the guideline's information and process. The application was described as “more user friendly and intuitive than a printed pdf document.” A younger clinician mentioned, “For our generation it’s definitely more helpful to have an application [as] pocketable information is much more preferred than having to find and search for information.” One clinician stated liking both mediums of the guideline (digital and print) as the printed form enabled the clinician to see the next steps in the guideline process. This same clinician stated, “I don’t like to be babied” referring to the decision process within the application.

“I would rapidly get used to using an application like this”

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

Advanced users

The clinicians' general impression of the application was also positive; further comments were made regarding the user interface being “accessible”, “straight forward”, and “intuitive.” A clinician stated “I would rapidly get used to using an application like this.” They suggested that further educational content needed to be incorporated in the guideline application to clarify Idarucizumab’s medical use and authority for first time users. A clinician stated, “the application needs to educate first-time users — there should be a summary included explaining Dabigatran and its reversal as an educational aspect to the application ... if I have never used the drug or guideline before—I want to read up on the information the first time I use it.”

The importance of the ‘disclaimer’ screen within the guideline application was recognised among the tested clinicians as it explained and clarified the medicine's financial status and administration within the hospital. The disclaimer needed to inform the clinicians of the high cost involved in administering Idarucizumab to patients.

The same issues were experienced by clinicians in scenario three. Within its decision pathway clinicians became confused and questioned themselves. After using the application, clinicians suggested that the decision pathway should be improved to enable users to be more decisive. Although clinicians stated how hard it is for all medical scenarios to be moulded to one decision pathway, this is the challenge that confronts its complex decision pathways. The clinicians mentioned that some content was missing within the application. Firstly, they suggested that the ‘considerations’ screen within the ‘proceed anyway’ decision pathway could be incorporated within the ‘inclusion’ and ‘exclusion’ decision pathways. This would bring more clarity to clinicians' decision-making before proceeding to the ‘not appropriate’ screen. Finally, an information page where educational literature can be included for first time users to learn about and understand the drug being administered would be advantageous. Scenarios one, two and four within the application were regarded as being “straightforward” and “specified well” within the application.

"I prefer using the app"

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

When the guideline application was compared to the paper form the clinicians described its process being much easier and intuitive than reading through a physical page. One clinician stated "I prefer using the app [compared to the paper form] ... with a long piece of paper – I might use it with a registrar to go over it together, but with paper, there is a tendency to mentally tick boxes and losing your way a little bit. This one [the app] helps you go back if you do lose your way"

Documentation of research

User interface refinements

27 Apple's iOS human interface guidelines:

<https://developer.apple.com/ios/human-interface-guidelines/overview/design-principles/>

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

The analysis and evaluation of the user tests identified the problems faced by clinicians when using the Idarucizumab application. The findings suggested that the clinicians preferred to use an application program on their smartphone device rather than a printed form to present clinical guideline information within practice. As all the clinicians within the anaesthesia department owned and used an iPhone device, the android prototype was further developed into an iOS application by the software developer. This would enable the application to be downloaded by the clinicians via the Apple app store on their personal device. As the application's interface was programmed for a specific platform (iOS), I used Apple's online human interface guidelines²⁷. This influenced the design of the visual language and synthesised the user interface to be adaptable across the iOS platform. Although the Metric font used within the interface was positively acknowledged by clinicians in the user tests, I replaced it with the most functional font for each application platform and device.

Within the iOS interface the standard font San Francisco was used for its adaptability and legibility on small screens as it was designed specifically for Apple iPhone devices. Within the android interface the standard font Roboto was used for the same reasons. This enabled both guideline interfaces to be tailored to the design styles incorporated within each platform. The idea was to further enhance usability among clinicians, as the guideline's interface would align to their devices interface. Thus, the user interface's design was refined to cater to the needs expressed by the clinicians who had tested the application.

Aa

San Francisco

10 Weights (light - heavy)
App - Web Applications
40 weights in total
(display - text - compact)
Large x - height

[Type Foundry: Apple Developer](#)

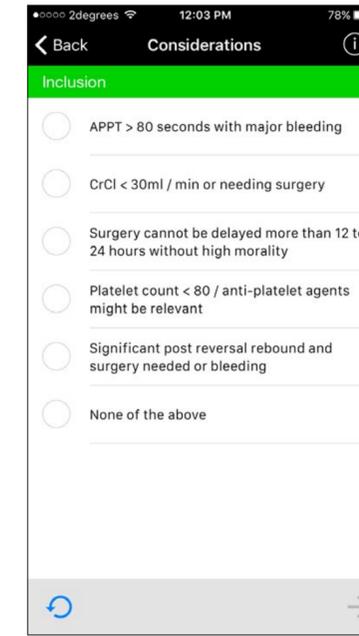
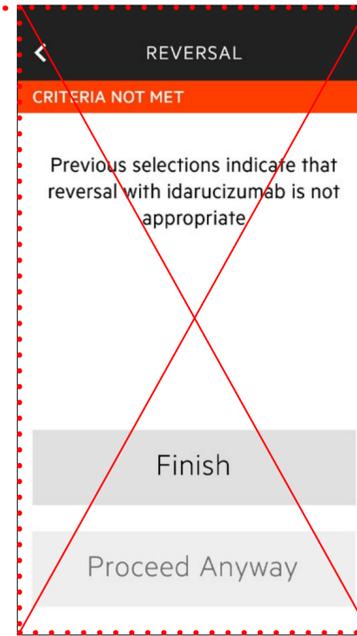
Aa

Roboto

12 Weights (thin - black)
App - Web Applications
48 weights in total
(normal - condensed)
Large x - height

[Type Foundry: Google Design](#)

The guideline's decision pathway was further refined and tested with the specialist anaesthetists to clarify its functionality. The 'proceed anyway' term was eliminated and the considerations screen was incorporated into the inclusion and exclusion decision pathway. This enabled complicated 'grey areas' scenarios to be identified within the clinician's decision-making process.



The 'criteria not met' screen within the application was refined to incorporate further call functionality. Clinicians, once reaching this decision outcome, were further presented with the member panel's contact numbers to enable further clarification or advice by senior clinicians.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

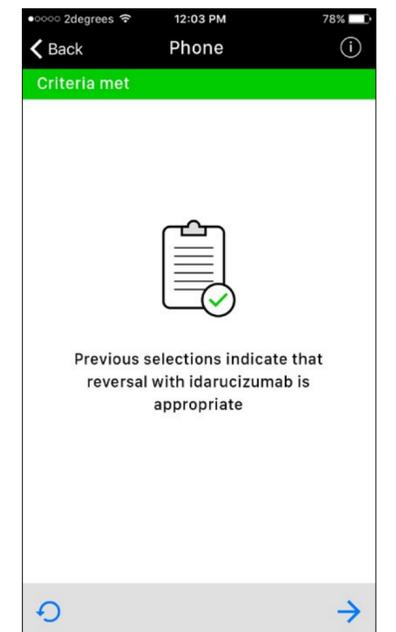
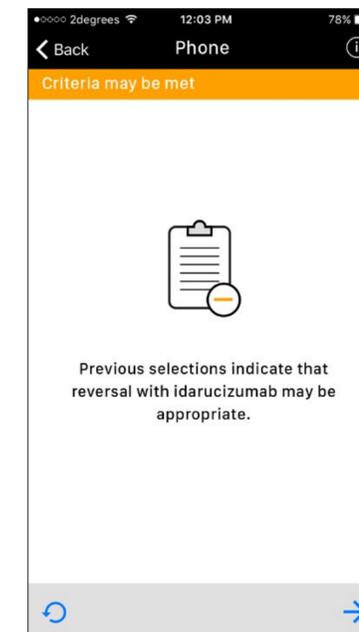
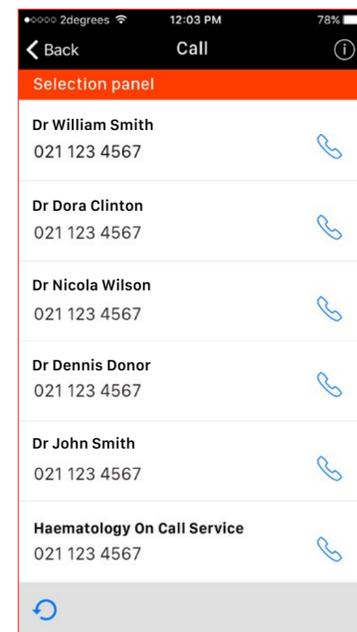
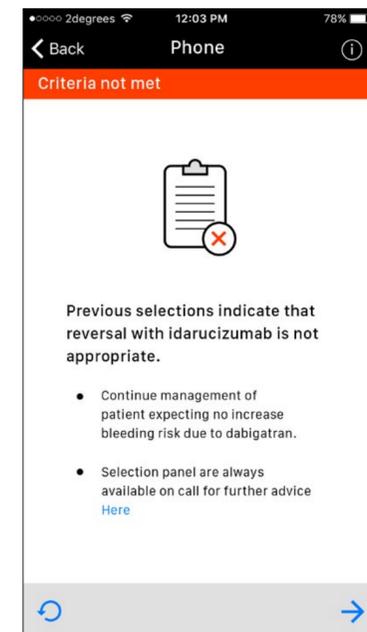


Figure 49. Thornhill, B. (2017). User interface refinements no.1.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

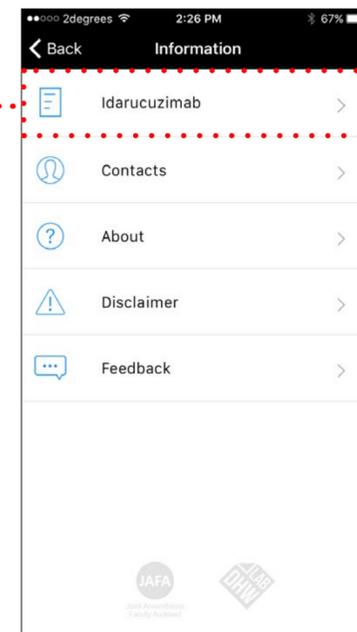
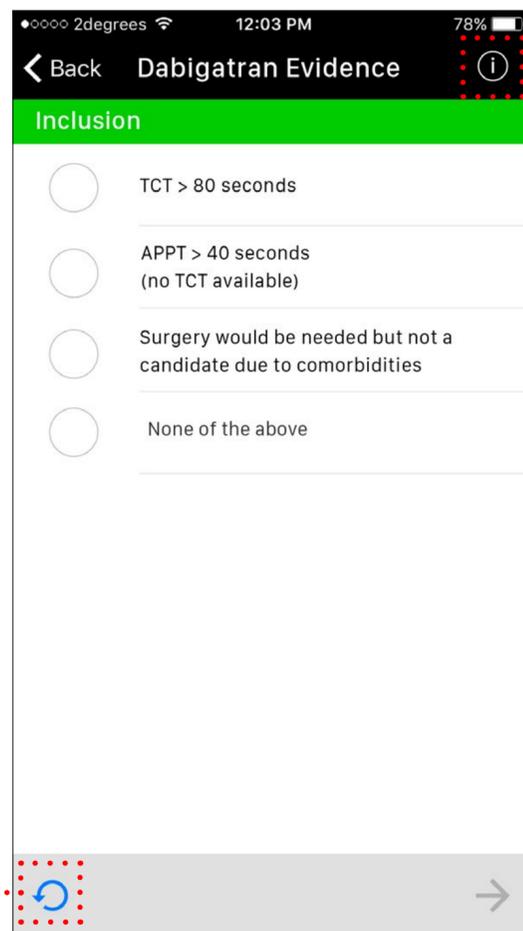
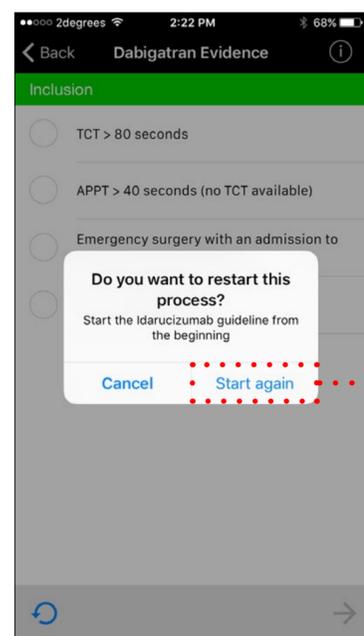
Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

A restart button was also incorporated within the interface to allow indecisive clinicians to easily restart the guideline decision pathway. This functionality was represented by an icon displayed in the lower left corner of the screen. Once pressed, a dialog box notifies the clinician to clarify the action. The 'back button' functionality was further programmed to remember and record previous selection screens entered by the clinician. This enabled clinicians to review their past selections for further clarification.



Additional information was included in the application to further educate first time clinicians, flagged by an information icon and menu. The Idarucizumab information was supplied from the senior anaesthetist and was academically referenced.

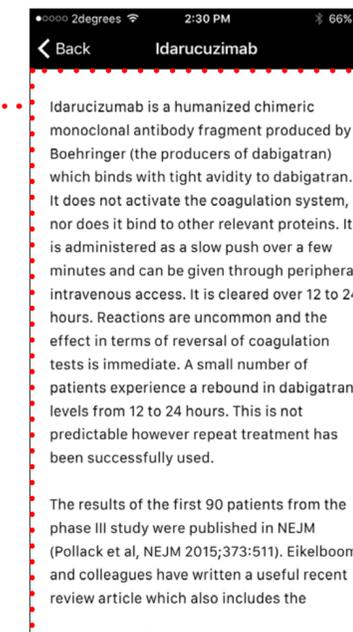


Figure 50. Thornhill, B. (2017). User interface refinements no.2.

The NHI patient data input was further refined to cater to the clinicians' suggestions. Within its functionality, the data was programmed to be case sensitive using capital letters. This enabled the clinicians to easily type the NHI code into the application without having to capitalise each letter. Due to the confusion caused by the noncollapsing keyboard among the clinicians, the keyboard was programmed to finalise the data inputted and collapse accordingly. The process of clinicians inputting the NHI data twice was eliminated and replaced by a pop-up dialogue box to clarify the data inputted. If the data is incorrect, an option to edit the data is presented.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

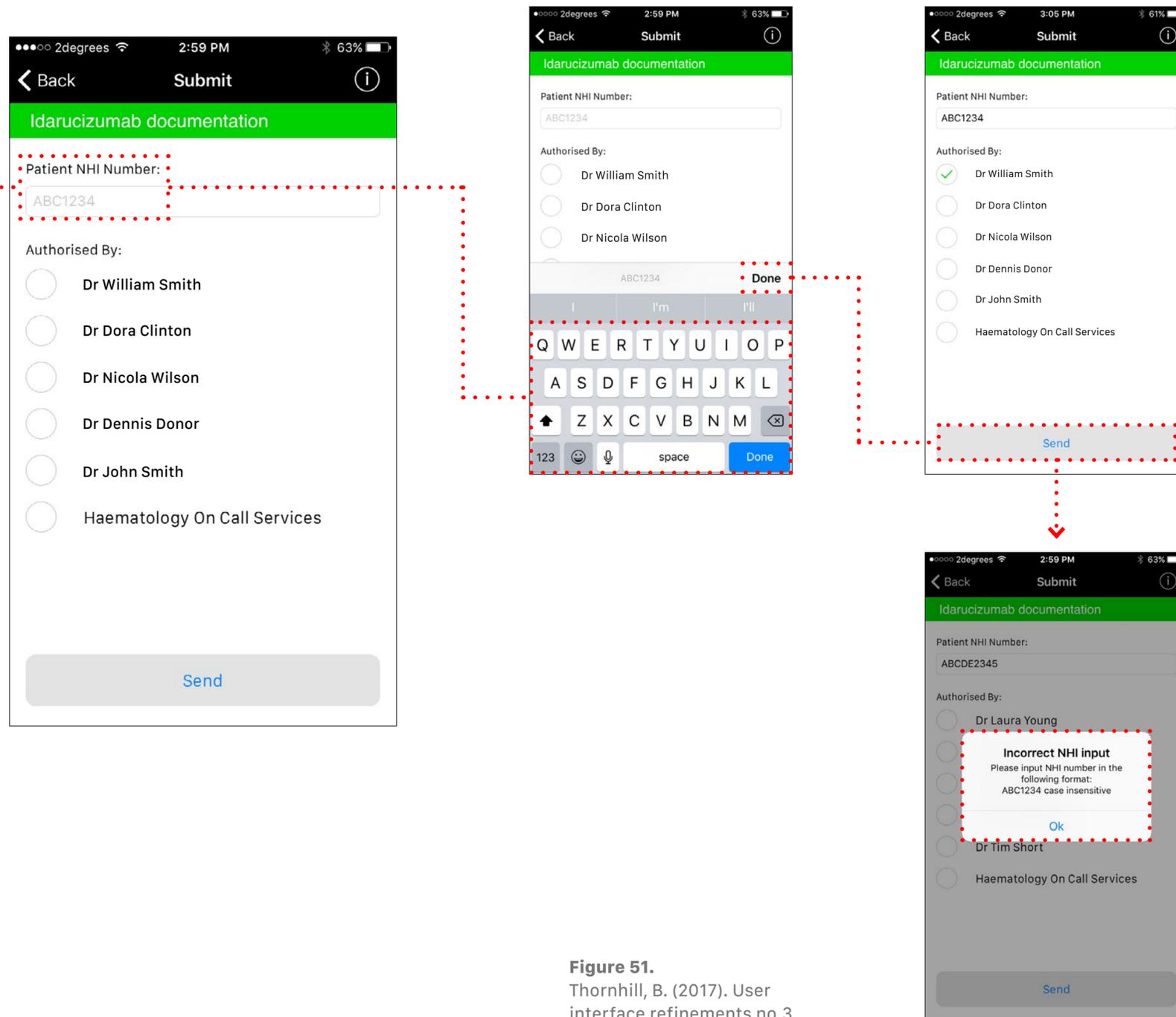
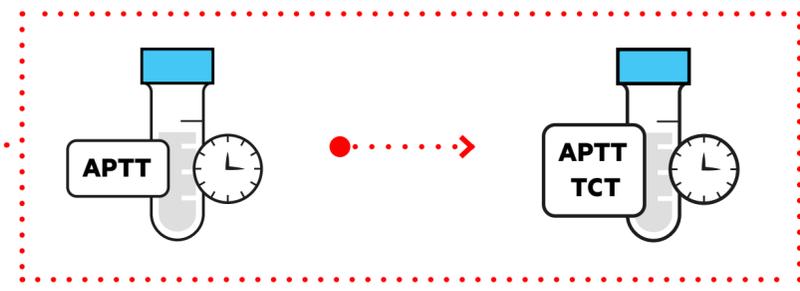


Figure 51. Thornhill, B. (2017). User interface refinements no.3.

One icon was refined after suggestions were made by the clinicians. The 'APPT/TCT measured in 15 mins' icon was reworked to include the TCT text.



Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements

The selection 'Immediate emergency surgery' within the first inclusion screen couldn't be simplified. All of its existing content was vital to the guideline's decision process. Its dense content was arranged using a typographic grid structure and an icon was incorporated to lay out its information clearly.

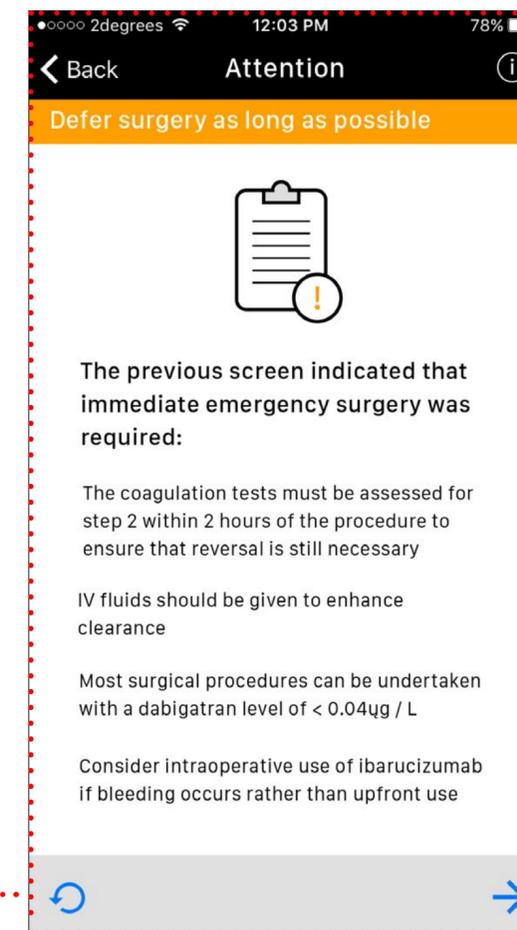
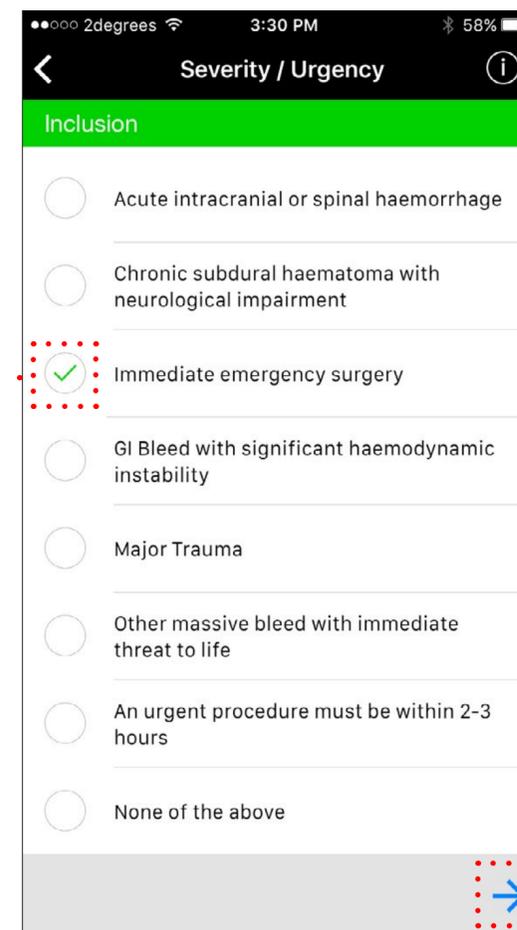


Figure 52. Thornhill, B. (2017). User interface refinements no.4.

Functional buttons and commands were coloured blue to distinguish their action functionality. The call screen was refined to display the member panel's contact numbers. The drop-down menu was eliminated to include the phone icon (coloured blue) to signify its functionality to clinicians.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

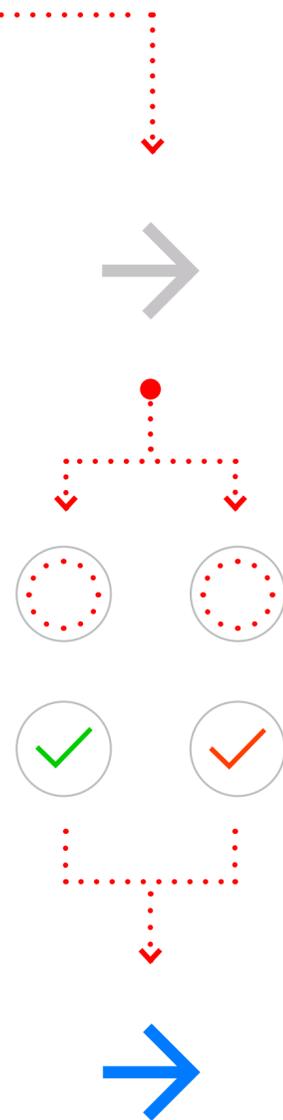
Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements



All the selections (tick boxes) throughout the interface were programmed to be physically ticked before the clinician could proceed further within the application. The forward arrow icon was greyed to signify the button's inaction. Once a selection was made, the arrow turned blue to signify the button's action.

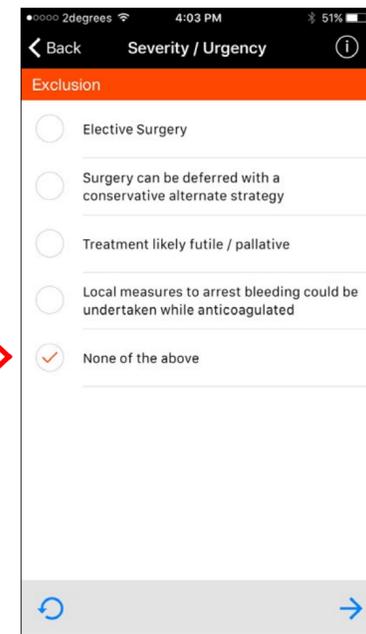
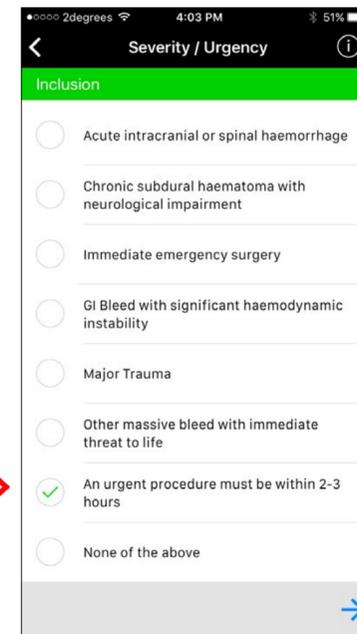
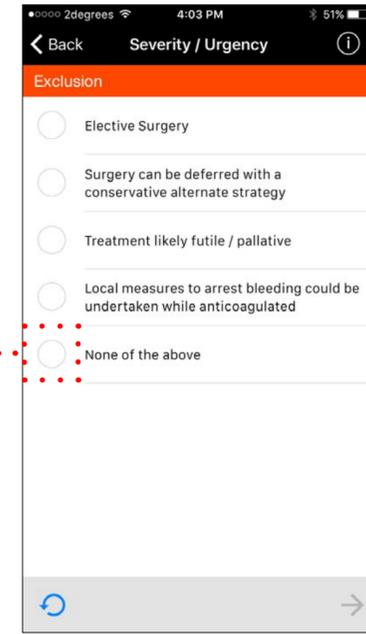
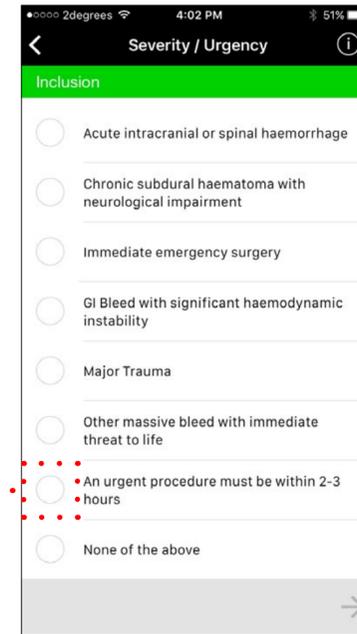


Figure 53. Thornhill, B. (2017). User interface refinements no.5.

Documentation of research

Explorative design phase

Capturing insights

Reframing the project: 1

Prototyping: 1

Reframing the project: 2

Prototyping: 2

Ida: Smartphone prototype

User tests

User interface refinements



Due to the guideline application incorporating personal contact numbers of senior clinicians (Idarucizumab selection panel) and automated emailing to the pharmacy department, its use was secured by incorporating a login screen and passcode. Once the application is downloaded, a passcode must be entered by the clinician to gain access. This was included for security reasons as the Idarucizumab application is designed to function solely in the environment of Auckland City Hospital.

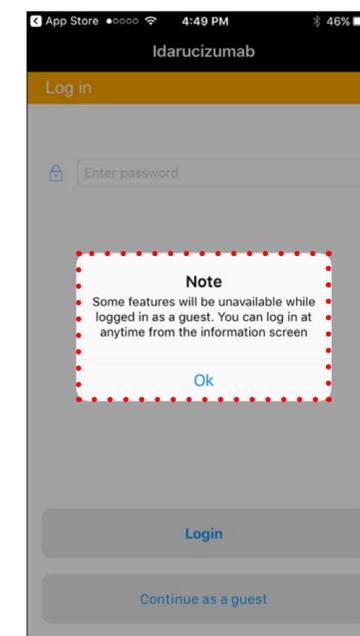
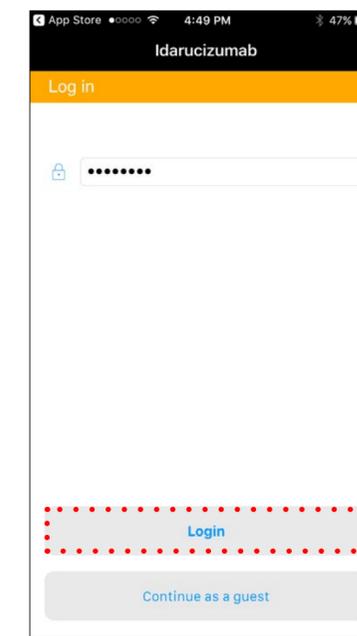
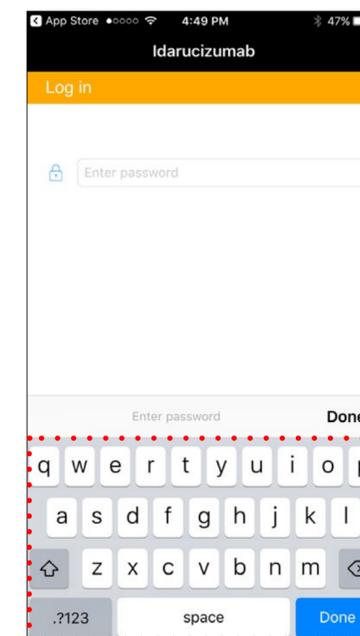


Figure 54. Thornhill, B. (2017). User interface refinements no.5.

Discussion

Discussion

Initially the focus of this research project was to investigate how information design could improve clinical guidelines to enhance accurate decision-making among clinicians practising in surgical environments. Based on the literature on clinicians' experiences, I recognised that my focus would be on the design of clinical information to further improve clinicians' understanding and retention of information in their practice. The surgical contexts for anaesthetists and haematologists were explored to gain a deeper understanding of their experiences while using clinical guidelines at Auckland City Hospital.

The literature review revealed barriers to the effective use of clinical guidelines; these were also reflected in expert interviews with clinicians. Complexities related to stressful environments, surgical processes, and personal biases/emotions among clinicians were recognised as having a negative influence on their decision-making during surgery (Gawande, 2010). Decision-making was impeded by the use of large, text-based documents that clinicians had to decipher to make complex decisions. While algorithms and data tables are often incorporated within clinical guideline documents to simplify the reading process, some clinicians consider this as undermining the complexity of the medical decision-making process (Woolf et al., 1999; Reach,

2014). Furthermore, the design and use of these documents is misaligned in relation to the surgical process, prolonging the time taken for clinicians to interpret the information (Vissers, Hasman, & van der Linden, 1996). In particular, the retrieval of clinical information is a long-winded process and impedes upon a clinician's workflow in surgery. Clinicians rely on access to the Auckland DHB intranet to retrieve up-to-date guidelines, which is made difficult due to poor indexing of the medical content—it has been described as a 'maze' by some clinicians who were interviewed. A clinician's valuable time in surgery is wasted in the process of searching for relevant medical content, printing the appropriate guideline, and then manually recording patient data. Additional consequences are evident within the hospital as incorrectly filled out guidelines omit key information, limiting the accuracy of record-keeping such as audits and medicinal stocktakes. Finally, a reliance on using dated technologies (such as facsimile machines) to send clinical information increases the amount of time spent dispatching and filing paper documents.

Discussion

An understanding of how clinicians use guidelines in surgical settings and how these guidelines work holistically within Auckland Hospital revealed the need for more succinct and accessible information to be made available for circumstances where clinicians' time is limited (Woolf et al., 1999; Reach, 2014). While visual information design is effective at addressing content-related issues in clinical guidelines, these solutions are limited by practical barriers in accessing the information. It was immediately evident that redesigning the Auckland DHB's intranet was not a feasible solution to improving access to clinical guidelines, simply due to the sheer amount of time and consultation this would require. Within the scope of this research, an appropriate solution was considered in relation to the technologies readily available to clinicians in their existing surgical processes, namely hand-held digital devices. The widespread accessibility of smartphones presented a unique opportunity to design clinical guidelines in the format of a smartphone application.

Discussion

The design solution

Functioning as an application programmed for smartphone devices, the Idarucizumab guideline interface helps clinicians to retrieve pocketable information anytime, anywhere. The existing processes for clinicians adopting the Idarucizumab guideline were incorporated into the application's functionality, enabling various touchpoints involved in the medicine's administration to be sequenced and automated within the user interface. In order to design an underlying system to unify clinicians' experiences using the Idarucizumab guideline, the interface's style, layout and components were designed to enhance its usability and interaction. It was acknowledged by the clinicians who tested the application that breaking up the guideline's information into a systematic network of screens enhances their understanding of it when making decisions during surgery. As a hand-held application, the guideline's information can be updated in future to remain relevant for practising clinicians.

Information graphics were used to enhance the usability and navigation within the guideline's interface, visually conveying complex messages and procedures while using minimal space on a smartphone screen (Lupton & Cunningham, 2014; Krum, 2014). The incorporation of graphical selection controls within the user interface enabled clinicians to engage and interact

with the listed textual content through an adaptive step by step process. Simplifying communication and administration functionalities within the guideline enabled time to be saved by the clinician retrieving and documenting its information in surgery. Phone call functionality allowed clinicians to easily contact the authorisation panel for the medication's approval without interruption. Furthermore, data entered by the clinician's selections were compiled into an automated email at the end of the guideline, enabling the recorded data to be electronically sent to the pharmacy department for archival purposes. By accommodating the needs of individual clinicians, the application allows flexibility for clinicians to adapt their decisions appropriately, catering to the patient's circumstance, and making it easier to learn and accurately administer Idarucizumab.

Discussion

Released on both the Apple app store and the Google play store as a smartphone application, the idarucuzimab guideline has been approved by all stakeholders involved in this research. Although released, further testing with practising clinicians would enable me to gain a deeper understanding of its adoption within surgical processes and environments. To demonstrate the application's functionality and adaptive capabilities, an animated video will portray the guideline's clinical features and inner workings, demonstrating how effective information design can improve clinical guidelines to enhance accurate decision-making among clinicians practising in surgical environments.

References

References

- Adaptive Path. (2013). Adaptive path's guide to experience mapping. Retrieved December 1, 2016, from <http://www.mappingexperiences.com/>
- "Apothecary". Oxford dictionary 2016. Retrieved August 11, 2016, from <https://en.oxforddictionaries.com/definition/apothecary>
- Apple. (2017). Human interface guidelines. Retrieved 14 February, 2017, from <https://developer.apple.com/ios/human-interface-guidelines/overview/design-principles/>
- Anwar, M., Joshi, J., & Tan, J. (2015). Anytime, anywhere access to secure, privacy-aware healthcare services: Issues, approaches and challenges. *Health Policy and Technology, 4*, 299-311. doi:10.1016/j.hlpt.2015.08.007
- Baer, K., & Vacarra, J. (2009). *Information design workbook: Graphic approaches, solutions, and inspiration + 30 case studies*. Beverly, MA: Rockport Publishers.
- Barnard, M. (2005). *Graphic design as communication*. London, England; New York, NY: Routledge, Taylor & Francis Group.
- "Basic Research". Oxford dictionary. Retrieved August 11, 2016, from https://en.oxforddictionaries.com/definition/basic_research
- Beck, B. (1969). The development of medicine as a profession: The contribution of the medieval university to modern medicine. *Journal of Health & Social Behavior, 10*(4), 346-347.
- Berg, M., Horstman, K., Plass, S., & van Heusden, M. (2000). Guidelines, professionals and the production of objectivity: Standardisation and the professionalism of insurance medicine. *Sociology of Health & Illness, 22*(6), 765-791.
- Bergström, B. (2008). *Essentials of visual communication*. London, England: Laurence King Pub
- Blank, R. H., & Burau, V. D. (2014). *Comparative health policy*. Basingstoke, England: Palgrave Macmillan.
- Bonner, T.N. (1995). *Becoming a physician: Medical education in Britain, France, Germany, and the United States, 1750–1945*. New York, NY: Oxford University Press.
- Brown, D. M. (2010). *Communicating design: Developing web site documentation for design and planning*. Berkeley, CA: New Riders.
- Budiu, R. (2013). Mobile: Native apps, web apps, and hybrid apps. Retrieved February 13, 2017, from <https://www.nngroup.com/articles/mobile-native-apps/>
- Carruthers, G. B., & Carruthers, L. A. (2005). *A history of Britain's hospitals*. Lewes, East Sussex, England: Book Guild Publishers.
- Clanton, J. (2011). The Definition of Modern Science. Retrieved August 23, 2016, from <https://prezi.com/ip5hct39dje4/the-definition-of-modern-science/>

References

- Clarke, M. A., Belden, J. L., Koopman, R. J., Steege, L. M., Moore, J. L., Canfield, S. M., & Kim, M. S. (2013). Information needs and information-seeking behaviour analysis of primary care physicians and nurses: A literature review. *Health Information & Libraries Journal*, *30*(3), 178-190. doi:10.1111/hir.12036
- Cochrane. (2016). Retrieved August 23, 2016, from <http://www.cochranelibrary.com/about/about-the-cochrane-collaboration-and-how-to-get-involved.html>
- Coumou, H. C. H., Zorgverzekeringen, A. G. I., & Meijman, F. J. (2006). How do primary care physicians seek answers to clinical questions? A literature review. *Journal of the Medical Library Association*, *94*(1), 55-59.
- Creswell, J. W. (2014). *Research design : Qualitative, quantitative, and mixed methods approaches*. (4th ed.). Thousand Oaks, CA: SAGE Publications.
- Daly, W. J., & Brater, D.C. (2000). Medieval contributions to the search for truth in clinical medicine. *Perspectives in Biology and Medicine*, *43*(4), 530-540.
- Daly, J. (2005). Evidence-based medicine and the search for a science of clinical care. Berkeley, CA: University of California Press; New York, NY: Milbank Memorial Fund.
- Duff, L. A., Kitson, A. L., Seers, K., & Humphris, D. (1996). Clinical guidelines: An introduction to their development and implementation. *Journal of Advanced Nursing*, *23*(5), 887-895. doi:10.1046/j.1365-2648.1996.00875.
- Durall, E. & Leinonen T. (2014). Design thinking and collaborative learning. *Media education research journal*, *42* (12), 107-116.
- Duska, L., & Elder, L. (2016). What is Clinical Research? Retrieved August 23, 2016, from <https://research.med.virginia.edu/clinicalresearch/participate-in-a-trial/what-is-medical-research/>
- Eddy, D. M. (2002). Evidence-based medicine: What it is, why to use it, and how to incorporate it into decision-making. *Formulary*, *37*(10), 525-530.
- Ebbell, B. (1937). *The papyrus ebers*. London, England: Oxford University Press.
- Font Shop. (2017). Glossary. Retrieved February 14, 2017, from <https://www.fontshop.com/glossary>
- Gadd, C. J. (1924). The Assyrian Herbal; A monograph on the Assyrian vegetable drugs. *Antiquaries Journal*, *4*(4), 431.
- "Gatekeeper". Farlex Partner Medical Dictionary. (2012). Retrieved January 15, 2017, from <http://medical-dictionary.thefreedictionary.com/gatekeeper>

References

- Gawande, A. (2010). *The checklist manifesto: How to get things right*. New York, NY: Metropolitan Books.
- Giacomin, J. (2014). What is human centred design? *The Design Journal*, 17(4), 606-623. doi:10.2752/175630614X14056185480186
- Google. (2017). Material design. Retrieved February 14, 2017, from <https://material.io/guidelines/>
- Graber, M. A., Randles, B. D., Ely, J. W., & Monnahan, J. (2008). Original contribution: Answering clinical questions in the ED. *American Journal of Emergency Medicine*, 26, 144-147. doi:10.1016/j.ajem.2007.03.031
- Graham, I. D., & Harrison, M. B. (2005). EBN users' guide. Evaluation and adaptation of clinical practice guidelines. *Evidence Based Nursing*, 8(3), 68-72.
- Gray, D. E. (2009). *Doing research in the real world*. London, England: SAGE.
- Greenhouse, E. S. (2012). *Human-centred design*. Retrieved July 14, 2016, from <http://www.aging.ny.gov/LivableNY/ResourceManual/DemographicAndSocialTrends/I9.pdf>
- Gunther, R. S. (1959). *The Greek herbal of dioscordes*. New York, NY: Hafner.
- Gupta, R., & Kumar, P. (2007). Social evils, poverty & health. *The Indian Journal of Medical Research*, 126(4), 279-288.
- Harrison, S., Moran, M., & Wood, B. (2002). Policy emergence and policy convergence: the case of 'scientific-bureaucratic medicine' in the United States and United Kingdom. *British Journal of Politics & International Relations*, 4(1)
- Health, M.o. *NEAC: National ethics advisory committee*. Retrieved 13 May, 2016, from: <http://neac.health.govt.nz/about-us>.
- HealthObs Ltd. (2017). *Managing Dabigatran for Apple iOS (Version 4.0)* [Mobile application software]. Retrieved January 13, 2017, from <https://itunes.apple.com/nz/app/managing-dabigatran/id498413737?mt=8>
- HealthObs Ltd. (2017). *Reversing Warfarin for Apple iOS (Version 1.0)* [Mobile application software]. Retrieved January 13, 2017, from <https://itunes.apple.com/nz/app/reversing-warfarin/id641461083?mt=8>
- Herk, R. V., Klazinga, N. S., Schepers, R. M. J., & Casparie, A. F. (2001). Medical audit: Threat or opportunity for the medical profession. A comparative study of medical audit among medical specialists in general hospitals in the Netherlands and England, 1970-1999. *Social Science and Medicine*, 53(12), 1721-1732. doi:10.1016/S0277-9536(00)00458-5
- Hochuli, J. (2015). *Detail in typography: Letters, letterspacing, words, wordspacing, lines, linespacing, columns*. Paris, France: Éditions B42.
- iAnesthesia. (2017). *PediSafe for Apple iOS (Version 3.4)* [Mobile application software]. Retrieved January 13, 2017, from <http://www.ianesthesia.org/apps/pedi-safe/>

References

- Information Design Association. (2017). Definition. Retrieved January 20, 2017, from <http://www.infodesign.org.uk/What-is-information-design/definitions>
- Information Architecture Institute. (2017). What is information design? Retrieved January 20, 2017, from <http://www.iainstitute.org/what-is-ia>
- International Institute for Information Design. (2017). Definitions. Retrieved January 20, 2017, from <http://www.iiid.net/home/definitions/>
- IDEO. (2015). The field guide to human-centred design. Retrieved October 20, 2016, from <http://www.designkit.org/resources/1>
- Jones, P. H. (2013). *Designing for care*. New York, NY: Rosenfield Media.
- Jong, C. (2006). *Sans serif: The ultimate sourcebook of classic and contemporary sans serif typography*. London, England: Thames & Hudson.
- Kang, M., Choo, P., & Watters, C. E. (2015). Design for experiencing: Participatory design approach with multidisciplinary perspectives. *Procedia - Social and Behavioral Sciences*, 174, 830-833. doi:<http://dx.doi.org/10.1016/j.sbspro.2015.01.676>
- Kraft, C. (2012). *User experience innovation : [user centered design that works]*. New York, NY : Apress.
- Krum, R. (2014). *Cool infographics : Effective communication with data visualization and design*. Indianapolis, IN : Wiley.
- Lamy, J.-B., Duclos, C., Bar-Hen, A., Ouvrard, P., & Venot, A. (2008). An iconic language for the graphical representation of medical concepts. *BMC Medical Informatics And Decision Making*, 8. doi:10.1186/1472-6947-8-16
- Lipton, R. (2007). *The practical guide to information design*. Hoboken, NJ: Wiley.
- Leedy, P.D., & Ormrod, J.E. (2010) *Practical research: Planning and design*. Boston, MA: Pearson
- Luck, R. (2003). Dialogue in participatory design. *Design Studies*, 24(6), 523-535. doi:[http://dx.doi.org/10.1016/S0142-694X\(03\)00040-1](http://dx.doi.org/10.1016/S0142-694X(03)00040-1)
- Lupton, E., & Cunningham, N. (2014). *Type on screen : A guide for designers, developers, writers, and students*. New York, NY: Princeton Architectural Press.
- Lupton, E. (2010). *Thinking with type : A critical guide for designers, writers, editors, & students*. (2nd ed.). New York, NY: Princeton Architectural Press.
- Lurie, N. H. (2004). Decision making in information-rich environments: The role of information structure. *Journal of Consumer Research*, 30(4), 473-486.
- Manzini, E., & Rizzo, F. (2011). Small projects/large changes: Participatory design as an open participated process, *CoDesign*, 7(3-4), 199-215.

References

- McKinnell, H. A., Kador, J., & Pfizer Inc. (2005). *A call to action: Taking back healthcare for future generations*. New York, NY: McGraw-Hill.
- Mobasheri, M. H., Johnston, M., Syed, U. M., King, D., & Darzi, A. (2015). Healthcare: The uses of smartphones and tablet devices in surgery: A systematic review of the literature. *Surgery, 158*, 1352-1371. doi:10.1016/j.surg.2015.03.029
- Nielsen, J. (1993). *Usability engineering*. Boston, MA: Academic Press.
- Nielsen Norman Group. (2014). Turn user goals into task scenarios for usability testing. Retrieved January 16, 2017, from <https://www.nngroup.com/articles/task-scenarios-usability-testing/>
- Newbury, D. (2001). Diaries and fieldnotes in the research process. *Research issues in art, design and media (1)*, 1-17. Retrieved from http://www.wordsinspace.net/course_material/mrm/mrmreadings/riadmIssue1pdf
- Norman, D. A. (2002). *The design of everyday things*. New York, NY: Basic Books.
- Norman, D. A. (2004). *Emotional design: Why we love (or hate) everyday things*. New York, NY: Basic Books.
- Norman, D. A. (2011). *Living with complexity*. Cambridge, MA: MIT Press.
- Norman, D. A., & Nielsen, J. (2017). The definition of user experience. Retrieved February 15, 2017, from <https://www.nngroup.com/articles/>
- Oborn, E., Barrett, M., & Racko, G. (2013). Knowledge translation in healthcare: Incorporating theories of learning and knowledge from the management literature. *Journal of Health Organization & Management, 27(4)*, 412-431. <http://dx.doi.org/10.1108/JHOM-01-2012-0004>
- Pereira, S., Hassler, S., Hamek, S., Boog, C., Leroy, N., Beuscart-Zéphir, M. C., & Lamy, J. B. (2014). Improving access to clinical practice guidelines with an interactive graphical interface using an iconic language. *BMC Medical Informatics and Decision Making, 14*, 77-77. doi:10.1186/1472-6947-14-77
- "Perioperative". Merriam-Webster dictionary. (2016). Retrieved December 11, 2016, from https://www.merriam-webster.com/dictionary/perioperative?utm_campaign=sd&utm_medium=serp&utm_source=jsonld
- Pfiffner, P., & Tschopp, M. (2016). *MedCalcX: The professional medical calculator support for Apple iOS* (Version 3.2.4) [Mobile application software]. Retrieved February 13, 2017, from <https://itunes.apple.com/app/id1041464932>
- Phillips, L. S., Branch, J. W. T., Cook, C. B., Doyle, J. P., El-Kebbi, I. M., Gallina, D. L., & Barnes, C. S. (2001). Clinical Inertia. *Annals of Internal Medicine, 135(9)*, 825-834. doi:10.7326/0003-4819-135-9-200111060-00012

References

- Potter, E. (2010). Ducks, decorators, and the dialogical: An examination of approaches to information design: A thesis submitted to Auckland University of Technology, Auckland, New Zealand.
- Prototype. (2015). In A. H. Blackwell & E. Manar (Eds.), *UXL Encyclopedia of Science* (3rd ed.). Farmington Hills, MI: UXL. Retrieved from http://link.galegroup.com/apps/doc/ENKDZQ347975681/SCIC?u=dclib_main&xid=0c8f739d
- Ragan, P., & Quincy, B. (2012). Evidence-based medicine: Its roots and its fruits. *Journal of Physician Assistant Education (Physician Assistant Education Association)*, 23(1), 35-38.
- Reach, G. (2014). Clinical inertia, uncertainty and individualized guidelines. *Diabetes & Metabolism*, 40(4), 241-245. doi:10.1016/j.diabet.2013.12.009.
- Reay, S., Kennedy-Good, J., Douglas, R., Jacob, E. Thornhill, B., Short, E., & Munn, J. (2015). *Designing together*. Retrieved March 16, 2016, from <http://www.dhwlab.com/lab-annual/>
- Resmini, A. & Rosati, L. (2012). A Brief History of Information Architecture. *Journal of Information Architecture. Vol. 3, No. 2*. Retrieved from <http://journalofia.org/volume3/issue2/03-resmini/>.
- Rhodes, P., & Bryant, J. H. (2016). Public health. Retrieved June 15, 2016, from <https://www.britannica.com/topic/public-health>
- Robertson, T., & Simonsen, J. (2012). Challenges and opportunities in contemporary participatory design. *Design Issues*, 28(3), 3-9.
- Rodrigues, R. J. (2000). Information systems: The key to evidence-based health practice. *Bulletin of the World Health Organization*, 78(11), 1344.
- Rosenbaum, S. E., Glenton, C., & Cracknell, J. (2008). User experiences of evidence-based online resources for health professionals: User testing of The Cochrane Library. *BMC Medical Informatics & Decision Making*, 8(1), 1.
- Rothman, D. J. (1991). *Strangers at the bedside : A history of how law and bioethics transformed medical decision making*. New York, NY: BasicBooks.
- Sackett, D. L. (2002). Clinical epidemiology: What, who, and whither. *Journal of Clinical Epidemiology*, 55(12), 1161.
- Salman, Y. B., Cheng, H.-I., & Patterson, P. E. (2012). Icon and user interface design for emergency medical information systems: A case study. *International Journal of Medical Informatics*, 81, 29-35. doi:10.1016/
- Sanders, E. B. & Stappers, P. J. (2014). Probes, toolkits and prototypes: Three approaches to making in co-designing, *Co-design: International Journal of Co-creation in Design and the Arts*, 10(1), 5-14.
- Schrivver, K.A. 1997. *Dynamics in document design: Creating texts for readers*. New York, NY: John Wiley & Sons.

References

- Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. Retrieved 22 December, 2016, from books.google.co.nz/books?id=ceJIWay4-jgC
- Schwesinger, B. (2010). *The form book: Creating forms for printed and online use*. New York, NY: Thames & Hudson.
- Sinuff, T., Eva, K., Meade, M., Dodek, P., Heyland, D., & Cook, D. (2007). Clinical practice guidelines in the intensive care unit: A survey of Canadian clinicians' attitudes. *Guide de pratique clinique dans les unités de soins intensifs: Un sondage sur les attitudes des cliniciens canadiens.*, 54(9), 728.
- Simmonds, D., & Reynolds, L. 1994. *Data presentation and visual literacy in medicine and science*. Oxford, England: Butterworth-Heinemann.
- Simonsen, J., & Hertzum, M. (2012). Sustained participatory design: Extending the iterative approach. *Design Issues*, 28(3), 10-21.
- Somekh, B., & Noffke, S. (2003). *Action Research* (pp. 89–96). Retrieved October 20, 2016, from http://www.sagepub.com/upm-data/9738_035889ch10.pdf
- Sowersby. (2012, February 27). Re: Metric & calibre design information [Weblog post]. Retrieved 30 January, 2017, from <https://klim.co.nz/blog/metric-and-calibre-design-information/>
- Sanders, E. B. & Stappers, P. J. (2014). Probes, toolkits and prototypes: Three approaches to making in codesigning, *Codesign: International Journal of Cocreation in Design and the Arts*, 10(1), 5-14.
- Stickdorn, M., & Schneider, J. (2011). *THIS IS SERVICE DESIGN THINKING: Basics, tools, cases*. Hoboken, N.J.: Wiley.
- Swann, C. (2002). Action research and the practice of design. *Design Issues*, 18(1), 49-61. doi:10.1162/07479360252756287
- Travis, D. (2009). The fable of the user-centered designer. Retrieved January 13, 2017, from www.userfocus.co.uk/pdf/fable.pdf
- Tournay, V. (2006). De la bioéthique à l'action publique en matière de biotechnologie: La production des thérapies cellulaires. *Cahiers internationaux de sociologie*, 121, 265–286.
- Trbovich, P. (2014). Five ways to incorporate systems thinking into healthcare organizations. *Biomedical Instrumentation & Technology*, 48, 31-36. doi:10.2345/0899-8205-48.s2.31
- Tyler, A. C. (1992). *Shaping belief: The role of audience in visual communication*, 21.
- Visocky O'Grady, J., & Visocky O'Grady, K. (2008). *The information design handbook*. Cincinnati, OH: How Books.

References

- Vissers, M. C., Hasman, A., & van der Linden, C. J. (1996). Impact of a protocol processing system (ProtoVIEW) on clinical behaviour of residents and treatment. *International Journal Of Bio-Medical Computing*, 42(1-2), 143-150.
- Ware, C. (2004). *Information visualization: Perception for design*. Burlington: Elsevier.
- Watters III, W. C. (2008). *Defining evidence-based clinical practice guidelines*. Retrieved August 15, 2016, from <http://www.aaos.org/AAOSNow/2008/Jul/research/research2/>
- Weisz, G., Cambrosio, A., Keating, P., Knaapen, L., Schlich, T., & Tournay, V. J. (2007). The Emergence of Clinical Practice Guidelines, 691.
- Woolf, S. H., Grol, R., Hutchinson, A., Eccles, M., & Grimshaw, J. (1999). Potential benefits, limitations, and harms of clinical guidelines. *British Medical Journal*, 318(7182), 527.
- Yang, C. C., Chen, H., & Hong, K. (2003). Visualization of large category map for Internet browsing. *Decision Support Systems*, 35, 89-102. doi:10.1016/S0167-9236(02)00101-X
- Young, I. (2015). *Practical empathy: For collaboration and creativity in your work*. New York, NY: Rosenfield Media.
- Zender, M., P.Pestian, J., & Glauser, T. A. (2010). Visual language system for representing medical concepts. *Information Design Journal (IDJ)*, 18(3), 184-197.

Appendices

Appendix 1

AUTEC Secretariat

Auckland University of Technology
 D-88, WU406 Level 4 WU Building City Campus
 T: +64 9 921 9999 ext. 8316
 E: ethics@aut.ac.nz
 www.aut.ac.nz/researchethics



3 August 2016

Stephen Reay
 Faculty of Design and Creative Technologies

Dear Stephen

Re: Ethics Application: **16/164 Information discourse: Improving the effectiveness of clinical protocols through visual information design.**

Thank you for your request for approval of an amendment to your ethics application.

I have approved minor amendments to your ethics application allowing video recording.

I remind you that as part of the ethics approval process, you are required to submit the following to the Auckland University of Technology Ethics Committee (AUTEC):

- A brief annual progress report using form EA2, which is available online through <http://www.aut.ac.nz/researchethics>. When necessary this form may also be used to request an extension of the approval at least one month prior to its expiry on 2 May 2019;
- A brief report on the status of the project using form EA3, which is available online through <http://www.aut.ac.nz/researchethics>. This report is to be submitted either when the approval expires on 2 May 2019 or on completion of the project.

It is a condition of approval that AUTEC is notified of any adverse events or if the research does not commence. AUTEC approval needs to be sought for any alteration to the research, including any alteration of or addition to any documents that are provided to participants. You are responsible for ensuring that research undertaken under this approval occurs within the parameters outlined in the approved application.

AUTEC grants ethical approval only. If you require management approval from an institution or organisation for your research, then you will need to obtain this. If your research is undertaken within a jurisdiction outside New Zealand, you will need to make the arrangements necessary to meet the legal and ethical requirements that apply there.

To enable us to provide you with efficient service, please use the application number and study title in all correspondence with us. If you have any enquiries about this application, or anything else, please do contact us at ethics@aut.ac.nz.

All the very best with your research,



Kate O'Connor
 Executive Secretary
 Auckland University of Technology Ethics Committee

Cc: Byron Thornhill, thornhillbyron@gmail.com

Appendix 1

Ethics approval

Appendix 2

Appendix 2

Expert interview questions

User test strategy

Task scenarios

User test questions

Clinical guidelines questionnaire

Most recent use of a clinical guideline

What setting were you in when you last used a clinical guideline?
Would you say this setting is a typical clinical setting to be using a guideline in, or is it different in some way? PROBE: If different in some way, in what ways is this setting different to when you would usually use clinical guidelines?
What difficulties were there in using the guideline in this context? PROBE: How was the space in which you were using the guidelines? Did you have enough room? Was it too loud? Did you feel as if you were under time pressure?
In what format did you use the guideline - was it digital or printed? PROBE: Did you find it easy to access the guideline? What could be changed to make it easier to use?
Still thinking about the last time you used a guideline, at what time of day was it? PROBE: Was it morning, evening, or during a night shift?

General perceptions of clinical guidelines

How is a guideline used?
Tell me as many settings as you can think of that clinical guidelines can be used in.
Of the different settings you just mentioned, which would you say is the most common?
What changes could be made to clinical guidelines to make them easier to use in this setting?
Describe what you think makes a guideline... Functional
Describe what you think makes a guideline... Easy to use
Describe what you think makes a guideline... Easy to understand
Generally speaking, do you tend to agree or disagree that clinical guidelines are kept up to date?
What is a guidelines main objective? Was this objective met the last time you used a guideline?
What else about clinical guidelines could be improved?

Visual aspects of clinical guidelines

Thinking about the clinical guideline that you use <u>most frequently</u> ...
- Does the guideline clearly inform you of what you need to do? PROBE: If no, what could be improved to make this clearer?
- Do you often remember the content within the guideline used?
- Is it easy to understand any calculations required?
- Do you find the information in the guideline easy to follow? PROBE: If no, what is it about the guideline that makes it difficult to follow?
- Do you find the guideline practical? (e.g. easy to use, easy to access) PROBE: If no, what is it about the guideline that makes it difficult to use or access?
- Is the information laid out in a clear hierarchy? PROBE: If you were under time pressure, would you know which part of the guideline is <u>most important</u> ? If no, what could be improved to make it clearer what is most important?
- How could the readability of the guideline be improved?
- Is colour used effectively?
- Is font used effectively? E.g. size, formatting

Profiling questions

What is your current job title?
How many hours do you work in an average week?
Do you typically work during the day, or at evenings, or during the night?
Does the type of shift you work (e.g. day or night) usually stay the same, or does it change?
During a typical working day, do you find it easy or difficult to complete all of the tasks expected of you?
How often would you say that you work longer than you should, in order to finish your day's work?
How do you stay up to date with the most current knowledge relevant your role?

Ida Application User Testing

Team roles:

- Byron – Moderator
- Ivana – Qualitative log observer

What are the project goals?

- Ease of accessing the information and understanding
- Reduce time to administer the drug
- Reduce paper trail within process
- Guide the users' decisions with confidence
- Create ease of communication between all parties involved in drug administration (e.g. member panel and pharmacy / blood bank).

Test goals

- Learn what new users do when error occurs
- Learn new users' expectation of the name
- Learn from advanced users' perceptions of the new product - Compared to form.
- Learn advanced users' perceptions of the new features

Status of the product for test

New product, not tested before, features added to make decisions easier, features added to enhance communication between all parties involved, Testing will take place at two points in development so that change resulting from first test can be tested in follow up.

Issues with current product

- Hard to access current information
- Product information is too complex to understand in its current format
- Information is too small to read
- Confusion over two decision options in the product – which to choose?
- Problems filing / auditing / the drug in its current form
- In its current form the information needs to be printed / filled out / faxed
- The process involves dialling contact numbers of member panel

New product features

- Structured information with underlying automation / logic
- Larger font size with restricted information stream
- Smart phone application
- Incorporated communication where phone is incorporated within the guideline to ease process
- Selections that are made within the apps use will be archived for member panel to audit
- Automated pdf. involving date / time / authority and patient NHI (patient privacy obeyed) sent to Pharmacy and Blood bank
- Easy access of information as it will be downloaded on personal smartphone.

Appendix 2

Expert interview questions

User test strategy

Task scenarios

User test questions

User profiles

junior doctors, registrars, anaesthetic nurse, anaesthetists, haematologists

Questions to ask potential participants PRE-TEST.

- Name?
- Job title?
- Age?
- Are you familiar with this drug?
- Do you use any medical applications on your smartphone as a part of your job?
- If so which ones?
- Do you use Android or iOS as a device?
- When accessing a clinical guideline within the hospital, how do you find the process?

Questions to ask potential participants POST-TEST.

- What is your general impression of the application after using it?
- Are there any words or labels that you don't understand?
- After using the taps and buttons within the app, can you share what you think about their usability?
- How legible was the text to read? and is there anything you would change?
- How legible were the icons? And is there anything you would change?
- In terms of content is there anything missed out within the process?
- Can you please circle the words that best describe your experience while using the Ida app? Reaction card...

The complete set of 118 product reaction cards				
Accessible	Creative	Fast	Meaningful	Slow
Advanced	Customizable	Flexible	Motivating	Sophisticated
Annoying	Cutting edge	Fragile	Not secure	Stable
Appealing	Dated	Fresh	Not valuable	Sterile
Approachable	Desirable	Friendly	Novel	Stimulating
Attractive	Difficult	Frustrating	Old	Straightforward
Boring	Disconnected	Fun	Optimistic	Stressful
Businesslike	Disruptive	Gets in the way	Ordinary	Time consuming
Busy	Distracting	Hard to use	Organized	Time saving
Calm	Dull	Helpful	Overbearing	Too technical
Clean	Easy to use	High quality	Overwhelming	Trustworthy
Clear	Effective	Impersonal	Patronizing	Unapproachable
Collaborative	Efficient	Impressive	Personal	Unattractive
Comfortable	Effortless	Incomprehensible	Poor quality	Uncontrollable
Compatible	Empowering	Inconsistent	Powerful	Unconventional
Compelling	Energetic	Ineffective	Predictable	Understandable
Complex	Engaging	Innovative	Professional	Undesirable
Comprehensive	Entertaining	Inspiring	Relevant	Unpredictable
Confident	Enthusiastic	Integrated	Reliable	Unrefined
Confusing	Essential	Intimidating	Responsive	Usable
Connected	Exceptional	Intuitive	Rigid	Useful
Consistent	Exciting	Inviting	Satisfying	Valuable
Controllable	Expected	Irrelevant	Secure	
Convenient	Familiar	Low maintenance	Simplistic	

- Is there anything within the application that can be improved in terms of content and look?

Tasks for Scenarios

Each task commences with the application already downloaded on an android smartphone. Starting point is clicking on the icon of the interface at phone home screen.

Scenario 1

A 75-year-old man taking dabigatran for AF is assessed in the emergency department, following a motor vehicle accident. He is complaining of abdominal pain, with a blood pressure of 90/- and heart rate 140/min (AF). An urgent CT suggests a significant splenic injury with visible bleeding. He last took his dabigatran 8 hours ago; coagulation tests taken on admission are pending.

Outcome: Inclusion of drug – send NHI number, authorization to pharmacy

Scenario 2

An 80-year-old female has fallen on stairs and has a closed fracture of her humerus with displacement. Neurologically she is intact. Coagulation tests on arrival show an APTT of 66 seconds with a TCT >80 seconds. Her creatinine is 90umol/L. Her GP confirms that she takes dabigatran 110mg bd for AF. A surgical repair of her humerus is required.

Outcome: Exclusion—not desperately urgent

Scenario 3

A 79-year-old woman presents with a neck of femur fracture following a fall. She takes dabigatran 110mg bd for atrial fibrillation. She was found on the floor of her home, and may have been on the floor for up to 9 hours before being discovered. Admission blood tests show APTT 60 seconds, TCT>80 seconds, and a creatinine of 200umol/L which is an exacerbation of acute on chronic renal failure. The orthopedic team describe surgery as urgent although they note that her condition is not immediately life threatening.

Outcome: Not essential but would be better to reverse – Proceed anyway – send NHI number, authorization to pharmacy.

Scenario 4

A 68 year old man presents with melaena. He has been taking dabigatran 150mg bd for a deep vein thrombosis which was spontaneous, diagnosed 3 months before. He has noted dyspepsia recently. His BP is 140/70 with a heart rate of 89/min, initial haemoglobin is 125g/L. He has a creatinine of 88 umol/L. APTT is 45 seconds, TCT 70 seconds.

Outcome: Exclusion as not severe enough – levels to low. Finish app

Appendix 2

Expert interview questions

User test strategy

Task scenarios

User test questions

Appendix 2

Expert interview questions

User test strategy

Task scenarios

User test questions

Questions to ask potential participants PRE-TEST

- Name:
- Job title:
- Age:
- Are you familiar with this drug?
- Do you use any medical applications on your smartphone as a part of your job?
- If so which ones?
- Do you use Android or iOS as a device?
- When accessing a clinical guideline within the hospital, how do you find the current process?

Questions to ask potential participants POST-TEST

- What is your general impression of the application after using it?
- Are there any words or labels that you don't understand?
- After using the taps and buttons within the app, can you share what you think about their usability?
- How legible was the text to read? and is there anything you would change?
- How legible were the icons? And is there anything you would change?
- In terms of content is there anything missed out within the process?
- Can you please circle the words that best describe your experience while using the Ida app? (reaction card will be a separate print out)
- Is there anything within the application that can be improved in terms of content and look?

Appendix 3

Appendix 3

Metric

FF Clan

Operator

Gotham

Font Matrix Metric

Metric

Type Foundry : Klim Type Foundry
 7 Weights (thin - black)
 1 font family
 App - Web Applications
 14 weights in total (normal)
 large x - height
 Neutral - Geometric

Normal

Handglovery	0123456789
<i>Handglovery</i>	0123456789
Handglovery	0123456789
<i>Handglovery</i>	0123456789
Handglovery	0123456789
<i>Handglovery</i>	0123456789
Handglovery	0123456789
<i>Handglovery</i>	0123456789
Handglovery	0123456789
<i>Handglovery</i>	0123456789
Handglovery	0123456789
<i>Handglovery</i>	0123456789
Handglovery	0123456789
<i>Handglovery</i>	0123456789

30. pt / 36.pt 30. pt / 36.pt

Basic Latin ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz 0123456789	Math Symbols $+ < = > \sim \pm \times \div \partial \Delta \Pi \Sigma \sqrt{\infty} \int \approx \neq \leq \geq$
Basic Latin ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz 0123456789	Math Symbols $+ < = > \sim \pm \times \div \partial \Delta \Pi \Sigma \sqrt{\infty} \int \approx \neq \leq \geq$

Font Matrix Metric

Medical Equations

APTT > 80 seconds } with major bleeding
 CrCl < 30ml / min } or needing surgery
 < 0.04ug / L

CHA₂DS₂VASc score of ≥ 6

250iu/h (patients < 60kg) or 500iu/h (> 60kg)

Metrics

Waterfall

Haematologist	10pt	0123456789
Haematologist	12pt	0123456789
Haematologist	14pt	0123456789
Haematologist	18pt	0123456789
Haematologist	24pt	0123456789
Haematologist	30pt	0123456789
Haematologist	36pt	0123456789
Haematologist	48pt	0123456789
Haematologist	60pt	0123456789

Appendix 3

Metric

FF Clan

Operator

Gotham

Font Matrix Operator

Operator

Type Foundry : Hoefler & Co
 5 Weights (extra light - bold)
 3 font family
 App - Web Applications
 10 weights in total (mono)
 large x-height - narrow width
 Energetic - typewriter

Normal	Normal
Handglovery	0123456789
<i>Handglovery</i>	0123456789
Handglovery	0123456789
<i>Handglovery</i>	0123456789
Handglovery	0123456789
<i>Handglovery</i>	0123456789
Handglovery	0123456789
<i>Handglovery</i>	0123456789

30. pt / 36.pt 30. pt / 36.pt

Basic Latin	Math Symbols
ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz 0123456789	+<=> ~±×÷/∂ΔΠΣ-/.√∞]≈#≤≥
ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz 0123456789	+<=> ~±×÷/∂ΔΠΣ-/.√∞]≈#≤≥
ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz 0123456789	+<=> ~±×÷/∂ΔΠΣ-/.√∞]≈#≤≥
ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz 0123456789	+<=> ~±×÷/∂ΔΠΣ-/.√∞]≈#≤≥

Font Matrix Operator

Medical Equations

APTT > 80 seconds } with major bleeding
 CrCl < 30ml / min } or needing surgery
 < 0.04ug / L

CHA₂DS₂VASc score of ≥ 6

250iu/h (patients < 60kg) or 500iu/h (60kg)

Metrics

Axhpgf<≤∂ϑ

ascender
caps height
x - height
baseline
descender

Waterfall

Haematologist	10pt	0123456789
Haematologist	12pt	0123456789
Haematologist	14pt	0123456789
Haematologist	18pt	0123456789
Haematologist	24pt	0123456789
Haematologist	30pt	0123456789
Haematologist	36pt	0123456789 0123456789 0123456789
Haematologist	48pt	0123456789 0123456789 0123456789 0123456789
Haematologist	60pt	0123456789 0123456789 0123456789 0123456789 0123456789

Body Copy

Extra Light

The indication for antiplatelet therapy should be reviewed before therapy interruption is planned. The minimum period of uninterrupted treatment for bare metal coronary stents is 6 weeks, and for drug eluting stents is 6 months of dual therapy respectively. Within these time frames there is a risk of in-stent thrombosis with high mortality. Where possible planned procedures should be deferred to outside these time frames. The risk of discontinuation of therapy for non-coronary stent related indications is significantly less and generally at least clopidogrel can be discon-

Light

The indication for antiplatelet therapy should be reviewed before therapy interruption is planned. The minimum period of uninterrupted treatment for bare metal coronary stents is 6 weeks, and for drug eluting stents is 6 months of dual therapy respectively. Within these time frames there is a risk of in-stent thrombosis with high mortality. Where possible planned procedures should be deferred to outside these time frames. The risk of discontinuation of therapy for non-coronary stent related indications is significantly less and generally at least clopidogrel can be discon-

Book

The indication for antiplatelet therapy should be reviewed before therapy interruption is planned. The minimum period of uninterrupted treatment for bare metal coronary stents is 6 weeks, and for drug eluting stents is 6 months of dual therapy respectively. Within these time frames there is a risk of in-stent thrombosis with high mortality. Where possible planned procedures should be deferred to outside these time frames. The risk of discontinuation of therapy for non-coronary stent related indications is significantly less and generally at least clopidogrel can be discon-

Medium

The indication for antiplatelet therapy should be reviewed before therapy interruption is planned. The minimum period of uninterrupted treatment for bare metal coronary stents is 6 weeks, and for drug eluting stents is 6 months of dual therapy respectively. Within these time frames there is a risk of in-stent thrombosis with high mortality. Where possible planned procedures should be deferred to outside these time frames. The risk of discontinuation of therapy for non-coronary stent related indications is significantly less and generally at least clopidogrel can be discontinued. Aspirin can be considered in place of clopidogrel if

Bold

The indication for antiplatelet therapy should be reviewed before therapy interruption is planned. The minimum period of uninterrupted treatment for bare metal coronary stents is 6 weeks, and for drug eluting stents is 6 months of dual therapy respectively. Within these time frames there is a risk of in-stent thrombosis with high mortality. Where possible planned procedures should be deferred to outside these time frames. The risk of discontinuation of therapy for non-coronary stent related indications is significantly less and generally at least clopidogrel can be discontinued. Aspirin can be considered in place of clopidogrel if

Fractions

1/3 2/3 1/8
3/3 5/8 7/8
8/8

Appendix 3

Metric

FF Clan

Operator

Gotham

Two Coloured Body Copy

The indication for antiplatelet therapy should be reviewed before therapy interruption is planned. The minimum period of uninterrupted treatment for bare metal coronary stents is 6 weeks, and for drug eluting stents is 6 months of dual therapy respectively. Within these time frames there is a risk of in-stent thrombosis with high mortality.

Where possible planned procedures should be deferred to outside these time frames. The risk of discontinuation of therapy for non-coronary stent related indications is significantly less and generally at least clopidogrel can be discontinued. Aspirin can be considered in place of clopidogrel if a vascular event was recent (<6 months).

LOW risk procedures (see section 1/2) can in general be performed on aspirin or clopidogrel. Discontinuation of clopidogrel for 5 days should be considered in patients on dual therapy if possible although the indication for the therapy is the main deciding factor. Exceptions include dental procedures (although wide clearance may be better with temporary cessation of clopidogrel)

HIGH risk procedures can in general be performed on aspirin therapy. However the POISE-2 trial suggested that discontinuing aspirin 3 days preoperatively reduces the risk of major bleeding without increasing the risk of MI/stroke therefore discontinuation preoperatively and starting again post-operatively at day 8 may be reasonable. For high risk sites such as neurosurgery aspirin is generally stopped. If

The indication for antiplatelet therapy should be reviewed before therapy interruption is planned. The minimum period of uninterrupted treatment for bare metal coronary stents is 6 weeks, and for drug eluting stents is 6 months of dual therapy respectively. Within these time frames there is a risk of in-stent thrombosis with high mortality.

Where possible planned procedures should be deferred to outside these time frames. The risk of discontinuation of therapy for non-coronary stent related indications is significantly less and generally at least clopidogrel can be discontinued. Aspirin can be considered in place of clopidogrel if a vascular event was recent (<6 months).

LOW risk procedures (see section 1/2) can in general be performed on aspirin or clopidogrel. Discontinuation of clopidogrel for 5 days should be considered in patients on dual therapy if possible although the indication for the therapy is the main deciding factor. Exceptions include dental procedures (although wide clearance may be better with temporary cessation of clopidogrel)

HIGH risk procedures can in general be performed on aspirin therapy. However the POISE-2 trial suggested that discontinuing aspirin 3 days preoperatively reduces the risk of major bleeding without increasing the risk of MI/stroke therefore discontinuation preoperatively and

The indication for antiplatelet therapy should be reviewed before therapy interruption is planned. The minimum period of uninterrupted treatment for bare metal coronary stents is 6 weeks, and for drug eluting stents is 6 months of dual therapy respectively. Within these time frames there is a risk of in-stent thrombosis with high mortality.

Where possible planned procedures should be deferred to outside these time frames. The risk of discontinuation of therapy for non-coronary stent related indications is significantly less and generally at least clopidogrel can be discontinued. Aspirin can be considered in place of clopidogrel if a vascular event was recent (<6 months).

LOW risk procedures (see section 1/2) can in general be performed on aspirin or clopidogrel. Discontinuation of clopidogrel for 5 days should be considered in patients on dual therapy if possible although the indication for the therapy is the main deciding factor. Exceptions include dental procedures (although wide clearance may be better with temporary cessation of clopidogrel)

HIGH risk procedures can in general be performed on aspirin therapy. However the POISE-2 trial suggested that discontinuing aspirin 3 days preoperatively reduces the risk of major bleeding without increasing the risk of MI/stroke therefore discontinuation preoperatively and starting again post-operatively at day 8 may be reasonable. For high risk sites such as neurosurgery aspirin is generally stopped. If there are firm indications for continuing aspirin discussion between specialists including a cardiologist is required.

The indication for antiplatelet therapy should be reviewed before therapy interruption is planned. The minimum period of uninterrupted treatment for bare metal coronary stents is 6 weeks, and for drug eluting stents is 6 months of dual therapy respectively. Within these time frames there is a risk of in-stent thrombosis with high mortality.

Where possible planned procedures should be deferred to outside these time frames. The risk of discontinuation of therapy for non-coronary stent related indications is significantly less and generally at least clopidogrel can be discontinued. Aspirin can be considered in place of clopidogrel if a vascular event was recent (<6 months).

LOW risk procedures (see section 1/2) can in general be performed on aspirin or clopidogrel. Discontinuation of clopidogrel for 5 days should be considered in patients on dual therapy if possible although the indication for the therapy is the main deciding factor. Exceptions include dental procedures (although wide clearance may be better with temporary cessation of clopidogrel)

HIGH risk procedures can in general be performed on aspirin therapy. However the POISE-2 trial suggested that discontinuing aspirin 3 days preoperatively reduces the risk of major bleeding without increasing the risk of MI/stroke therefore discontinuation preoperatively and starting again post-operatively at day 8 may be reasonable. For high risk sites such as neurosurgery aspirin

Operator Matrix

Look / Feel and Semantics	Legibility	Numerals and Mathematics	Font Flexibility	Total
Notes:	Notes:	Notes:	Notes:	
Score: 1 - 10	Score: 1 - 10	Score: 1 - 10	Score: 1 - 10	

Appendix 4

Novice User:**Appendix 4**

Data table

Novice user analysis

Advanced user analysis



Occupation

Senior House Officer

Age

26**Technology use:**

- iPhone 6 smartphone iOS
- Operation room PC's (Intranet)

Use of medical applications on Smartphone:

Yes

- QX Calculate
- MIMS

Familiar with Idarucizumab Drug:

Vaguely heard of it

Current process accessing clinical guidelines:

- Relatively straight forward
- Haven't looked for guidelines much
- New to Auckland City Hospital (2 months)



Occupation

Senior House Officer

Age

27**Technology use:**

- iPhone 6 smartphone iOS
- Operation room PC's (Intranet)

Use of medical applications on Smartphone:

Yes

- MED Calaculate

Familiar with Idarucizumab Drug:

No

Current process accessing clinical guidelines:

- Hard to get too
- Subject lists are hard to get to — a lot of scrolling to get to the desired guideline
- Time consuming process
- Doesn't have time to read through 8 page pdf. document files filled with text

Novice User:

Appendix 4

Data table

Novice user analysis

Advanced user analysis



Occupation
Anaesthetic Registrar



Age
30

Technology use:

- iPhone 6 smartphone iOS
- Operation room PC's (Intranet)

Familiar with Idarucizumab Drug:

Not really — never requested it

Current process accessing clinical guidelines:

- Intranet can be tedious
- Not established
- Time consuming

Use of medical applications on Smartphone:

Yes

- Med Calculate
- Warfarin Reversal
- Predexa



Occupation
Anaesthetic Registrar



Age
31

Technology use:

- iPhone 6 smartphone iOS
- Operation room PC's (Intranet)

Familiar with Idarucizumab Drug:

Yes

Current process accessing clinical guidelines:

- Hard to remember which guideline to use
- Different DHB's have different guidelines
- Hard to find guidelines when jumping from DHB to DHB

Use of medical applications on Smartphone:

Yes

- Oxford Anaesthesia Book
- MedCalculate
- PediLite
- PD app

Novice User:**Appendix 4**

Data table

Novice user analysis

Advanced user analysis



Occupation

Anaesthetic Registrar

Age

32**Technology use:**

- iPhone 6 smartphone iOS
- Operation room PC's (Intranet)

Familiar with Idarucizumab Drug:

No

Current process accessing clinical guidelines:

- Slow process
- Difficult to find guidelines

Use of medical applications on Smartphone:

Yes

- MedCalculate
- MIMS
- Oxford Anaesthesia Handbook



Occupation

Anaesthetic Registrar

Age

29**Technology use:**

- iPhone 6 smartphone iOS
- Operation room PC's (Intranet)

Familiar with Idarucizumab Drug:

No

Current process accessing clinical guidelines:

- Time consuming
- Also uses Anaesthesia department webpage to access guidelines

Use of medical applications on Smartphone:

Yes

- MedCalculate
- Pedisafe

Appendix 4

Data table

Novice user analysis

Advanced user analysis

Novice User:

Occupation

Anaesthetic Registrar

Age

31**Technology use:**

- iPhone 6 smartphone iOS
- Operation room PC's (Intranet)

Familiar with Idarucizumab Drug:

No

Current process accessing clinical guidelines:

- Easy
- Confident using computers

Use of medical applications on Smartphone:

Yes

- Oxford Anaesthesia Handbook
- EuroScore II



Occupation

Anaesthetic Fellow

Age

33**Technology use:**

- iPhone 6 smartphone iOS
- Operation room PC's (Intranet)

Familiar with Idarucizumab Drug:

Yes

Current process accessing clinical guidelines:

- Uses Anaesthesia Department website via intranet
- Easy for certain guidelines but not others

Use of medical applications on Smartphone:

Yes

- MedCalculate

Scenario 1 — Selection Summary

Outcome : Inclusion of drug – send NHI number, authorization to pharmacy

A 75-year-old man taking dabigatran for AF is assessed in the emergency department, following a motor vehicle accident. He is complaining of abdominal pain, with a blood pressure of 90/- and heart rate 140/min (AF). An urgent CT suggests a significant splenic injury with visible bleeding. He last took his dabigatran 8 hours ago; coagulation tests taken on admission are pending.

Appendix 4

Data table

Novice user analysis

Advanced user analysis



Senior House Officer
Outcome not achieved

Severity / Urgency

Inclusion
GI bleed with significant haemodynamic instability
Major trauma

Exclusion
None of the above

Dabigatran Evidence

Inclusion
None of the above

Exclusion
—



Senior House Officer
Outcome achieved

Severity / Urgency

Inclusion
Immediate emergency surgery

Exclusion
None of the above

Dabigatran Evidence

Inclusion
Emergency surgery with an admission to theatre time <60 minutes

Exclusion
None of the above



Anaesthetic Registrar
Outcome achieved

Severity / Urgency

Inclusion
Immediate emergency surgery

Exclusion
None of the above

Dabigatran Evidence

Inclusion
APPT > 40 seconds (no TCT)

Exclusion
None of the above



Anaesthetic Registrar
Outcome achieved

Severity / Urgency

Inclusion
Major Trauma
An urgent procedure must be within 2-3 hours

Exclusion
None of the above

Dabigatran Evidence

Inclusion
Emergency surgery with an admission to theatre time <60 minutes

Exclusion
None of the above

Scenario 1 — Selection Summary

Outcome : Inclusion of drug – send NHI number, authorization to pharmacy

Appendix 4

Data table

Novice user analysis

Advanced user analysis



Anaesthetic Registrar

Outcome achieved

Severity / Urgency

Inclusion
Major trauma
An urgent procedure must be within 2-3 hours

Exclusion
None of the above

Dabigatran Evidence

Inclusion
Emergency surgery with an admission to theatre time <60 minutes

Exclusion
None of the above



Anaesthetic Registrar

Outcome achieved

Severity / Urgency

Inclusion
Major trauma

Exclusion
None of the above

Dabigatran Evidence

Inclusion
Emergency surgery with an admission to theatre time <60 minutes

Exclusion
None of the above



Anaesthetic Registrar

Outcome achieved

Severity / Urgency

Inclusion
Major trauma

Exclusion
None of the above

Dabigatran Evidence

Inclusion
APPT > 40 seconds (no TCT)

Exclusion
None of the above



Anaesthetic Fellow

Outcome achieved

Severity / Urgency

Inclusion
Major Trauma
An urgent procedure must be within 2-3 hours

Exclusion
None of the above

Dabigatran Evidence

Inclusion
Emergency surgery with an admission to theatre time <60 minutes

Exclusion
None of the above

Scenario 1

Inclusion of drug – send NHI number, authorization to pharmacy

Quotes

“I only started at the hospital 2 months ago”

“I would always call the Haematology department as I have in the past.”

“This is hard to understand”

Rating



Findings

7 out of 8 clinicians completed the scenario to the correct outcome. The 1 clinician that didn't reach the desired outcome also stated being new to Auckland DHB and has only been on the job for 2 months

4 out of 8 clinicians became confused when reaching the call screen within the application. Although all clinicians acknowledged the need to call the member panel to gain approval, when 6 different contacts were listed within the same screen there was hesitation on which contact to call.

Users hesitated when interacting with the dropdown menu. Within the recorded footage, their fingers hovered over different aspects of the 'Call' screen. Decision making and users interacting with the screen halted. This caused an interruption to the users decision making that led to further confusion.

Recommendations

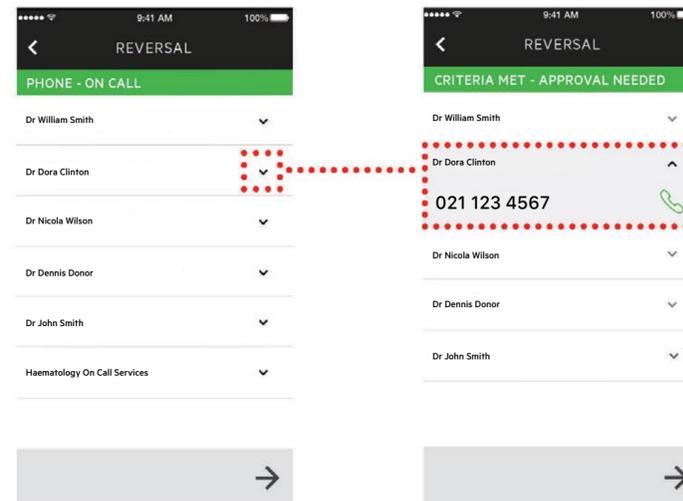
Display the contact numbers along side the name associated rather than hiding it within a drop down menu.

Appendix 4

Data table

Novice user analysis

Advanced user analysis



Scenario 1

Inclusion of drug – send NHI number, authorization to pharmacy

Quotes

“Have I done something wrong here?”

“The NHI input needs to be automatically capitalised”

Rating



Findings

Regarding the NHI patient data input, there were a number of cases where clinicians had to re-enter the data as the keyboard didn't collapse within the application. This caused frustration and confusion within the guideline process. A clinician also mentioned whether the data input could be case sensitive as NHI numbers always involve all cap letters.

Recommendations

Automatic capitalisation of the letters within the inputs of NHI number.

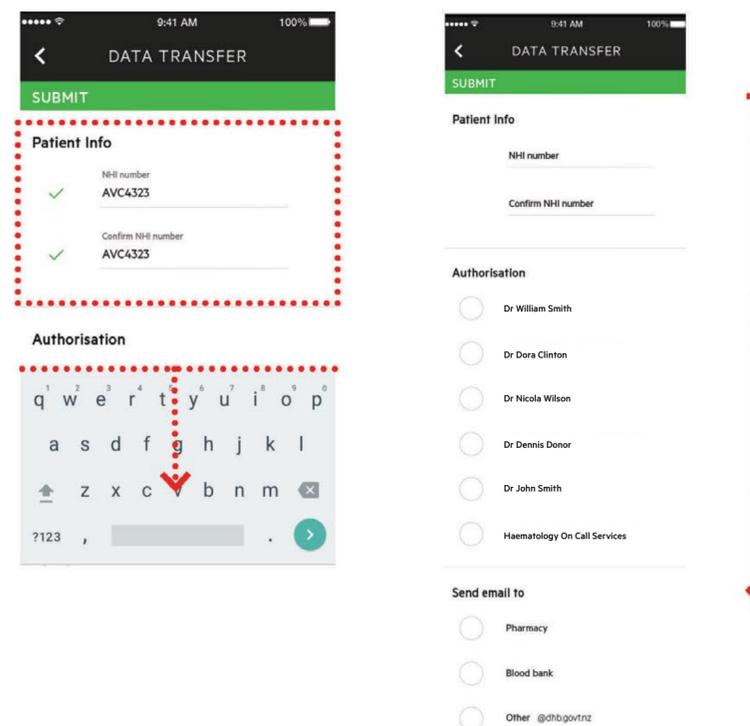
Include collapsible keyboard once NHI number is inputted

Appendix 4

Data table

Novice user analysis

Advanced user analysis



Scenario 1

Inclusion of drug – send NHI number, authorization to pharmacy

Quotes

“Direct steps help with the process as a lot of the time when searching for the correct drug its spent looking through a room filled with them”

Rating



Findings

All clinicians responded positively to the procedure screen and followed the content with ease. 3 clinicians intuitively clicked on the procedure pictograms to enlarge each step. This feature wasn't featured on the prototype. As the clinician's realised this, intuitively their first reaction was to scroll down the screen.

Recommendations

Appendix 4

Data table

Novice user analysis

Advanced user analysis



Scenario 1

Inclusion of drug – send NHI number, authorization to pharmacy

Quotes

“I’m having trouble understanding what ‘Dabigatran Evidence’ means”

Rating



Findings

1 clinician within this scenario had a problem understanding the screen heading ‘Dabigatran Evidence.’ This seemed inconsistent to the other clinicians as nobody else had any issues with this title.

Recommendations

Appendix 4

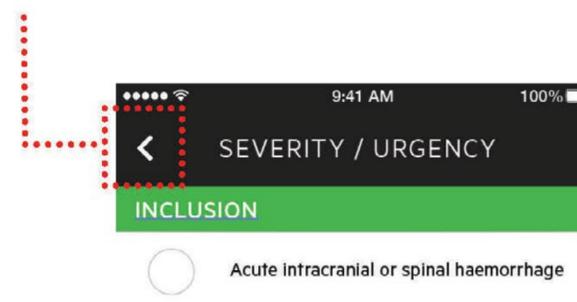
Data table

Novice user analysis

Advanced user analysis



The ‘back’ functionality within the application is clear and widely understood.



Scenario 2 — Selection Summary

Outcome : Exclusion of drug—not desperately urgent

An 80-year-old female has fallen on stairs and has a closed fracture of her humerus with displacement. Neurologically she is intact. Coagulation tests on arrival show an APTT of 66 seconds with a TCT >80 seconds. Her creatinine is 90umol/L. Her GP confirms that she takes dabigatran 110mg bd for AF. A surgical repair of her humerus is required.

Appendix 4

Data table

Novice user analysis

Advanced user analysis



Senior House Officer

Outcome not met

Severity / Urgency

Inclusion
An urgent procedure must be within 2-3 hours

Exclusion
None of the above

Dabigatran Evidence

Inclusion
APPT > 40 seconds (no TCT)

Exclusion
None of the above



Senior House Officer

Outcome met

Severity / Urgency

Inclusion
None of the above

Exclusion
—

Dabigatran Evidence

Inclusion
—

Exclusion
—



Anaesthetic Registrar

Outcome met

Severity / Urgency

Inclusion
None of the above

Exclusion
—

Dabigatran Evidence

Inclusion
—

Exclusion
—



Anaesthetic Registrar

Outcome met

Severity / Urgency

Inclusion
None of the above

Exclusion
—

Dabigatran Evidence

Inclusion
—

Exclusion
—

Scenario 2 — Selection Summary

Outcome : Exclusion of drug—not desperately urgent

Appendix 4

Data table

Novice user analysis

Advanced user analysis



Anaesthetic Registrar
Outcome met

Severity / Urgency

Inclusion
None of the above

Exclusion
—

Dabigatran Evidence

Inclusion
—

Exclusion
—



Anaesthetic Registrar
Outcome met

Severity / Urgency

Inclusion
None of the above

Exclusion
—

Dabigatran Evidence

Inclusion
—

Exclusion
—



Anaesthetic Registrar
Outcome not met

Severity / Urgency

Inclusion
An urgent procedure must be within 2-3 hours

Exclusion
None of the above

Dabigatran Evidence

Inclusion
TCT > 80 seconds
APPT > 40 seconds (no TCT)

Exclusion
None of the above



Anaesthetic Fellow
Outcome met

Severity / Urgency

Inclusion
None of the above

Exclusion
—

Dabigatran Evidence

Inclusion
—

Exclusion
—

Scenario 2

Exclusion of drug—not desperately urgent

Quotes

“I like this a lot.”

“Clinicians don’t like finishing things.”

Rating



Findings

6 out of 8 clinicians completed the scenario to the correct outcome. The 1 clinician who didn’t reach the desired outcome stated being new to Auckland DHB and didn’t understand the scenario put forward. The second clinician seemed very frazzled with the scenario but also the functionality of the application as he skipped screens and didn’t read the content correctly.

When the ‘finish’ button was pressed one clinician became confused as to whether the procedure had actually finished. When the button is pressed it leads the clinician to the disclaimer screen. There is no notification whether the application is actually finished.

Recommendations

Selections need to be manually ticked before the user is able to proceed to the next screen within the application.

It was suggested to include a contact list within this aspect of the application as then clinicians can call for advice.

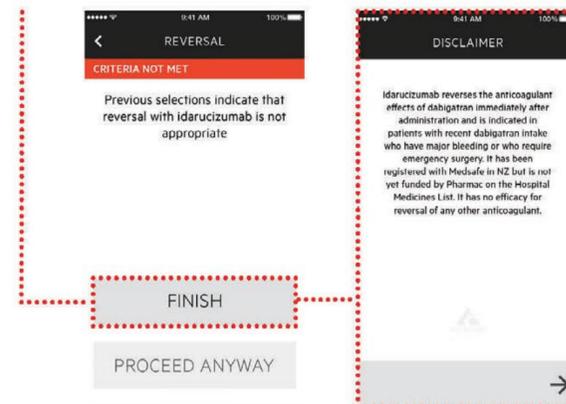
A notification needs to be added when the finish button is engaged with. This will clarify that the guideline is finished

Appendix 4

Data table

Novice user analysis

Advanced user analysis



Scenario 3 — Selection Summary

Outcome : Not essential but would be better to reverse – Proceed anyway – send NHI number, authorization to pharmacy.

A 79-year-old woman presents with a neck of femur fracture following a fall. She takes dabigatran 110mg bd for atrial fibrillation. She was found on the floor of her home, and may have been on the floor for up to 9 hours before being discovered. Admission blood tests show APTT 60 seconds, TCT>80 seconds, and a creatinine of 200umol/L which is an exacerbation of acute on chronic renal failure. The orthopedic team describe surgery as urgent although they note that her condition is not immediately life threatening.

Appendix 4

Data table

Novice user analysis

Advanced user analysis



Senior House Officer

Outcome not achieved

Severity / Urgency

Inclusion

An urgent procedure must be within 2-3 hours

Exclusion

None of the above

Dabigatran Evidence

Inclusion

TCT > 80 seconds

Exclusion

None of the above



Senior House Officer

Outcome not achieved

Severity / Urgency

Inclusion

An urgent procedure must be within 2-3 hours

Exclusion

None of the above

Dabigatran Evidence

Inclusion

TCT > 80 seconds

Exclusion

None of the above



Anaesthetic Registrar

Outcome not achieved

Severity / Urgency

Inclusion

An urgent procedure must be within 2-3 hours

Exclusion

None of the above

Dabigatran Evidence

Inclusion

TCT > 80 seconds

Exclusion

None of the above



Anaesthetic Registrar

Outcome achieved

Severity / Urgency

Inclusion

None of the above
Proceed anyway

Exclusion

—

Dabigatran Evidence

Inclusion

—

Exclusion

—

Scenario 3 — Selection Summary

Novice users | Usability Evaluation

Outcome : Not essential but would be better to reverse – Proceed anyway – send NHI number, authorization to pharmacy.

Appendix 4

Data table

Novice user analysis

Advanced user analysis



Anaesthetic Registrar
Outcome not met

Severity / Urgency

Inclusion
None of the above

Exclusion
—

Dabigatran Evidence

Inclusion
—

Exclusion
—



Anaesthetic Registrar
Outcome not met

Severity / Urgency

Inclusion
An urgent procedure must be within 2-3 hours

Exclusion
None of the above

Dabigatran Evidence

Inclusion
TCT > 80 seconds
APPT > 40 seconds (no TCT)

Exclusion
None of the above



Anaesthetic Registrar
Outcome not met

Severity / Urgency

Inclusion
An urgent procedure must be within 2-3 hours

Exclusion
None of the above

Dabigatran Evidence

Inclusion
TCT > 80 seconds
APPT > 40 seconds (no TCT)

Exclusion
None of the above



Anaesthetic Fellow
Outcome met

Severity / Urgency

Inclusion
None of the above
Proceed anyway

Exclusion
—

Dabigatran Evidence

Inclusion
—

Exclusion
—

Scenario 3

Inclusion of drug — not essential but would be better to reverse – proceed anyway – send NHI number, authorization to pharmacy.

Quotes

“The patient doesn’t meet any of the criteria. I would need to discuss with the haematology department.”

Rating



Findings

Only 1 user met the correct outcome for this scenario. The user described this scenario as a ‘grey area’ and stated personally wanting to reverse the patient even though they don’t meet the criteria. It was here that seeking further advice from the member panel is needed.



2 clinicians understood that the patient within the scenario did not meet the criteria but before pressing the finish button mentioned only using the ‘proceed anyway’ function with the advice and approval of the surgical team. They also mentioned wanting to get in contact with the member panel if they were unsure whether the drug should be approved.



The clinicians that didn’t meet the correct outcome were very hesitant when given the option to ‘proceed anyway’ so much so the button was never pressed and instead pressed ‘finish.’

Recommendations

It was suggested including a contact list within this aspect of the application as then clinicians can call for advice.

Change the terminology of the ‘proceed anyway’ button where it doesn’t cause hesitation to the users

Appendix 4

Data table

Novice user analysis

Advanced user analysis



Scenario 4 — Selection Summary

Outcome : Exclusion as not severe enough – levels to low. Finish app

A 68 year old man presents with melaena. He has been taking dabigatran 150mg bd for a deep vein thrombosis which was spontaneous, diagnosed 3 months before. He has noted dyspepsia recently. His BP is 140/70 with a heart rate of 89/min, initial haemoglobin is 125g/L. He has a creatinine of 88 umol/L. APTT is 45 seconds, TCT 70 seconds.

Appendix 4

Data table

Novice user analysis

Advanced user analysis



Senior House Officer

Outcome met

Severity / Urgency

Inclusion
None of the above

Exclusion
—

Dabigatran Evidence

Inclusion
—

Exclusion
—



Senior House Officer

Outcome met

Severity / Urgency

Inclusion
None of the above

Exclusion
—

Dabigatran Evidence

Inclusion
—

Exclusion
—



Anaesthetic Registrar

Outcome met

Severity / Urgency

Inclusion
None of the above

Exclusion
—

Dabigatran Evidence

Inclusion
—

Exclusion
—



Anaesthetic Registrar

Outcome met

Severity / Urgency

Inclusion
None of the above

Exclusion
—

Dabigatran Evidence

Inclusion
—

Exclusion
—

Scenario 4 — Selection Summary

Outcome : Exclusion as not severe enough – levels to low. Finish app



Anaesthetic Registrar

Outcome met



Anaesthetic Registrar

Outcome met



Anaesthetic Registrar

Outcome met



Anaesthetic Fellow

Outcome met

Severity / Urgency

Inclusion

None of the above

Exclusion

—

Dabigatran Evidence

Inclusion

—

Exclusion

—

Severity / Urgency

Inclusion

None of the above

Exclusion

—

Dabigatran Evidence

Inclusion

—

Exclusion

—

Severity / Urgency

Inclusion

None of the above

Exclusion

—

Dabigatran Evidence

Inclusion

—

Exclusion

—

Severity / Urgency

Inclusion

None of the above

Exclusion

—

Dabigatran Evidence

Inclusion

—

Exclusion

—

Rating

Findings



All users reached the desired outcome for this scenario

Appendix 4

Data table

Novice user analysis

Advanced user analysis

Visual Design Feedback

Text Legibility

Quotes

“Easy to read—and I haven’t even got my glasses on”

“Nothing needs changing, its quite friendly”

Rating



Findings

The comments made regarding the legibility of the text within the application were positive where all advanced users stated how clear and easy to read the text is to read on screen

Recommendations

The first <Severity / Urgency> inclusion page is over crowded. The textual information needs to be further slimmed. It was described as “too cluttered”

Icon Legibility

Quotes

“Icons make it easier to understand in case you don’t have time to read all the steps”

“The medication room icon should be a PACU logo. All clinicians would understand instantly where to go”

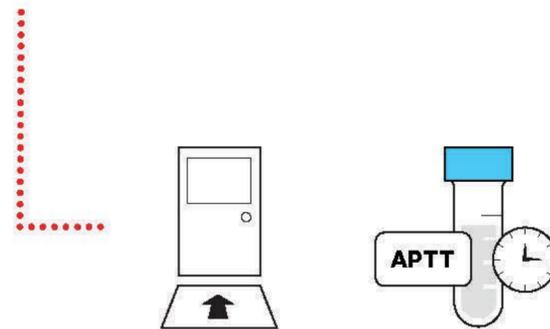
“The icons look very pretty and cartoony”

Rating



Findings

The comments made regarding the legibility of the icons within the application were positive where all novice users stated they were legible and further segregated the steps and processes within the guideline.



Recommendations

Include PACU logo rather than the medication room door icon. Include ‘TCT’ label in the APPT / TCT icon.

Appendix 4

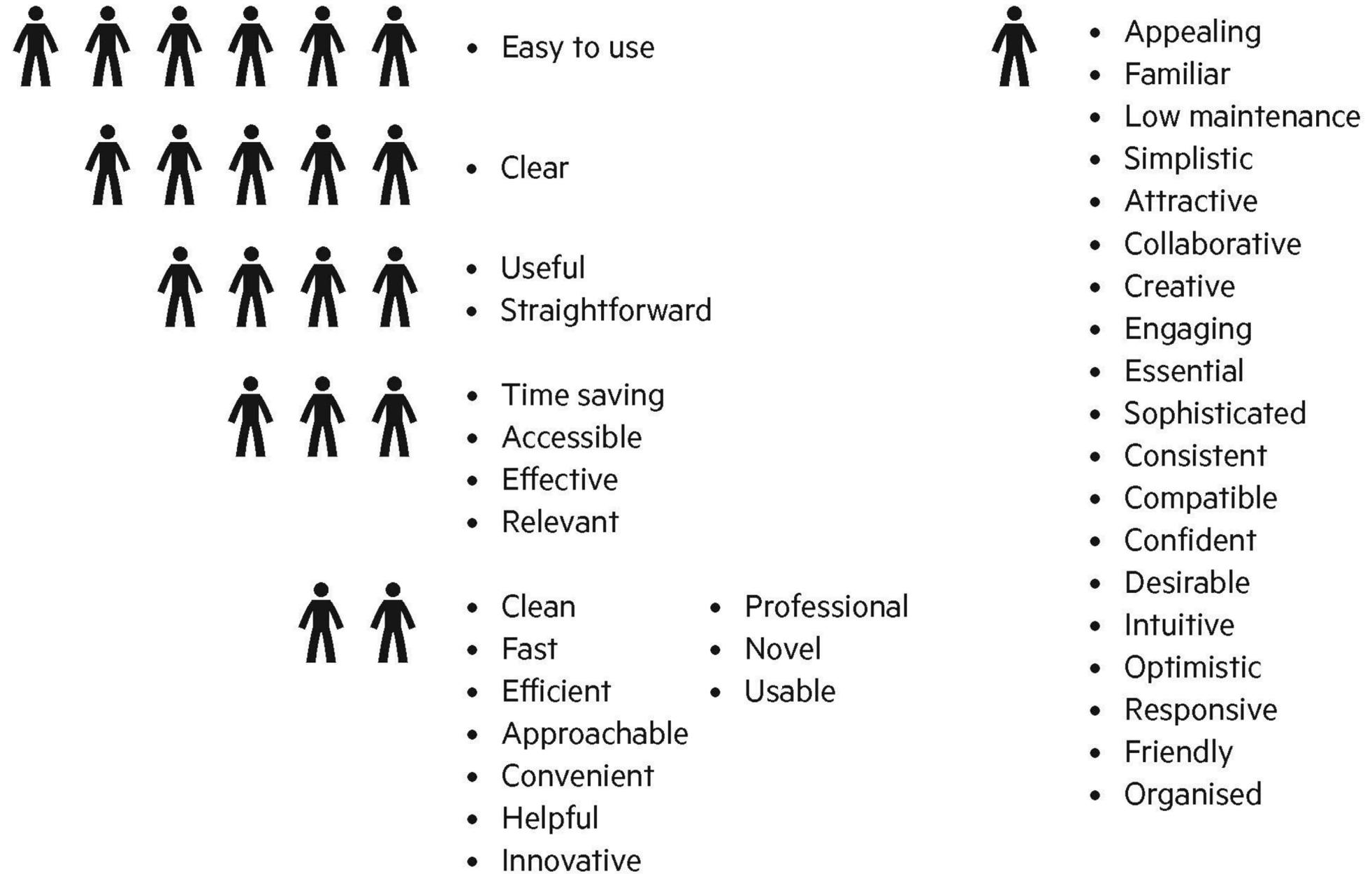
Data table

Novice user analysis

Advanced user analysis

Usability Reaction Cards

Circled words that best described the advanced users experience while they used the Ida application (catagorised by number of users)



Appendix 4

Data table

Novice user analysis

Advanced user analysis

Advanced User:

Occupation

Specialist Anaesthetist

Age

56**Technology use:**

- iPhone 6 + smartphone iOS
- 13" Macbook air (personal)
- Operation room PC's (Intranet)

Use of medical applications on Smartphone:

Yes

- Warfarin Reversal
- Dabigatran
- Gas Guide
- Med Calc
- iResus

Familiar with Idarucizumab Drug:

Yes

Current process accessing clinical guidelines:

The process of accessing clinical guidelines is described as cumbersome as they are only available via desktop computers in the operation rooms, using the Auckland DHB intranet. This restricts 'on the fly' access of information. This is followed by quality concerns regarding whether the guidelines that are supplied through the Auckland DHB intranet are up-to-date within their content.

Appendix 4

Data table

Novice user analysis

Advanced user analysis

Advanced User:

Occupation

Haematologist

Age

42**Technology use:**

- iPhone 6 smartphone iOS
- Operation room PC's (Intranet)

Use of medical applications on Smartphone:

Yes

- Warfarin Reversal

Familiar with Idarucizumab Drug:

Yes

Current process accessing clinical guidelines:

The process of accessing clinical guidelines is described as "laborious" as they are not easy to find or categorised intuitively on the Auckland DHB intranet.

Appendix 4

Data table

Novice user analysis

Advanced user analysis

Advanced User:

Occupation

Specialist Anaesthetist

Age

59**Technology use:**

- iPhone 6 smartphone iOS
- Operation room PC's (Intranet)

Familiar with Idarucizumab Drug:

Yes

Current process accessing clinical guidelines:

The process of accessing clinical guidelines is described as “not too bad,” although only some of the guidelines were commented on being up-to-date. The anaesthetist also mentioned her department having a stand alone website where the guideline information is up-to-date but this website is still accessed through the Auckland DHB

Use of medical applications on Smartphone:

Yes

- Warfarin Reversal
- Dabigatran
- MedScape
- QX Calculate
- Hippocrates

Appendix 4

Data table

Novice user analysis

Advanced user analysis

Advanced User:

Occupation

Clinical Director

Age

57**Technology use:**

- iPhone 6 smartphone iOS
- Operation room PC's (Intranet)

Familiar with Idarucizumab Drug:

No

Current process accessing clinical guidelines:

The clinical director strongly dislikes the process of having to use the Auckland DHB intranet to access clinical guidelines stating, “when you need to use a guideline you are not necessarily always in front of your computer, someone might phone me for advice, I might be talking about a patient at a meeting so what you want is a guideline that is on you now, so when you need it you don’t need to leave your surroundings to go and find it on a computer.”

Use of medical applications on Smartphone:

Yes

- Warfarin Reversal
- Dabigatran
- MIMS
- BMI Calculator
- Difficult Airways Society

“I’ve always maintained that if we were a good department we would have all our guidelines in one place on an application—I’ve been trying to twist peoples arms for ages”

Appendix 4

Data table

Novice user analysis

Advanced user analysis

Scenario 1 — Selection Summary

Outcome : Inclusion of drug – send NHI number, authorization to pharmacy

A 75-year-old man taking dabigatran for AF is assessed in the emergency department, following a motor vehicle accident. He is complaining of abdominal pain, with a blood pressure of 90/- and heart rate 140/min (AF). An urgent CT suggests a significant splenic injury with visible bleeding. He last took his dabigatran 8 hours ago; coagulation tests taken on admission are pending.

Appendix 4

Data table

Novice user analysis

Advanced user analysis



Specialist Anaesthetist

Outcome achieved

Severity / Urgency

Inclusion
 Immediate emergency surgery
 Major Trauma
 An urgent procedure within 2-3 hours

Exclusion
 None of the above

Dabigatran Evidence

Inclusion
 Emergency surgery with an admission to theatre time <60 min

Exclusion
 None of the above



Specialist Anaesthetist

Outcome achieved

Severity / Urgency

Inclusion
 Major Trauma

Exclusion
 None of the above

Dabigatran Evidence

Inclusion
 Emergency surgery with an admission to theatre time <60 minutes

Exclusion
 None of the above



Haematologist

Outcome achieved

Severity / Urgency

Inclusion
 Major Trauma

Exclusion
 None of the above

Dabigatran Evidence

Inclusion
 Emergency surgery with an admission to theatre time <60 minutes

Exclusion
 None of the above



Clinical Director

Outcome achieved

Severity / Urgency

Inclusion
 Immediate emergency surgery
 Major Trauma

Exclusion
 None of the above

Dabigatran Evidence

Inclusion
 Emergency surgery with an admission to theatre time <60 minutes

Exclusion
 None of the above

Scenario 1

Inclusion of drug – send NHI number, authorization to pharmacy

Quotes

“Pre-ticked selections influence bad habits”

“I missed one bit of information on the first scenario because I read it too fast”

Rating



Findings

On initial use of the application, 2 clinicians overlooked the second inclusion selection screen within the guideline causing confusion and questioning within the scenario process. This was caused by both clinicians racing through the information within the application as they continually pressed the next arrow to the next screen.



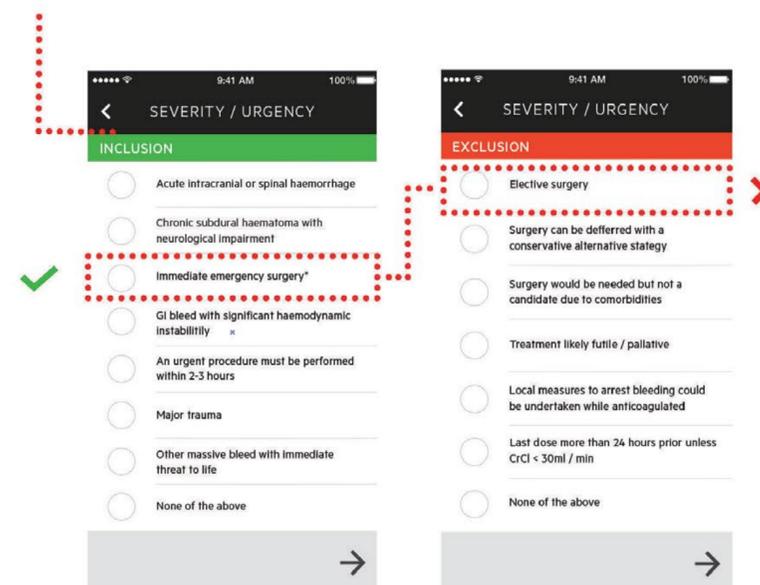
Recommendations

Selections need to be manually ticked before the user is able to proceed to the next screen within the application.

“Get rid of redundant selections”



Some of the content within the inclusion and exclusion selections are internally linked to each other—depending on what’s selected—some become redundant. There was confusion caused to the user as some selections don’t make sense



Appendix 4

Data table

Novice user analysis

Advanced user analysis

Scenario 1

Inclusion of drug – send NHI number, authorization to pharmacy

Quotes

“Double input of NHI will drive me mad!”

“The NHI input needs to be automatically capitalised”

Rating



Findings

NHI patient input within the applications <data transfer> screen caused confusion and frustration to users for two reasons;

1. The double input of the NHI number was tedious to users as they often sighed when having to re-input the data.
2. Users couldn't collapse the keyboard within the application after inputting the NHI data. This left users baffled and interrupted the users flow scrolling down to further selections on the same screen

Recommendations

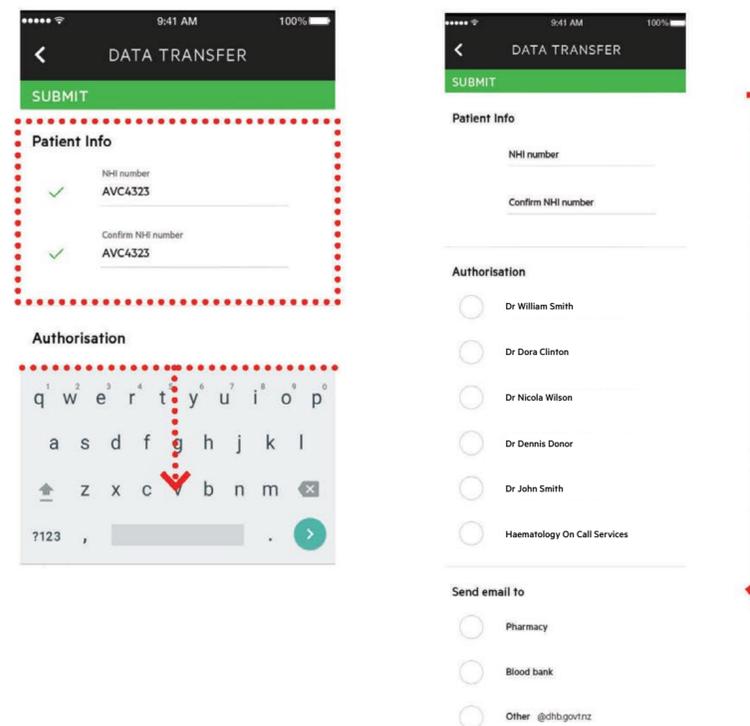
Automatic capitalisation of the letters within the inputs of NHI number.

Appendix 4

Data table

Novice user analysis

Advanced user analysis



Scenario 1

Inclusion of drug – send NHI number, authorization to pharmacy

Quotes

“That’s cool - I like this function”

Rating



Findings

Although the contacts names were clearly listed within the design of the screen it took time for the users to understand how to engage with the selection panel. This was because the actual phone numbers were hidden by a drop down menu. The contacts name needs to be touched as a button. The functionality of this screen did not seem obvious to the users as being a call screen.

Recommendations

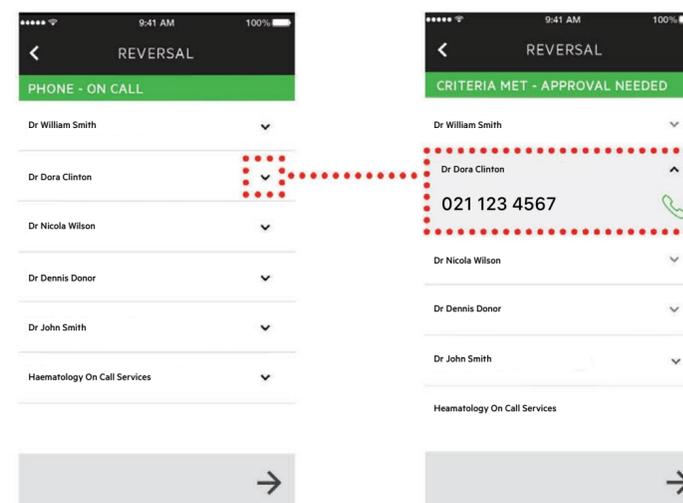
Display the contact numbers along side the name associated rather than hiding it within a drop down menu.

Appendix 4

Data table

Novice user analysis

Advanced user analysis



Scenario 1

Inclusion of drug – send NHI number, authorization to pharmacy

Quotes

“The procedure steps are nice and clear”

“This is easy”

Rating



Findings

All advanced users intuitively scrolled down through the <procedure> screen with ease. While the users thought out loud when following the procedure screen all stated this is easy and clear.

Recommendations

Nil

Appendix 4

Data table

Novice user analysis

Advanced user analysis



Scenario 2 — Selection Summary

Outcome : Exclusion of drug—not desperately urgent

An 80-year-old female has fallen on stairs and has a closed fracture of her humerus with displacement. Neurologically she is intact. Coagulation tests on arrival show an APTT of 66 seconds with a TCT >80 seconds. Her creatinine is 90umol/L. Her GP confirms that she takes dabigatran 110mg bd for AF. A surgical repair of her humerus is required.

“I like this a lot!”

— Specialist Anaesthetist

Appendix 4

Data table

Novice user analysis

Advanced user analysis



Specialist Anaesthetist
Outcome achieved

Severity / Urgency

Inclusion
None of the above

Exclusion
—

Dabigatran Evidence

Inclusion
—

Exclusion
—



Specialist Anaesthetist
Outcome achieved

Severity / Urgency

Inclusion
None of the above

Exclusion
—

Dabigatran Evidence

Inclusion
—

Exclusion
—



Haematologist
Outcome achieved

Severity / Urgency

Inclusion
None of the above

Exclusion
—

Dabigatran Evidence

Inclusion
—

Exclusion
—



Clinical Director
Outcome achieved

Severity / Urgency

Inclusion
None of the above

Exclusion
—

Dabigatran Evidence

Inclusion
—

Exclusion
—

Scenario 2

Exclusion of drug—not desperately urgent

Quotes

“I like this a lot.”

“Once app prompts finish — advice is needed to be given regarding where or what to do next.”

Rating



Findings

All clinicians completed this scenario to the correct outcome with ease as the functionality of the application was clear after initially going through it.

As the users reach the ‘criteria not met’ screen and press the <finish> button there is no added information regarding what the user should do next. Instead the user is sent back to the ‘disclaimer’ screen — this creates confusion as there is no clarification the application has finished

Recommendations

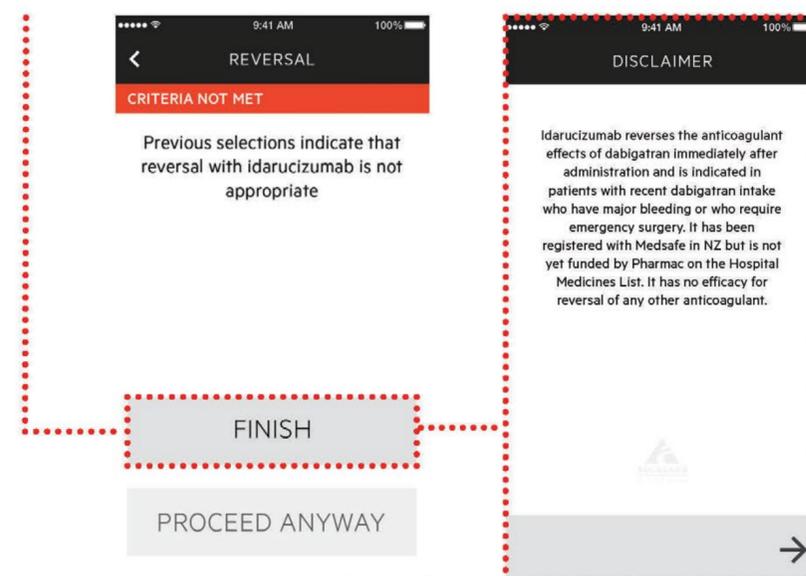
Include <start again> option and addition advice of the users next step forward within ‘criteria not met’ screen.

Appendix 4

Data table

Novice user analysis

Advanced user analysis



Scenario 3 — Selection Summary

Outcome : Not essential but would be better to reverse – Proceed anyway – send NHI number, authorization to pharmacy.

A 79-year-old woman presents with a neck of femur fracture following a fall. She takes dabigatran 110mg bd for atrial fibrillation. She was found on the floor of her home, and may have been on the floor for up to 9 hours before being discovered. Admission blood tests show APTT 60 seconds, TCT>80 seconds, and a creatinine of 200umol/L which is an exacerbation of acute on chronic renal failure. The orthopedic team describe surgery as urgent although they note that her condition is not immediately life threatening.

“Grey area scenario”

— Specialist Anaesthetist

Appendix 4

Data table

Novice user analysis

Advanced user analysis



Specialist Anaesthetist

Outcome not achieved

Severity / Urgency

Inclusion

None of the above

Exclusion

—

Dabigatran Evidence

Inclusion

—

Exclusion

—



Specialist Anaesthetist

Outcome not achieved

Severity / Urgency

Inclusion

An urgent procedure must be within 2-3 hours

Exclusion

None of the above

Dabigatran Evidence

Inclusion

TCT > 80 seconds
APPT > 40 seconds (no TCT available)

Exclusion

None of the above



Haematologist

Outcome achieved

Severity / Urgency

Inclusion

None of the above
Proceed anyway

Exclusion

—

Dabigatran Evidence

Inclusion

—

Exclusion

—



Clinical Director

Outcome not achieved

Severity / Urgency

Inclusion

An urgent procedure must be within 2-3 hours

Exclusion

None of the above

Dabigatran Evidence

Inclusion

TCT > 80 seconds
APPT > 40 seconds (no TCT available)

Exclusion

None of the above

Scenario 3

Inclusion of drug — not essential but would be better to reverse – proceed anyway – send NHI number, authorization to pharmacy.

Quotes

“The inclination to proceed anyway is unavoidable but having information which clarifies if you do proceed anyway you’re going to have to meet some fairly tight criteria might be useful ”

“Proceed anyway needs clarification regarding its conditions”

“Clinical team prefer to reverse option is not clear”

“This scenario is a grey area decision”

“The term ‘proceed anyway’ will encourage careless decision making amongst clinicians”

Rating



Findings

As the users reach the ‘criteria not met’ screen, the <proceed anyway> button caused hesitation and confusion to users which halted the flow of the decision process. This confusion was further caused by not including the ‘conditions’ information screen within the decision wireframe. Only after the <proceed anyway> was pressed did users view the ‘further conditions’ screen to consider the patient inclusion of the drug.

Recommendations

Bring the ‘conditions’ screen from outside the algorithm (enabling more selections to output drug inclusion)

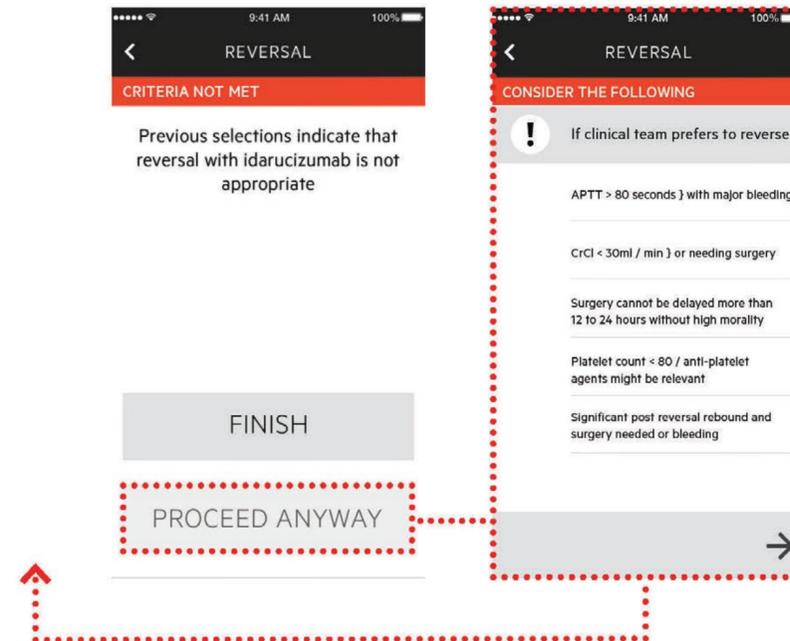
There needs to be a fixed wireframe decision tree where the considerations are considered before being rejected from the guideline

Appendix 4

Data table

Novice user analysis

Advanced user analysis



Scenario 3

Inclusion of drug — not essential but would be better to reverse – proceed anyway – send NHI number, authorization to pharmacy.

Quotes

“There needs to be a back to home screen button. If there is confusion caused — a restart button needs to be easily accessible” Senior clinician

“If you miss something in the software or feel your outcome is not right then have another look at it. Check logic or start from the beginning”

“I look for the ‘back’ buttons – I completely overlooked that cause I only use iOS – I was thinking, where is the ‘back’ button?”

Rating



Findings

The functionality within the application incorporated a ‘back’ button at the top left corner of each screen but when users navigated back 3-5 screens to check their selections they became confused as to where in the guideline process they were.

In some cases, users had a hard time finding the ‘back’ button within the application.

Recommendations

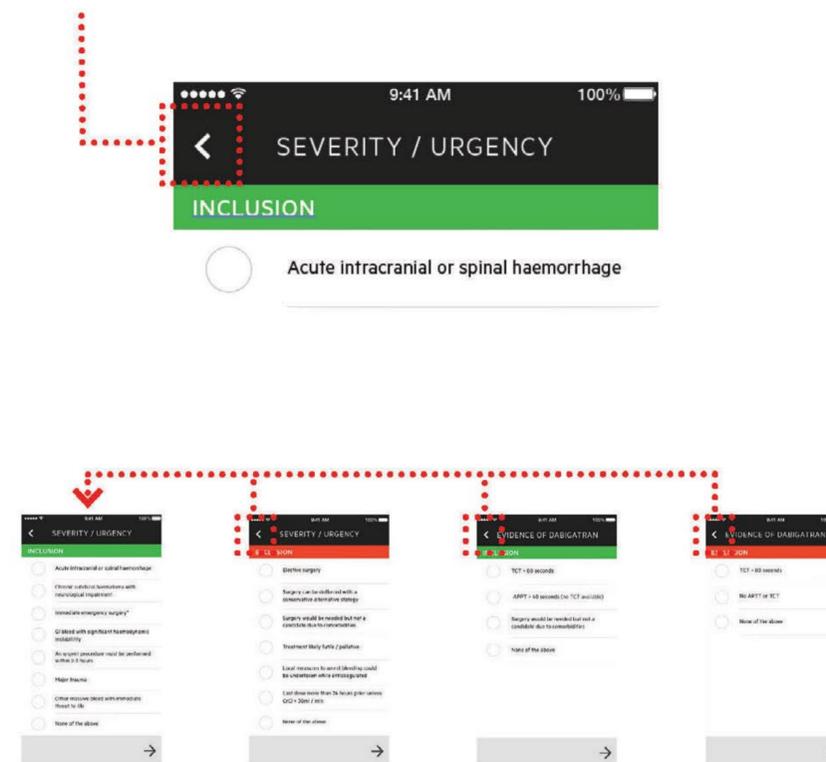
All advanced users suggested a ‘restart’ functionality within the application.

Appendix 4

Data table

Novice user analysis

Advanced user analysis



Scenario 4 — Selection Summary

Outcome : Exclusion as not severe enough – levels to low. Finish app

A 68 year old man presents with melaena. He has been taking dabigatran 150mg bd for a deep vein thrombosis which was spontaneous, diagnosed 3 months before. He has noted dyspepsia recently. His BP is 140/70 with a heart rate of 89/min, initial haemoglobin is 125g/L. He has a creatinine of 88 umol/L. APTT is 45 seconds, TCT 70 seconds.

Appendix 4

Data table

Novice user analysis

Advanced user analysis



Specialist Anaesthetist

Outcome achieved

Severity / Urgency

Inclusion

None of the above

Exclusion

—

Dabigatran Evidence

Inclusion

—

Exclusion

—



Specialist Anaesthetist

Outcome achieved

Severity / Urgency

Inclusion

None of the above

Exclusion

—

Dabigatran Evidence

Inclusion

—

Exclusion

—



Haematologist

Outcome achieved

Severity / Urgency

Inclusion

None of the above

Exclusion

—

Dabigatran Evidence

Inclusion

—

Exclusion

—



Clinical Director

Outcome achieved

Severity / Urgency

Inclusion

None of the above

Exclusion

—

Dabigatran Evidence

Inclusion

—

Exclusion

—

Scenario 4

Exclusion of drug as not severe enough – levels to low – Finish

Quotes

“The only information that’s crowded within the application is the first inclusion screen”

“Every word mentioned needs to be gold”

Rating



Findings

As an advanced user started the fourth scenario they stated the first inclusion screen information presentation needed additional work as it is overcrowded and not approachable, especially in the case of an emergency

Recommendations

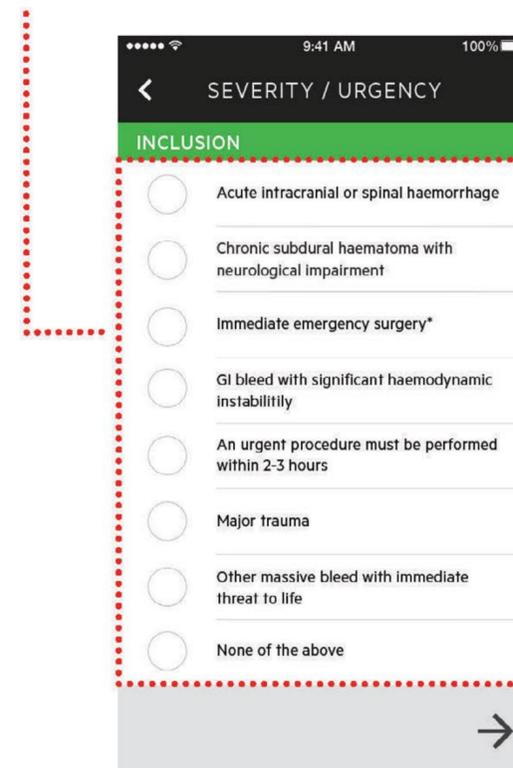
Try slim content within the screen — shorten content but with the same meaning.

Appendix 4

Data table

Novice user analysis

Advanced user analysis



Scenario 4

Exclusion of drug as not severe enough – levels to low – Finish

Quotes

“Once the app prompts ‘finish’ — advice is needed to be given regarding where or what to do next”

Rating



Findings

One user stated additional information needed regarding what to do next when the user is prompted to finish the application on the ‘criteria not met’ screen. This then creates closure for the ‘finish decision’ as well giving advice to the user of what to do next.

Recommendations

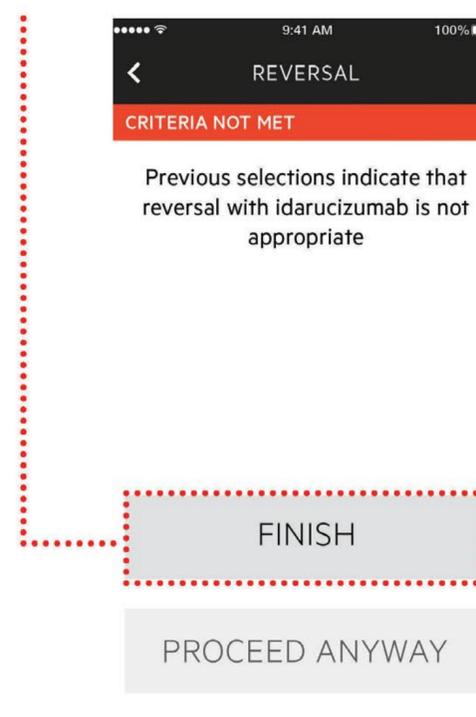
Add additional information to clarify the next steps forward when the guideline is not appropriate.

Appendix 4

Data table

Novice user analysis

Advanced user analysis



“The app needs to eliminate first time users — there should be an included summary of Dabigatran and its reversal as an educational aspect to the app”



One user stated “if I have never used the drug or guideline before, I want to read up on the information the first time I use it. I want to read up on what the application has got to tell me about the dabigatran reversal agent”

Include an information screen within the application summarising dabigatran and its reversal as an educational aspect.

Visual Design Feedback

Text Legibility

Quotes

“Easy to read”

“Good spacing”

“Very clear”

Rating



Findings

The comments made regarding the legibility of the text within the application were positive where all advanced users stated how clear and easy to read the text is to read on screen

Recommendations

The first <Severity / Urgency> inclusion page is over crowded. The textual information needs to be further slimmed.

Icon Legibility

Quotes

“I like the logo”

“Good - wouldn’t change them”

“They help to put my memory in line — Easier step by step process”

Rating



Findings

The comments made regarding the legibility of the icons within the application were positive where all advanced users stated they were legible and further segregated the steps and processes within the guideline. One advanced user endorsed the logo of the Ida application mentioning how professional it is.

Recommendations

No changes



Appendix 4

Data table

Novice user analysis

Advanced user analysis

Usability Reaction Cards

Circled words that best described the advanced users experience while they used the Ida application (catagorised by number of users)



- Accessible
- Easy to use



- Comprehensive
- Familiar
- Clear
- Expected
- Clean
- Innovative
- Low maintenance
- Responsive
- Stable
- Straightforward
- Understandable
- Usable
- Complex
- Creative
- Cutting edge
- Exceptional
- Novel
- Sophisticated
- Businesslike
- Essential



- Useful
- Effective



- Advanced
- Friendly
- Organised
- Approachable
- Consistent
- Convenient
- Efficient
- Fast
- Helpful
- High quality
- Integrated
- Intuitive
- Meaningful
- Professional
- Relevant
- Timesaving
- Trustworthy
- Valuable

Appendix 4

Data table

Novice user analysis

Advanced user analysis