

University of
South Australia

Transforming the Perioperative Journey: Leveraging Immersive Technologies to Reduce Stress and Anxiety for Better Patient Outcomes

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PhD of Architecture
Master of Architecture
Graduate Diploma in Nursing Science
Bachelor of Architecture
Bachelor of Nursing

A thesis submitted for the degree of Doctor of Philosophy

Creative Unit



University of
South Australia

August 2025

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Abstract

This research is driven by my diverse expertise as an anaesthetic nurse, architect, and researcher, positioned at the vibrant intersection of healthcare and advanced design. The aim is to transform the perioperative journey from the initial consultation to complete recovery. The objective of this study was to deepen my professional understanding and enhance the perioperative patient experience, ensuring optimal patient-centred care throughout the surgical process, from diagnosis to full recovery.

Perioperative anxiety, a natural response to the stress of surgery, can occur at any stage before or after a procedure. Research indicates that high levels of this anxiety pose significant threats to health and recovery by impacting both psychological and physiological responses. It increases the risk of cardiac mortality and adverse outcomes during anaesthesia induction and recovery phases. Furthermore, it is linked to increased postoperative pain, higher consumption of analgesics and anaesthetics, prolonged hospital stays, decreased quality of life, and lower satisfaction with perioperative care.

The concept of Digital Health is increasingly playing a more substantial role in health care provision and there is a body of research showing that technology-based therapeutic tools can play an effective, acceptable, and cost- effective role in many aspects of health care delivery. This study explores how Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (XR), Virtual Companions, and Holograms can alleviate intense stress and anxiety associated with surgical procedures, particularly targeting 'Tomophobia'—a condition affecting nearly 48% of patients.

This study employed the Delphi method and Co-Design to gather original data on patient needs, concerns, and experiences in surgical procedures. The primary goal was to obtain firsthand perspectives on the perioperative process from both healthcare providers—including anaesthetists, surgeons, and nurses—and patients themselves. The research commenced with a Policy Delphi survey to collect insights from medical professionals, effectively harmonizing expert opinions. It then transitioned to Co-Design sessions with patients who had undergone surgery, engaging them directly in discussions about critical aspects of their perioperative experiences. This dual-method approach provided comprehensive insights into the various dimensions of surgical care, from preparation through to recovery.

This thesis extends beyond simple application of digital health technologies; it seeks to redefine them as core components of a more responsive healthcare system. By employing immersive technologies, this research advocates for a model where digital tools are not just supplementary but integral to enhancing patient care.

This study introduces the RED Rules—Relaxation, Education, Distraction. These principles represent a strategic framework developed through this research, aimed at systematically reducing patient anxiety and enhancing the overall quality of care. They embody the thesis's core findings and suggest practical, implementable strategies for incorporating digital health solutions into the perioperative process.

By integrating human-centered design and design thinking with clinical practices, my research addresses existing deficiencies in healthcare models and charts a course towards a future where technology and compassionate care are seamlessly intertwined, enhancing healing and patient outcomes.

Declaration

This thesis presents work carried out by myself and does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; to the best of my knowledge, it does not contain any materials previously published or written by another person except where due reference is made in the text; and all substantive contributions by others to the work presented, including jointly authored publications, are clearly acknowledged.

AI was used as a tool for feedback within this research process. It was not used to generate or analyse any data and was only used within a text-generation capacity / editing tool. And to assist the literature review, exploring generic or interdisciplinary uses of research terminology to help reveal existing interdisciplinary relationships, if indeed they existed in the context of this research. ChatGPT also used as a starting point for chapter summaries and to provide feedback on writing clarity during some of the drafting stages. Contextual prompts were used to assist in the structure and documentation of the research.

Nikou Javadi



01/07/2025

Acknowledgments

This thesis is the culmination of a collaborative effort involving many dedicated individuals. I am profoundly grateful to Professor Ian Gwilt, my principal supervisor, and Dr. Aaron Davis, my co-supervisor, for their guidance throughout this journey.

I also wish to express my appreciation to the remarkable participants in my research, whose generosity and engagement were indispensable.

My deepest thanks go to my family—my parents and sister—for their valuable presence.

The journey to completing this PhD was not without its challenges. I believe there are beautiful moments, amidst adversity. At particularly difficult times last year, when I was close to giving up, I was fortunate enough to meet Derrick- love of my life, the man of my dreams. Derrick, you brought light into my life during a dark 0me, believing in the value of my work and its future impact. Your encouragement and love have been a source of strength and inspiration. Thank you for being my partner, my supporter, and my love. I am immensely grateful for everything you have brought into my life.

Acknowledgement of Funding

I acknowledge the support I have received from the Australian Government Research Training Program (RTP) in the form of a scholarship, which has contributed to the completion of this research.

Note from Nikou

Change is an inevitable force that continually reshapes our lives in unexpected ways. For me, change came in the form of migration—from the familiar streets of my homeland in Iran to the vibrant and diverse landscapes of Australia. It was a leap into the unknown, filled with hopes and dreams of new beginnings.

However, embracing change often introduces new challenges. Despite holding a PhD in Architecture, my transition to a new country brought unforeseen professional hurdles. My qualifications, once a source of pride, unexpectedly became barriers in my pursuit of career opportunities within my field. In search of stability, I found myself stepping into a role vastly different from anything I'd imagined — in nursing. It wasn't a choice driven by passion but by necessity, a field vastly different from architecture yet profoundly interconnected through the underlying principles of empathy and care. This unexpected shift not only broadened my perspective but also deepened my appreciation for human-centered design in ways that architecture alone might never have revealed

The transition from designing buildings to designing patient journeys was dramatic yet enlightening. I exchanged architectural blueprints for patient care, Now, instead of worrying about the strength of concrete, I have to worry about the strength of my coffee to get through night shifts!

Driven by a relentless desire for knowledge and a commitment to enhance human potential and experience, I embarked on a second PhD. This journey is not just a continuation of my academic pursuits but a fusion of my diverse experiences and current aspirations, aiming to pioneer innovative solutions through human-centered design. This thesis represents more than an academic endeavor; it is a personal quest to explore and harness the transformative power of design in improving lives.

I hope this note provides a meaningful context for the research presented in this thesis and demonstrates the profound connections between personal experience and professional inquiry.

Achievements

1. Recipient of Bright Star Award Burnside Hospital for excellence in human-centred care (2023)
2. Judith Berry Perioperative Nurse Excellence Award (2022).
3. Accepted for PhD Thinkers program 2022
4. Accepted for UniSA Creative HDR coaching program 2022
5. Winner of 3MT People's Choice 2021.
6. Recipient of University of South Australia Vice Chancellor and President's Scholarship- top 7 PhD students (2020).

Featured Talks & Research Publications

1. Keynote speaker at Tropical Innovation Festival - Cairns, June 2024
2. Keynote speaker at Business House of Australia - Adelaide, June 2024
3. Keynote speaker at Rotary Adelaide Central, 2023 (20 audience)
4. Keynote speaker at SAPNA Weekend Education 2023. Virtual reality: helping with patients' anxiety. (200 audience)
5. Keynote to Perioperative Nurse conference as the former recipient of the Excellence Award 2023 (200 audience)
6. Presentation at Renmark High School. 'RED Rules' for Anxiety Reduction for Students 2023 (80 teenage audience)
7. Presentation at Berri Community event. 'RED Rules' for Anxiety Reduction as a Community Flood Recovery Strategy 2023 (50 audience)
8. Training sessions for clinical improvement at Burnside Hospital and Calvary Adelaide Hospital 2021- 2022 (25 audience)
9. Winner of People's Choice Award 2020 In the UniSA Creative Three Minute Thesis (80 audience)
10. Keynote speaker at SAPNA Weekend Education 2022. Battling with CO2; The lived experience of Malignant hyperthermia emergency (120 audience)
11. Keynote to UniSA staff and students as the Recipient of The Kathleen Fitzpatrick Australian Research Council Laureate Fellowship PhD Thinker 2022 (20 audience)
12. Publication - Keynote speaker at International Design Research Society Conference – Bilbao- Spain 2022 (150 multinational people)
13. Keynote speaker at Ground Round Calvary Adelaide Hospital 2022. Codesigning immersive technology interventions to reduce anxiety in theperioperative patient journey. (40 audience)
14. Lecturing at the University of Cyprus and associated training overseas (15 sessions 40 audience)
15. Keynote speaker at the 7th Optimising Health Environments (OHE) Forum. Codesigning AR/VR interventions to reduce anxiety in the perioperative patient journey! 2021 (100 audience)
16. Presentation to the UniSA Executive leadership team as Recipient of Vice-Chancellor and President's Scholarship 2020 (30 audience)
17. Keynote speaker at Eastern Mediterranean University Design Week 2015 – Influence of design principles on environmental psychology
18. Keynote speaker at Istanbul University International Conference. Role of mediaarchitecture in promoting tourism in historic cities 2015
19. Clinical education training sessions for Anglicare SA; clinical, non-clinical staff and leadership team 2023 – (multi topics I developed myself)

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Chapter 1.

Introduction; setting the scene

This chapter introduces the research problem by outlining its context within healthcare innovation, the stakeholders involved, and definitions of key terms. It further discusses the scope and significance of the study and provides a structured overview of the thesis.

Chapter 1: Introduction; setting the scene

1.1 The Path to the Research Question

This study was driven by a professional curiosity to explore Perioperative Anxiety and improve patient care and experience during the surgical process; working as a perioperative nurse and a trained designer, I was looking for a personal opportunity to bring these experiences and processes into the emergent field of Design for Health and Wellbeing. My research is driven by a passion to integrate design knowledge with a comprehensive understanding of health, recognizing it as a multidisciplinary endeavor. By drawing on my diverse background in architecture, nursing, and neuro-change, I aim to revolutionize the perioperative patient experience. My focus is on ensuring exceptional patient-centered care from the initial consultation and diagnosis, through surgery, and onto full recovery. Additionally, I am exploring the innovative application of immersive digital media technologies in healthcare to enhance patient outcomes and experiences.

1.2 The scale of the problem

The number of surgical procedures worldwide reached 294 million in 2022. It is anticipated increase to 373 million by 2030 (Quene et al., 2022). According to Lederer et al. (2022) surgeries often involve complex procedures that physically, emotionally, and mentally strain patients. These strains can continue even after a successful surgery is performed as patients take time to recover.

In Australia, around 2.8 million surgical procedures occur annually, with about one-third of all hospital admissions related to surgical procedures (Ralph, 2018). Consequently, Australian healthcare spends over $25 billion annually on elective surgery (Elective surgery, 2023). Elective surgery refers to a prearranged surgical procedure that can be scheduled in advance following a thorough evaluation by a specialised medical professional. Elective surgery is considered medically necessary and may be required urgently but is not conducted because of an emergency presentation. Most individuals undergoing surgery achieve favourable outcomes; however, research suggests that approximately 28.6% of patients encounter complications throughout their surgical process (Australia's hospitals at a glance, 2024; Elective surgery, 2023). These complications are frequently linked to the apprehension and anxiety surrounding the surgical procedure or invasive medical interventions, a psychological state commonly referred to as 'Tomophobia' (Bhattacharya, 2023).

A significant proportion of patients who are anticipating a surgical procedure have feelings of anxiety (Abate et al., 2020). According to Gürsoy et al. (2016) this worry can be considered a normal response to the uncertain and possibly distressing circumstances commonly encountered during the preoperative phase. Nevertheless, it has been shown that an elevated degree of anxiety can detrimentally affect the effectiveness of treatment, as evidenced by various studies conducted on patients across diverse medical contexts (Alanazi, 2014). Adding to the problem, family carers are often tasked with assuming a multifaceted caregiving role for these individuals, consequently exposing them to mental distress and physical deterioration (Liu et al., 2020).

According to Abate et al. (2020), anxiety is a psychological condition characterized by fear, apprehension, and worry. This emotional state is accompanied by a number of physiological manifestations, including heightened awareness, restlessness, exhaustion, difficulty focusing, and muscular tension (Aust et al., 2018; Burgess et al., 2019). Anxiety can arise in response to both external and internal stimuli, resulting in various behavioral, emotional, cognitive, and physical symptoms (Bhattacharya, 2023; Zhang et al., 2021). In addition, anxiety can be characterised by enduring and disproportionate concerns that persist without a triggering stimulus associated with stress.

Stress and anxiety are common aspects of the human experience, often used interchangeably but with distinct characteristics. While both are natural responses to challenging situations, they differ in terms of duration, triggers, and impact on an individual's well-being (Gürsoy et al., 2016;

Manou-Stathopoulou et al., 2019). Stress is a short-term physiological and emotional response to external pressures or demands. It can be linked to a specific stressor, such as work deadlines, financial concerns, or relationship issues. Stress is a natural part of life and, in moderation, can even be beneficial, motivating individuals to overcome challenges (Stress, 2022).

The significance of stress should not be overlooked when focusing on perioperative anxiety. Stress significantly contributes to the development of anxiety. However, it is crucial to highlight that anxiety and anxiety disorders should not be conflated. Unlike developmentally normative fear or anxiety, anxiety disorders entail an excessive and enduring state of anxiety that extends beyond the expected developmental periods. This distinction sets them apart from transient fear or anxiety, which is often stress-induced and does not exhibit the same persistent nature (Dong et al., 2022; Ji et al., 2022a). Furthermore, it is commonly observed that the symptoms associated with stress tend to decrease once the stressful circumstances have been resolved. However, anxiety can often be challenging to comprehend (Mirani et al., 2019; Sveinsdóttir et al., 2021). Anxiety concerns or apprehensions can be linked to potential threats or challenges, as well as the anxiety that arises from the anxiety itself. Stress and anxiety are inherent aspects of the human experience; nonetheless, their prolonged presence or detrimental effects on our overall well-being and everyday functioning can give rise to significant concern (Alanazi, 2014; Aust et al., 2018).

The perioperative journey (see section 2, chapter 2) may be highly distressing for surgical patients and healthcare personnel responsible for ensuring their safe and effective passage through it. Consequently, healthcare professionals have consistently endeavoured to alleviate this distress by implementing strategies at each stage of the procedure (Bailey, 2010; Manou-Stathopoulou et al., 2019). A general sense of unease characterises perioperative anxiety, the specific causes of which may be specific or nonspecific and unknown to the individual (Bruckenthal & Simpson, 2016). However, both these causes are known to elicit undesirable changes in the body's hemodynamics as a result of the activation of the sympathetic nervous system (which triggers the "fight-or-flight" response), the parasympathetic nervous system (which predominates during periods of rest and digestion), and the endocrine stimulation system (which releases adrenaline into the body during episodes of anxiety) (Hanalis-Miller et al., 2022; McCorry, 2007). This phenomenon can occur at any phase before, during, or after a surgical procedure. Research reveals that perioperative anxiety is influenced by a variety of factors, including the type of surgical procedure, the patient's gender, reasons for the surgery, educational background, and personality traits. Other significant contributors are fears related to anesthesia, the surgical outcomes, financial burdens, post-operative pain, diminished quality of life, and the fear of mortality. Studies indicate that the prevalence of such anxiety can vary widely, affecting 67% to 92% of patients, underscoring the complexity and individual variability of this issue (Abate et al., 2020; Kumar et al., 2019). From a care perspective, Gualandi et al. (2019) report that the patient's surgical journey begins at home and concludes upon their safe return home. Perioperative care encompasses a comprehensive and collaborative approach to patient management, tailored to each individual's unique needs, aiming to achieve the best possible outcome from the moment surgical intervention is considered until the patient reaches an ideal state of health (Bruckenthal & Simpson, 2016; De Ridder et al., 2018; Manou-Stathopoulou et al., 2019). The perioperative care team (POCT) encompasses every individual who may participate in a patient's perioperative experience. This may include, but is not limited to, medical practitioners such as doctors, nurses, and other healthcare professionals employed in hospitals or clinics, in addition to individuals who provide care, such as family members or other carers (Figure 1) (The perioperative care team, 2021).

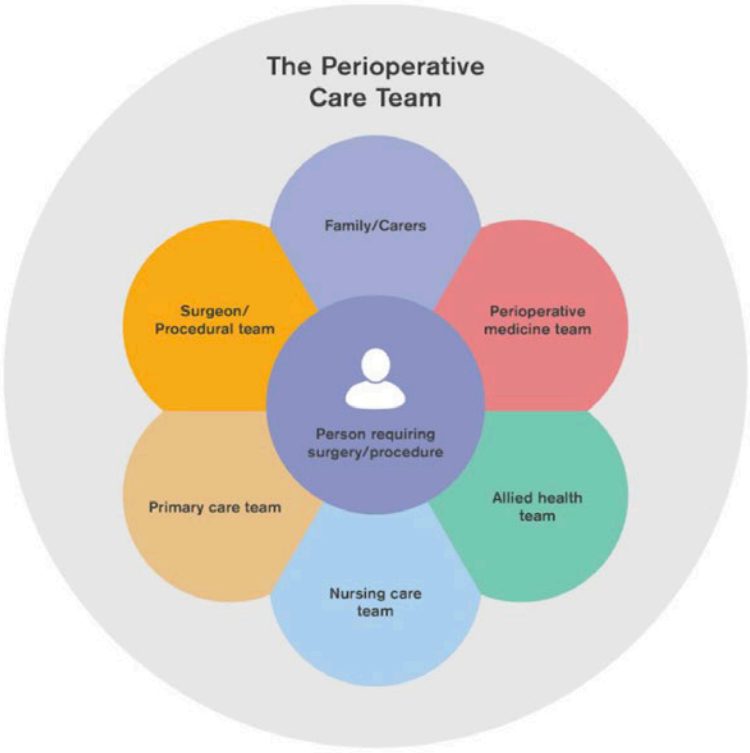

Figure 1 The perioperative care team (POCT) (The perioperative care team, 2021)

Point-of-care testing can facilitate shared decision-making and coordination of care across various phases of the surgical process. These phases include:

- The preoperative phase, which involves risk assessment, shared decision-making, and optimisation of the patient's condition.
- The operative phase, which encompasses pre-procedure review, intraoperative care, and post-procedure disposition and care.
- The postoperative phase, which focuses on ensuring a safe recovery, providing post-acute care, and facilitating the handover of care to primary healthcare providers (Davrieux et al., 2019; De Ridder et al., 2018).

The precise correlation between patient anxiety and unfavourable patient outcomes remains ambiguous. Nevertheless, previous research has put forth many ways in which the adverse effects of worry can affect patients (De Ridder et al., 2018; Hanalis-Miller et al., 2022; Kumar et al., 2019). These mechanisms encompass the overproduction of cortisol, insulin resistance, and abnormalities in the sympathetic and vagal systems. One example of a hormone that regulates the body's stress response is cortisol (Almedhesh et al., 2022). With this in mind it is important to consider the possibility that the patient may have ongoing concerns during treatment and after the operation. In instances where anxiety reaches excessive levels, it is important to recognise that elevated cortisol levels may detrimentally impact the immune system. This, in turn, could potentially contribute to the onset of postoperative infectious complications, heightened postoperative pain, increased reliance on analgesics, patient dissatisfaction, an augmented rate of readmissions, and prolonged hospital stays. The cumulative effect of these factors may result in substantial healthcare costs (Ji et al., 2022a; Mirani et al., 2019).

1.3 Patient- Centred Care: Principles and Significance in Modern Healthcare

Patient-centred care (PCC) has become a cornerstone in the evolution of healthcare, emphasizing a shift from a traditional disease-centred model to a more holistic and individualized approach. This paradigm places the patient at the centre of their healthcare experience, acknowledging their unique needs, preferences, and values. The principles of patient-centred care, supported by recent research, underscore its crucial importance in achieving improved healthcare outcomes and patient satisfaction.

The first principle of patient-centred care revolves around respecting patient values and preferences (Cook & Baxendale, 2022). This principle recognises the diversity among patients, emphasizing the need for healthcare providers to engage in open and respectful communication to better understand and incorporate individual values into care plans. Doing so makes healthcare more tailored to the patient's beliefs and goals, fostering a collaborative and patient-empowered approach.

Transparency and information sharing form another vital principle of patient-centred care (Atlas et al., 2019). Moreover, recent studies emphasize clear and understandable communication regarding diagnosis, treatment options, and potential risks or benefits (Légaré et al., 2018). Informed decision-making is also promoted, enabling patients to actively participate in shaping their healthcare journey based on a comprehensive understanding of their options.

Effective coordination and care integration represents a third principle of patient-centred care (Kwame & Petrucka, 2021). Recent research highlights the importance of seamless collaboration among healthcare providers and departments to ensure a unified and cohesive approach to patient care (Hallgren et al., 2021; Nakarada-Kordic et al., 2020). This integrated model reduces fragmentation, improves continuity of care, and enhances the overall patient experience (Holetzek & Holmberg, 2022) .

The emotional support principle emphasizes the acknowledgment of the psychosocial aspects of healthcare (Hardy et al., 2018). Recent studies affirm the positive impact of empathy and compassion in healthcare interactions, recognising that emotional well-being is intricately linked to physical health outcomes (Croke, 2020). Establishing a therapeutic relationship based on understanding and support contributes to a more comprehensive and effective healthcare experience.

Finally, patient-centred care emphasises the importance of physical comfort (Kwame & Petrucka, 2021). Recent reference underscores the significance of pain management, privacy, and the physical environment in promoting a healing atmosphere. Attention to these details ensures patients feel comfortable and secure during their healthcare journey, positively influencing their overall well-being (Johnson & Woodall, 2022; Tian, 2023).

The importance of patient-centred care in modern healthcare cannot be overstated. Recent studies consistently demonstrate its positive impact on patient satisfaction (Jaensson et al., 2019). Satisfied patients are more likely to adhere to treatment plans, actively engage in preventive care, and report higher levels of overall well-being. Moreover, patient-centred care has been associated with improved health outcomes, as patients who actively participate in decision-making and follow personalised care plans tend to experience better management of chronic conditions and reduced hospital readmissions (Chén & Roberts, 2021). See section 2.3 for further discussion around Patient Reported Outcomes.

In conclusion, patient-centred care represents a transformative approach to healthcare, emphasizing personalized, collaborative, and holistic care experiences. The principles of respecting patient values, transparent information sharing, care coordination, emotional support, and attention to physical comfort are fundamental in achieving the goals of patient-centred care. Recent research solidifies the importance of this approach, showing its positive impact on patient satisfaction, health outcomes, and overall healthcare effectiveness. As healthcare systems evolve, embracing and implementing patient-centred care principles remains essential for delivering high-quality, patient-focused services. In the next section I explore how the aspirations of these patient-centred care approaches are supported by the adoption of digital technologies in healthcare.

1.4 Digital Health

Digital health is an emerging area of practice that explores how digital technologies can enhance and extend patient care (Shaw et al., 2018). There are many ways to define digital health, but critical features of these definitions often propose that digital health should empower patients to be more in control of their healthcare journey (Richardson et al., 2022) and that digital health can increase the scale and reach of healthcare interventions, supporting more people to receive a higher standard of care with fewer resources (Murray et al., 2016).

One of the critical areas of interest explored in this research is how digital technologies can enhance patient outcomes by alleviating stress and anxiety levels as they navigate the healthcare system. In particular, the study explores how immersive technologies such as Virtual Reality (VR), Augmented Reality (AR) and Mixed reality (XR) can be applied in the surgical journey to reduce stress and anxiety in pre- and post-surgery environments (Brown & Foronda, 2020; Vles et al., 2020)

Digital Health is increasingly playing a more substantial role in healthcare provision, and a body of research shows that technology-based therapeutic tools can play an effective, acceptable, and cost-effective role in many aspects of healthcare delivery (Béranger & Rizoulières, 2021; Lee et al., 2021).

Much of the research and development focuses on applications in personal health management and wellness, diagnostics and triage, virtual care and telehealth, remote monitoring and data and analytics. However, there is little research into models for how a digital health intervention might successfully promote patient-centred care in the adult perioperative journey. According to Kondylakis et al. (2022a), research on digital health interventions to enhance perioperative patients' experiences of care is lacking in the field.

However, digital health interventions have begun to contribute significantly to improving healthcare; key components include Electronic Health Records (EHRs), Telehealth, Mobile Health (mHealth), Remote Patient Monitoring (RPM), and Medical Imaging (Choun & Petre, 2022). These innovations collectively play a crucial role in improving accessibility, efficiency, and personalized treatment in healthcare.

The utilization of immersive technology, particularly virtual reality (VR) interventions, in addressing pain and anxiety among paediatric patients represents an innovative and economically feasible approach, and evidence suggests there is potential for extending this intervention to the adult perioperative experience (Kondylakis et al., 2022a; Shaw et al., 2018). Pain is a feeling experienced by patients across various therapeutic contexts, and its manifestation is subject to the influence of stress and anxiety levels. Virtual reality applications have demonstrated effectiveness in alleviating stress and managing pain primarily due to their ability to provide distraction (Alqudimat et al., 2021).

Additionally, digital health interventions generate substantial amounts of data that can be harnessed for customization, employing artificial intelligence (AI) methodologies, particularly in the context of perioperative care recipients (Shaw et al., 2018). Health recommender systems (HRSs) represent a specific category of AI systems that can tailor patient interventions based on their behavioural patterns and health needs (Bharti et al., 2016). Given the significant variability in the perception of perioperative anxiety among patients, influenced by factors such as illness severity and the nature of the surgical procedure, it is important to assess stress levels and implement interventions aimed at equipping patients with coping mechanisms. Notably, these interventions should be crafted with a specific focus on aligning with health behaviour theories. Again, digital technologies have an increasingly important role to play in this respect and understanding this potential is a central driver of this research.

As mentioned, digital health applications have the potential to offer a cost-effective alternative to traditional hospital-based care. These digitally enabled healthcare delivery systems often incorporate behavioural change models to facilitate the customization of educational and behavioural interventions (Currie et al., 2022; Kondylakis et al., 2022a). Furthermore, it is possible to integrate and provide a combination of several procedural comfort measures without necessitating additional training or causing delays to the regular workflows of medical personnel. From a user perspective these applications can generate captivating and interactive material that can be distributed and

accessed promptly and conveniently by most patients (Bunyi et al., 2021; Gentili et al., 2022). The utilisation of digital health technology to drive innovations in patient-centred healthcare has been shown to enhance procedural knowledge and decrease self-reported anxiety levels (Shaw et al., 2018). Moreover, empirical evidence has demonstrated the potential of virtual reality-increasingly with the integration of artificial intelligence - in mitigating suffering experienced during unpleasant medical procedures. However, it should be noted that these VR interventions currently serve a singular objective, either in terms of preparation or diversion, and are typically implemented within the confines of the hospital setting. Additionally, their successful execution often necessitates training healthcare personnel (Bohr & Memarzadeh, 2020; Brown & Foronda, 2020).

While digital health technology holds considerable potential, its integration into routine treatment practices requires substantial improvement. The impetus for broader adoption is influenced by several factors, encompassing challenges related to usability, such as the simplicity of application use and task performance (Javadi et al., 2022). Additionally, obstacles like inadequate integration into existing healthcare workflows, habits, and concerns about perceived value, including enhancing task efficiency or enjoyment, have collectively contributed to limited uptake (Choun & Petre, 2022). According to Hardy et al. (2018), to optimize adoption and utilization, applications must align with users' needs and daily routines, while also being perceived as valuable and user centric. The active involvement of patients and caregivers in the initial stages of app design and development is paramount for establishing a patient-centred approach that resonates with their daily routines and experiential realities (Bunyi et al., 2021). Furthermore, involving stakeholders during the design phase is essential to ensure maximum adoption in practical settings and alignment with routine healthcare practices and helps with issues of drop off in use.

1.5 The contribution of this research

This research makes four significant original contributions to knowledge at the intersection of healthcare, design thinking, and digital technology:

First, it develops a novel interdisciplinary framework that bridges three previously disparate domains—perioperative anxiety management, design thinking methodologies, and immersive digital technologies. While these fields have evolved separately, their strategic integration creates new possibilities for addressing complex healthcare challenges. By synthesizing knowledge across disciplines that rarely intersect in research, this study offers a comprehensive approach to perioperative anxiety that transcends the limitations of single-domain solutions.

Second, through empirical research with both healthcare professionals and patients, this study introduces the RED Rules framework (Relaxation, Education, Distraction) as an original contribution that translates complex research findings into actionable principles for clinical application. This framework, derived from both professional expertise and lived patient experience, provides a structured yet adaptable approach for implementing immersive technologies in perioperative settings, filling a critical gap between theoretical digital health possibilities and practical healthcare applications.

Third, the research contributes a methodological innovation through patient journey-centered technological mapping. By identifying specific anxiety triggers across the complete perioperative journey and systematically mapping appropriate technological interventions to these moments, this approach offers a more nuanced understanding of digital intervention timing and content than existing models that typically address isolated moments in the patient experience.

Fourth, the adaptation of co-design methodologies specifically for perioperative anxiety management advances participatory approaches in healthcare technology development. This methodological contribution demonstrates how meaningful patient involvement in technology design can reveal intervention opportunities and preferences that might remain undiscovered through expert-driven design alone.

Consistent and thorough evaluation of perioperative anxiety during the preoperative assessment and preparation for anaesthesia and surgery is not uniformly observed. Improving perioperative care can positively impact multiple facets of the patient experience, including the quality of care delivered and overall satisfaction with the received treatment. Moreover, it can contribute to better perioperative health outcomes by ensuring a seamless transition for patients back to their routine life, thereby enhancing their overall quality of life. Additionally, optimizing perioperative care can alleviate the per capita cost of healthcare by enhancing the value derived from healthcare services. Implementing a perioperative approach can enhance an individual's sense of preparedness and empowerment before and after surgical procedures. The implementation of this approach has the potential to mitigate postoperative problems and decrease hospital length of stay, facilitating faster recovery and enabling individuals to resume their normal activities promptly.

As we will see through this study, perioperative anxiety in Australian adult elective same-day surgery patients is fraught with challenges and has received relatively little design attention. How these services might be designed better to accommodate perioperative anxiety is the central question that this study interrogates by exploring the perioperative patient journey of the future through design-thinking research and practice in an increasingly technologized healthcare environment.

1.6 The research aims, objectives and questions

The ultimate goal of this study is to transform the Australian healthcare system's approach to perioperative care by integrating digital health interventions that not only alleviate patient stress and anxiety but also enhance healthcare delivery and surgical outcomes. Adopting Findeli's (2010) design research model, this research focuses on the effective integration of immersive technologies into perioperative care.

Central Research Question:

How can immersive technologies be effectively integrated into perioperative care to not only reduce patient stress and anxiety but also revolutionize healthcare delivery and improve surgical outcomes?

Supporting Subsidiary Questions:

1. Patient-Centered Care Assessment:

- What are the key tensions, challenges, and problems encountered by patients during the perioperative experience?

2. Methodological Approaches:

- What methods can be employed to apply immersive digital health interventions effectively along the perioperative patient journey from the healthcare provider's perspective?

3. Sector-Wide Communication and Impact:

- How can findings from digital health research and practice on the perioperative patient experience be communicated effectively to inspire change across the healthcare sector?

Research Objectives:

To achieve this goal, the research pursues the following specific objectives:

1. To better understand the causes and manifestations of perioperative stress from existing literature across healthcare, design, and technology domains

2. To collect and analyse primary data on issues surrounding perioperative stress from both healthcare professionals and patient perspectives

3. To identify and outline potential immersive technology applications at specific points along the patient perioperative journey

4. To develop recommendations for immersive reality content forms and their potential usage across different perioperative contexts

5. To produce a set of guiding principles (RED Rules) for healthcare providers to adopt when implementing immersive technologies for perioperative anxiety management

1.7 The thesis structure

This thesis comprises seven chapters.

Chapter 1: This chapter investigated the stress and anxiety in perioperative journey of Australian adults and unpacked some of the contributing factors.

Chapter 2: This chapter critically reviews the literature on the perioperative journey, detailing each phase and emphasizing patient engagement and reported measures. It highlights significant gaps in existing knowledge, particularly in managing perioperative anxiety and enhancing patient experience. The findings from this review help shape the research question that guides the rest of the thesis, aiming to improve patient outcomes and experiences through innovative strategies.

Chapter 3: This chapter investigates how design thinking enhances digital therapeutics in healthcare, focusing on user-centric, evidence-based approaches for optimizing patient care. It highlights the role of service design in transforming healthcare experiences and aligning with person-centered care principles. The chapter also compares participatory and human-centered design approaches to showcase their effectiveness in driving innovation and engaging stakeholders in healthcare projects.

Chapter 4: This chapter explores the transformative impact of digital health innovations on healthcare delivery. It outlines the evolution and categories of digital health, then delves into emerging technologies like virtual reality (VR), augmented reality (AR), artificial intelligence (AI), and more. The chapter highlights their potential to revolutionize healthcare through patient-centric immersive solutions and interventions for stress relief in perioperative care, addressing both the opportunities and challenges of these advancements.

Chapter 5: This chapter provides the logic that connects the theory with the design practice in this study and provides the methodological frameworks which is applied within the study.

Chapter 6: This chapter presents the core results of the research, detailing the comprehensive analysis, key findings, and the consequent responses. This chapter synthesizes the data gathered through various methods, interpreting how these findings impact the broader field of study. It also evaluates the implications of these results for both theory and practice, suggesting potential applications and future research directions. This section is pivotal in understanding the effectiveness of the methodologies employed and the innovative contributions of the study to existing knowledge.

Chapter 7: This chapter provides a reflective overview of the entire research process, summarizing the key findings and discussing the broader implications. It offers critical reflections on the methodologies used, the challenges encountered, and the lessons learned. The chapter concludes by outlining potential next steps for future research, suggesting ways to build on the insights gained and proposing directions for further inquiry. This final chapter ensures that the research is contextualized within the ongoing academic dialogue and sets the stage for continued exploration in the field.

Finally, this thesis is accompanied by a series of appendices which provide further information in relation to some aspects of the study.

SECTION 1

Multiple perspectives on perioperative anxiety

This section will explore at existing ideas and research related to this project. As this research sits across several disciplines (perioperative care, immersive technologies and participatory design methods), this contextual literature review will draw together key issues and established knowledge bases to inform the study further and identify where it sits in relation to current thinking and practice. The main areas of concern and their relationships for this research are visually mapped in the following diagram (Figure 3).

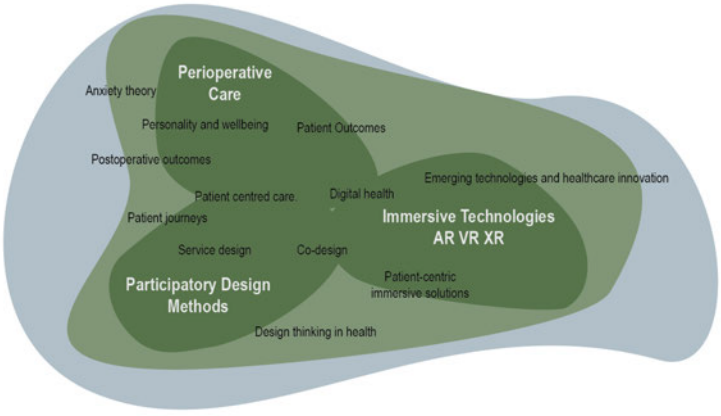

Figure 2 mapping of main areas of concern/disciplines relevant to this study

Chapter 2.

Understanding and evaluating the perioperative journey from the healthcare research context

This chapter critically reviews the literature on the perioperative journey, detailing each phase and emphasizing patient engagement and reported measures. It highlights significant gaps in existing knowledge, particularly in managing perioperative anxiety and enhancing patient experience. The findings from this review help shape the research question that guides the rest of the thesis, aiming to improve patient outcomes and experiences through innovative strategies.

Chapter 2: Understanding and evaluating the perioperative journey from the healthcare research context

2.1 The Perioperative journey

Phases of the Surgical Experience

The perioperative journey encompasses several phases, which may vary slightly among different healthcare providers and unfold over varying durations. Generally, upon being informed about the necessity for surgery, the patient embarks on the perioperative period, initiating the implementation of a comprehensive care plan. This plan encompasses consultation discussions, preoperative preparations, and postoperative recovery periods as patients transition back to their normal activities. This study specifically examines the encounters associated with medical procedures typically conducted on the same day in the elective category. It excludes consideration of long-term treatments or surgeries performed as a direct result of emergency department visits.

There are three phases in the surgical process: preoperatively, intraoperatively, and postoperatively. All three steps are included under the term "perioperative" (Davrieux et al., 2019). Various contributors play integral roles in perioperative care, encompassing surgeons, anaesthesiologists, nurses, allied health providers, administrative support and of course the patient. It is imperative to guarantee that each stakeholder comprehensively understands their duties and responsibilities to deliver safe and effective care (Bansal & Joon, 2016). Achieving optimal patient outcomes in perioperative care requires a smooth transition through each stage, from preoperative assessment to postoperative follow-up (Aust et al., 2018). Effective communication and coordination among healthcare providers are crucial for ensuring that all aspects of the patient's needs are met. Every team member must be aligned and diligent to manage the perioperative process safely and deliver high-quality care (Al Ghunimat et al., 2020).

Preoperative

The preoperative phase initiates when the patient or their representative receives information about the necessity for surgery and concludes upon the patient's transfer to the operating room. This phase commences as the patient undergoes physical and psychological preparations for the upcoming surgery (Stephanie et al., 2021). The length of the preoperative period can vary, often extending for patients undergoing elective surgery. Specialist clinical assessments are crucial in determining the timing and scheduling of elective procedures, ensuring they are booked well in advance. Elective surgery aims to treat medical conditions and address urgent needs without emergency surgery. Based on 2022 Australian national data, the patient can be placed on the waiting list from around 40 days to two years for elective surgery provided by public hospitals (AIHW, 2023). A large number of elective surgeries are also performed in private hospitals in Australia. This PhD research focuses on private hospitals rather than public hospitals, a future study is required to examine how longer waiting lists affects public patients' anxiety levels. In the preoperative period, diagnostic studies and medical regimens may be instituted, and the patient's care plan is based on information obtained during preoperative assessment and interviews (Aloweidi et al., 2022).

In summary, the preoperative phase begins when the decision for surgery is made and continues until the patient is transferred to the operating room. This phase involves several crucial steps, including:

1. **Preoperative Evaluation:** A comprehensive assessment of the patient's medical history, physical examination, and diagnostic tests is performed to evaluate their fitness for surgery and identify potential risks or complications.

2. **Patient Education:** Patients receive information about the surgical procedure, potential risks and benefits, and instructions for preoperative preparation, such as fasting, medication adjustments, and other precautions.

3. **Informed Consent:** Patients are provided with detailed information about the surgical procedure, and their consent is obtained after ensuring they understand the risks, benefits, and alternatives.

4. **Preoperative Optimization:** Depending on the patient's condition, various interventions may be implemented to optimize their health status before surgery, such as optimizing glycemic control, addressing anemia, or initiating smoking cessation programs.

5. **Preoperative Anxiety Management:** Strategies are employed to address and alleviate preoperative anxiety, which can include counselling, relaxation techniques, or pharmacological interventions.

Intraoperative

Once the patient is transferred into the operating room, the intraoperative phase commences and concludes with the transition to the post-anaesthesia care unit (PACU) or another designated recovery area. This phase encompasses critical activities such as Anaesthesia Administration, Monitoring and Management, Documentation and Legal Compliance, and Surgical Procedure (De Ridder et al., 2018).

An in-depth analysis of anaesthesia techniques and their applications, depending on the type of surgery and patient factors is provided. This includes a discussion on the choice between general, regional, and local anaesthesia, and the mechanisms by which anaesthesia is maintained throughout the surgery (Australian Society of Anaesthetists, 2024). The role of the anaesthesiologist in monitoring the patient's vital signs and adjusting anaesthesia levels to ensure optimal patient comfort and safety during the procedure is also explored (Wacker & Staender, 2014).

The core of this section details the surgical procedure itself, elaborating on the standard practices and innovative techniques employed by surgeons. Surgical team dynamics and the importance of communication during surgery are highlighted to underline how intraoperative decisions are made and adapted to the unfolding surgical scenario (Davrieux et al., 2019). This section also covers safety checks and protocols to prevent surgical errors, such as wrong-site surgery and instrument counts.

In summary, the intraoperative phase begins when the patient is transferred to the operating room and ends when the patient is admitted to the post-anaesthesia care unit (PACU) or intensive care unit (ICU). This phase involves:

1. **Anesthesia Administration:** The anaesthesia team administers the appropriate type of anaesthesia (general, regional, or local) based on the surgical procedure and the patient's condition.

2. **Surgical Procedure:** The surgical team performs the planned operation, following established protocols and guidelines to ensure patient safety and optimal outcomes.

Monitoring and Management: Throughout the procedure, the patient's vital signs, fluid balance, and other physiological parameters are closely monitored and managed by the anaesthesia team and surgical staff (Allegranzi et al., 2016; Yang et al., 2022).

Postperative

The postoperative phase begins once the patient leaves the operating room and continues until the full recovery of the patient. This phase is critical for ensuring recovery without complications, managing pain, and preparing the patient for discharge. Effective postoperative care aims to minimise the risk of infection, facilitate pain management, and monitor for any signs of complications.

In contemporary healthcare, outpatient procedures have gained prominence due to advancements in surgical techniques, anaesthesia, and healthcare delivery models. Often called day surgery or same-day discharge, with some cases involving discharge within 24 hours of admission (Chen et al., 2022; Jaensson et al., 2019). This trend is supported by recent studies highlighting the safety and efficacy of outpatient surgeries, emphasizing reduced costs and enhanced patient satisfaction (Department of Health. Victoria, Australia, 2023).

Immediate Postoperative Care describes the initial steps taken as the patient is transferred to the Post-Anaesthesia Care Unit (PACU) or similar recovery area. The focus is on stabilizing vital signs, assessing the effects of anaesthesia, and initial pain management strategies. The roles of various healthcare professionals, including surgeons, anaesthesiologists, and nurses, in these early stages are discussed to highlight their contributions to ensuring patient safety and comfort (Mert, 2023).

Detailed protocols for monitoring patients in the postoperative phase address potential complications such as bleeding, infection, and adverse reactions to anaesthesia. The integration of modern technology in continuous monitoring and its impact on patient outcomes is also essential (Bayrak et al., 2019; Weatherly & Reay, 2022).

Effective management of pain is pivotal in postoperative care, influencing patient comfort, recovery speed, and overall satisfaction with the surgical experience. There are variety of pain control strategies, from pharmacological options such as opioids to non-pharmacological methods including distraction and relaxation techniques (Brescia et al., 2021; Cronin et al., 2020). The concept of multimodal pain management is highlighted, which integrates different therapeutic approaches to achieve superior pain relief while minimising opioid use and associated side effects (Kornhaber et al., 2016). Emphasis is placed on the creation of tailored pain management plans that are customized to meet the specific needs and circumstances of each patient, thereby enhancing the efficacy of interventions and improving patient outcomes (Bayrak et al., 2019).

Physiotherapy is an essential component of postoperative care, particularly for surgeries that affect the musculoskeletal system. Early mobilization and targeted rehabilitation play pivotal roles in enhancing recovery, reducing the duration of hospital stays, and preventing post-surgical complications such as deep vein thrombosis (DVT) and pulmonary embolism (Jaensson et al., 2019). The role of physiotherapists in the recovery process, as explored by Ditton et al. (2020), highlights their contributions to guiding patients through personalized rehabilitation protocols. These tailored programs aim to restore function, enhance strength, and support a return to daily activities.

Nutrition plays a crucial role in promoting healing and facilitating recovery after surgery. The management of hydration and electrolyte balance is also essential, ensuring that patients maintain adequate fluid levels to support recovery. The personalised criteria and strategies for safely transitioning patients from intravenous fluids to oral intake are a significant step towards recovery and normalcy (Hirsch et al., 2021).

Discharge planning plays a vital role for ensuring a smooth transition from hospital to home care or another care facility. Effective communication and education contribute significantly to patient empowerment and adherence to discharge protocols, such as wound care, appropriate activity levels, and recognizing signs of potential complications (Gholizadeh et al., 2018).

The postoperative phase begins immediately after the surgical procedure and continues until the patient has fully recovered and been discharged from the healthcare facility. This phase includes:

1. **Post-Anesthesia Care Unit (PACU):** Patients are closely monitored in the PACU for any immediate postoperative complications, such as pain, nausea, or respiratory issues, and appropriate interventions are provided.

2. **Pain Management:** Effective pain management strategies are implemented to ensure patient comfort and facilitate recovery.

3. **Postoperative Care:** Depending on the surgical procedure and the patient's condition, various postoperative care measures may be implemented, such as wound care, physical therapy, or nutritional support.

4. **Discharge Planning:** Patients receive instructions for postoperative care at home, including activity restrictions, medication management, and follow-up appointments.

5. **Follow-up Care:** Patients attend scheduled follow-up appointments to monitor their recovery progress and address any concerns or complications that may arise (Gonçalves-Bradley et al., 2022).

2.2 Patient Engagement in the Perioperative Setting

Patient engagement has emerged as a crucial focus in healthcare research, particularly in the context of the perioperative journey. The term "patient engagement" is widely used by researchers, but often without a clear, working definition. This lack of conceptual clarity is further compounded by the interchangeable use of related terms such as patient activation, patient empowerment, and shared decision-making.

Defining Patient Engagement

Despite the lack of a universally accepted definition, several studies have attempted to conceptualize patient engagement in the perioperative setting. A systematic review by Cooper et al. (2023) found that only 38% of the included studies offered an explicit definition of patient engagement. The review identified four major themes associated with the operationalization of patient engagement:

1. **Provision of Information:** This theme encompasses the sharing of information with patients about their condition, treatment options, and expected outcomes, enabling them to make informed decisions.

2. **Communication:** Effective communication between patients and healthcare providers is essential for patient engagement. This includes active listening, addressing concerns, and fostering a collaborative relationship.

3. **Decision-Making:** Patient engagement involves actively involving patients in the decision-making process, considering their preferences, values, and goals.

4. **Action-Taking:** This theme refers to the patient's ability to take an active role in their care, such as adhering to treatment plans, self-management, and participating in rehabilitation activities.

These four themes are interconnected and co-dependent, highlighting the multifaceted nature of patient engagement.

Studies have shown that active patient participation in perioperative care can lead to better surgical outcomes, reduced anxiety, and increased patient satisfaction (Cooper et al., 2023; Holetzek & Holmberg, 2022). However, barriers such as lack of information, cultural differences, and varying

health literacy levels can impede effective engagement (Petkovic et al., 2020). Extensive research has highlighted the benefits of active patient participation in perioperative care, demonstrating significant improvements in clinical outcomes and patient experiences. According to Bombard et al. (2018), engaging patients through informative sessions and consultations prior to surgery significantly enhances the surgical outcomes by fostering a better understanding of the procedure, which helps in reducing preoperative anxiety and improving postoperative compliance. Similarly, Cooper et al. (2023)reports that patient engagement initiatives, such as preoperative education programs and postoperative feedback mechanisms, are associated with reduced levels of anxiety and stress, contributing to faster recovery and increased overall patient satisfaction.

Despite these positive outcomes, several studies have identified critical barriers that can limit the effectiveness of patient engagement strategies in the perioperative setting. Aschmann et al. (2020) emphasize that insufficient provision of information often leaves patients inadequately prepared for the physical and emotional impacts of surgery, thereby affecting their active participation and engagement. Additionally, cultural differences pose significant challenges, as healthcare providers may not always have the resources or training to appropriately address diverse cultural norms and communication styles, which can affect the patient's understanding and involvement in their care (Xie, 2020).

Furthermore, health literacy emerges as a predominant factor influencing patient engagement. Johnson and Woodall (2022) found that patients with low health literacy were less likely to understand their surgical options and postoperative care requirements, leading to lower engagement levels and poorer health outcomes. This is compounded by the technical nature of information typically communicated in the perioperative phases, which can be overwhelming for patients without medical training.

Studies indicate that technology-based interventions, including digital health platforms and mobile apps, can substantially improve patient engagement. These tools offer personalized health information and facilitate easier communication between patients and healthcare providers (Lee et al., 2021). These tools not only help bridge the information gap but also allow for a more personalized approach to patient education and involvement, adapting to individual literacy levels and cultural backgrounds.

Importance of Patient Experience in Perioperative Setting

The importance of patient experience in the surgical context is increasingly recognized as a crucial element of healthcare quality and effectiveness. The study by de Ridder et al. (2018) highlights several key aspects of why patient experience is vital.

1. **Impact on Clinical Outcomes:** Patient experience is directly linked to clinical outcomes. Patients who have positive experiences are more likely to adhere to postoperative instructions and engage in follow-up care, which can lead to better health outcomes. Positive patient experience has been associated with a lower likelihood of complications, reduced readmission rates, and improved overall health status. This relationship underscores the need for surgical teams to prioritize patient engagement and comfort as part of the care process (Burgess et al., 2019).

2. **Psychological Well-being:** The psychological state of a patient can significantly impact their recovery and long-term health. Research shows feelings of insecurity and lack of control were prevalent among patients, affecting their overall well-being. Addressing these psychological aspects through better communication, providing reassurance, and ensuring comprehensive patient education can enhance the patient's mental and emotional resilience (Petkovic et al., 2020).

3. **Patient Satisfaction:** Patient satisfaction is often used as an indicator of quality in healthcare. A positive experience in the surgical context can enhance patient satisfaction, which is not only important for the patient's perception of care but also influences the reputation of healthcare providers and institutions. Satisfied patients are more likely to recommend the services to others and return for future care, thus benefiting the healthcare system both directly and indirectly (Jaensson et al., 2019).

4. **Healthcare Efficiency:** Improving patient experience can lead to more efficient use of healthcare resources. When patients understand their treatment plan, feel reassured, and are engaged in their care, there is typically a smoother flow of the surgical process, fewer delays, and a reduction in the unnecessary use of resources. This efficiency is crucial for cost management in healthcare, especially in high-volume settings like outpatient surgery (de Ridder et al., 2018).

5. **Ethical and Legal Considerations:** Enhancing patient experience also touches on ethical and legal aspects of healthcare. Providing care that considers the patient's preferences, needs, and values is part of respecting patient autonomy, a fundamental ethical principle i n medicine. Moreover, well-informed patients are less likely to have misunderstandings about the consent process, reducing legal risks associated with surgical care (N. J. Brown et al., 2021).

6. **Market Differentiation:** In an increasingly competitive healthcare market, institutions that prioritize and effectively manage patient experience can differentiate themselves. This focus can attract more patients, particularly in elective and outpatient surgical contexts, where patients may have more options to choose from (Hallgren et al., 2021).

2.3 Patient-reported measures

Patient Reported Measures (PRMs) are a crucial component of modern healthcare, providing valuable insights into patients' experiences, satisfaction, and outcomes. PRMs encompass two main categories: Patient Reported Outcome Measures (PROMs) and Patient Reported Experience Measures (PREMs).

Patient Reported Outcome Measures (PROMs)

PROMs are standardized questionnaires that capture patients' perceptions of their health status, quality of life, symptoms, and functional abilities (Kingsley & Patel, 2017). They provide a direct account of the patient's experience, measuring outcomes that are difficult or impossible to assess through clinical observations or tests alone, such as pain, fatigue, depression, and self-efficacy (Øvretveit et al., 2017). PROMs serve several important purposes:

1. **Enhancing Shared Decision-Making:** By incorporating patients' perspectives on their health status and treatment goals, PROMs facilitate shared decision-making between patients and clinicians, enabling personalized care plans tailored to individual needs and preferences.

2. **Quality Improvement:** Comparing PROMs data across different treatments, providers, or healthcare settings can identify unwarranted variations in outcomes, informing quality improvement initiatives and driving better value-based care.

3. **Population Health Monitoring:** Aggregated PROMs data can provide insights into population health trends, informing policy decisions, resource allocation, and healthcare system planning (Berkowitz, 2016; Kingsley & Patel, 2017).

Patient Reported Experience Measures (PREMs)

PREMs are validated questionnaires that capture patients' perspectives on various aspects of their healthcare experience, such as accessibility, physical environment, and interactions with healthcare providers. PREMs provide valuable feedback on the quality of care delivery, enabling healthcare organizations to identify areas for improvement and enhance patient satisfaction (Raine et al., 2016). PREMs can assess various aspects of the healthcare experience, including:

1. **Access and Timeliness:** Patients' experiences with appointment scheduling, wait times, and the availability of services.

2. **Communication and Interpersonal Interactions:** The quality of communication between patients and healthcare providers, including clarity of explanations and responsiveness to questions and concerns.

3. **Physical Environment:** Patients' perceptions of the cleanliness, comfort, and overall atmosphere of healthcare facilities (Hallgren et al., 2021; Kingsley & Patel, 2017).

Importance of Patient Reported Measures

Incorporating PRMs into healthcare delivery offers numerous benefits:

1. **Patient-Centered Care:** PRMs ensure that patients' voices are heard and their perspectives are valued, promoting a patient-centered approach to care.

2. **Improved Outcomes:** By actively involving patients in their care and addressing their concerns and priorities, PRMs can lead to better health outcomes and increased patient satisfaction.

3. **Quality Monitoring and Benchmarking:** PRMs data can be used to monitor and benchmark the quality of care across different healthcare providers, facilitating continuous improvement and accountability.

4. **Value-Based Healthcare:** PRMs provide a comprehensive understanding of the value of healthcare interventions from the patient's perspective, supporting the transition towards value-based healthcare models (Ditton et al., 2020; Weatherly & Reay, 2022).

As healthcare systems worldwide strive to deliver high-quality, patient-centred care, the systematic collection and utilization of PRMs will become increasingly important. By empowering patients to share their experiences and outcomes, PRMs can drive improvements in care delivery, enhance shared decision-making, and ultimately lead to better health outcomes for individuals and populations.

2.4 Perioperative anxiety

During the perioperative process, patients frequently experience stress and anxiety as common psychophysiological reactions. These responses are not merely emotional states but affect physiological functions that can complicate both surgical and recovery phases. Research indicates that heightened levels of presurgical anxiety are linked to increased risks of postsurgical complications, which can adversely affect the trajectory towards a comprehensive and positive recovery (Manou-Stathopoulou et al., 2019).

The mechanisms through which perioperative stress and anxiety impact surgical outcomes are multifaceted. Anxiety can exacerbate pain perception, hinder immune function, and increase the likelihood of cardiovascular events, which collectively contribute to prolonged hospital stays and heightened medical interventions (Bansal & Joon, 2016). Furthermore, the stress response can elevate cortisol levels, which in turn may delay wound healing and increase the risk of infection (Chu et al., 2024).

Despite the known impacts, preventative measures and interventions for managing stress and anxiety in surgical patients are not routinely implemented. Only a small proportion of patients receive dedicated support for stress and anxiety relief before undergoing surgery. This gap in care is often due to resource constraints: many healthcare facilities find it challenging to allocate time and staff for face-to-face education and intervention sessions, which are crucial for alleviating anxiety (Hallgren et al., 2021).

Recent epidemiological studies have highlighted the prevalence of perioperative anxiety, indicating that a significant proportion of patients awaiting surgical procedures experience varying degrees of anxiety. According to Smith and Jones (2023), approximately 60-80% of patients exhibit noticeable anxiety prior to surgical operations. Factors contributing to this anxiety include fear of the unknown, fear of pain, concern over loss of control, anxiety about postoperative outcomes, sociodemographic characteristics, psychosocial variables, past surgical experiences, knowledge about the surgical process, and awareness about anaesthesia. Females generally exhibit a higher predisposition to anxiety compared to males, and anxiety levels exhibit a correlation with the significance of the surgery (Abate et al., 2020). Patients undergoing more complex or impactful surgical procedures tend to report higher anxiety levels. Notably, a history of cancer significantly elevates preoperative anxiety. Mental health conditions, such as depression, can also contribute substantially to preoperative anxiety (Aust et al., 2018; Kumar et al., 2019).

The relationship between personality traits and anxiety levels is a well-established area of psychological research, and it is particularly relevant in the context of healthcare, including perioperative care. Certain personality traits can predispose individuals to higher or lower levels of anxiety, which can affect their overall health outcomes, particularly in stressful situations such as surgery. The Big Five personality traits, also known as the Five-Factor Model, is a widely accepted framework for understanding personality. It consists of five broad dimensions: openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism.

Neuroticism: This trait is characterized by emotional instability and a tendency to experience negative emotions such as anxiety, fear, and sadness. Individuals high in neuroticism are more prone to experiencing anxiety and are at an increased risk for developing anxiety disorders (Yang et al., 2023).

Extraversion: Extraverts tend to be outgoing, sociable, and experience more positive emotions. Low levels of extraversion (introversion) are associated with higher levels of anxiety, particularly social anxiety (Ji et al., 2022a).

Conscientiousness: This trait involves being organized, disciplined, and goal oriented. Higher levels of conscientiousness are linked to lower levels of anxiety, as conscientious individuals may be better able to manage stressful situations (Ferguson & Bibby, 2012).

Agreeableness: Agreeable individuals are cooperative, trusting, and compassionate. Lower levels of agreeableness have been associated with an increased risk of anxiety disorders, possibly due to difficulties in interpersonal relationships (Karuniawati Hasanah et al., 2022).

Openness to Experience: This trait is related to curiosity, imagination, and openness to new ideas. The relationship between openness and anxiety is less clear, with some studies suggesting a potential link to certain types of anxiety disorders.

These personality traits underline the importance of identifying at-risk individuals through preoperative screening, to tailor interventions more effectively (Javadi et al., 2022). Understanding the interplay between personality traits and anxiety is crucial for healthcare providers, especially when preparing patients for surgery. For instance, patients with high neuroticism might benefit from additional counselling and reassurance, whereas those with high conscientiousness might appreciate detailed information about their procedure to reduce anxiety. Based on personality assessments, tailored psychological interventions can be more effective. Understanding these dynamics not only helps in managing anxiety but also enhances overall patient care by aligning medical interventions with individual psychological profiles. This tailored approach can lead to better patient experiences, lower levels of perioperative anxiety, and improved surgical outcomes.

The relationship between anxiety and surgical outcomes has been extensively documented in the medical literature. Doe (2021) provides a comprehensive review indicating that higher levels of preoperative anxiety correlate with negative postoperative outcomes. These include increased perception of pain, which can complicate pain management efforts and increase the requirement for analgesics. Additionally, heightened anxiety levels have been linked to longer hospital stays as these patients often require more time to recover emotionally and physically.

Moreover, the incidence of postoperative complications is higher among anxious patients. The physiological stress responses associated with anxiety, such as increased heart rate and blood pressure, can exacerbate surgical risks and delay wound healing. Furthermore, anxiety can impair immune function, making patients more susceptible to infections and other complications.

The Consequences of Perioperative Anxiety on Surgical Outcomes

The anticipation of surgery often induces a spectrum of emotions in patients, with preoperative anxiety being a prevalent and consequential experience. This section explores the multifaceted consequences of preoperative anxiety on postoperative outcomes, shedding light on the intricate interplay between psychological well-being and physical recovery (Ji et al., 2022a). These include:

Delayed Recovery: Preoperative anxiety can trigger a cascade of physiological responses, including the release of stress hormones like cortisol and adrenaline. These hormonal fluctuations can impede the body's natural healing processes, potentially leading to delayed postoperative recovery. The heightened state of alertness and tension associated with anxiety may hinder the restoration of normal physiological functions (Ji et al., 2022a).

Increased Pain Perception: Anxiety has a direct impact on the perception of pain. Patients with elevated preoperative anxiety often report heightened sensitivity to pain, necessitating higher doses of pain medication postoperatively. The intricacies of pain management become more challenging, as anxiety exacerbates the subjective experience of pain, potentially leading to prolonged discomfort (Burgess et al., 2019).

Compromised Immune Function: Chronic stress and anxiety are known to suppress immune function. In the context of surgery, compromised immunity may increase the vulnerability of patients to postoperative infections and other complications. A weakened immune response can impede the body's ability to ward off pathogens and promote efficient healing (Hanalis-Miller et al., 2022).

Greater Use of Healthcare Resources: Patients with high preoperative anxiety may exhibit a tendency to utilize healthcare resources more extensively, both before and after surgery. Increased emergency department visits, additional consultations, and diagnostic tests contribute to heightened healthcare costs, emphasizing the need for effective preoperative interventions to mitigate anxiety (Harper & Mustafee, 2023).

Extended Hospital Stay: The connection between preoperative anxiety and prolonged hospital stays is evident. Anxiety may contribute to a slower recovery process, necessitating an extended hospital stay. Longer durations of hospitalization not only strain healthcare resources but also impact the patient's overall well-being and satisfaction with the healthcare experience (Aloweidi et al., 2022).

Poorer Surgical Outcomes: Emerging evidence suggests a correlation between preoperative anxiety and poorer surgical outcomes. Physiological stress responses and potential deviations from postoperative care instructions may contribute to suboptimal results. Recognizing and addressing preoperative anxiety becomes imperative to optimize surgical outcomes and enhance patient recovery (Mirani et al., 2019).

Psychological Distress: The psychological ramifications of preoperative anxiety extend into the postoperative period, with heightened risks of depression and post-traumatic stress disorder (PTSD). The mental health impact may compromise the patient's ability to cope with the recovery process, highlighting the need for comprehensive preoperative psychological support (Hanalis-Miller et al., 2022).

Impaired Cognitive Function: Anxiety's influence on cognitive function can impede postoperative recovery. Difficulties in concentration and memory recall may hinder the patient's ability to actively participate in their recovery process, potentially affecting adherence to medication regimens and rehabilitation protocols (Newman et al., 2020).

As we can see, preoperative anxiety exerts a profound influence on various facets of postoperative outcomes, encompassing delayed recovery, increased pain perception, compromised immune function, heightened healthcare resource utilization, extended hospital stays, poorer surgical outcomes, psychological distress, and impaired cognitive function. Healthcare providers must recognize the importance of addressing preoperative anxiety through tailored interventions to enhance overall patient well-being and optimize postoperative recovery. A holistic approach that combines medical and psychological strategies is paramount in mitigating the consequences of preoperative anxiety and fostering a positive postoperative experience.

Comprehensive Management Strategies

This body of research demonstrates a clear need for effective management strategies to mitigate perioperative anxiety, thereby improving patient experiences and surgical outcomes. The evidence suggests that interventions should not only focus on the immediate preoperative period but also extend into postoperative care, addressing anxiety as a continuum throughout the perioperative process.

The scope of this study centred on same-day elective surgery. While same-day surgery offers undeniable advantages, it is essential to acknowledge and carefully consider the potential drawbacks associated with this approach. The cons of same-day surgery encompass various aspects, each demanding attention to ensure patient safety, satisfaction, and optimal outcomes (Aloweidi et al., 2022). From limited postoperative observation time to the risk of delayed complications, challenges in selecting suitable procedures, and the psychological impact on patients, these considerations underscore the need for a comprehensive understanding and effective management of potential issues. Additionally, logistical challenges, the potential for limited postoperative support at home, and variations in insurance coverage further contribute to the nuanced landscape of cons associated with same-day surgery (Aloweidi et al., 2022; Christal Vimala et al., 2021). A thorough exploration of these concerns is imperative for healthcare professionals, policymakers, and patients alike as they navigate the landscape of modern surgical practices.

It is evident from recent research that recognising perioperative anxiety as a multifaceted issue with implications beyond the immediate clinical setting is essential for developing comprehensive strategies to mitigate its impact. This understanding allows for implementing targeted interventions, ranging from psychological support services to enhanced preoperative education programs, to address preoperative anxiety's clinical and economic dimensions (Abate et al., 2020; Aloweidi et al., 2022).

Given the significant prevalence and negative consequences associated with perioperative anxiety, there is a need to provide appropriate treatment interventions. Perioperative anxiety can be addressed through two distinct categories of interventions: pharmacological and non-pharmacological methodologies (Agbayani et al., 2020; McCorry, 2007). Pharmacological interventions encompass the use of sedatives and anti-anxiety medications. According to the literature, midazolam, diazepam, ketamine, and fentanyl are well-recognised as the prevailing pharmacological agents for anxiolysis, which refers to alleviating anxiety (Ji et al., 2022b). The administration of anxiolytic medications necessitates caution due to the potential for pharmacological interventions to elicit unfavourable outcomes, including respiratory complications, somnolence, interference with anaesthetic agents, and protracted recuperation (Maurice-Szamburski et al., 2015). As a result, non-pharmacological therapies are increasingly being employed. According to reports, anaesthesiologists tend to employ non-pharmacological therapies more than pharmaceutical interventions prior to operations for both paediatric and adult patients. In the United Kingdom, a study found that the large majority of anaesthesiologists indicated they employ educating and communication with patients, and reassurance, as their primary approach to mitigating preoperative anxiety among adults (Al Ghunimat et al., 2020).

Non-pharmacological therapies encompass diverse strategies, including patient interviews conducted by healthcare professionals, effective communication techniques, information packs, engagement in religious or spiritual activities, music therapy, visits from family members, acupuncture, various distraction techniques, and patient education (Figure 3). The recognition of digital health interventions as a substantial advancement highlights their potential to enhance health knowledge

and empower individuals to make informed choices for physical and mental well-being. These digital health tools include non-immersive technologies, such as mobile applications and wearable devices, and immersive systems, such as virtual reality (VR) (Javadi et al., 2022)..



Figure 3 Non-pharmacologic approaches in the preoperative anxiety (Wang et al., 2022)

Within the realm of digital health, the integration of various features, including aiding patients in effectively managing pain through medications and treatment plans, as well as promoting healthy lifestyle choices, represents a significant stride forward (Brown & Foronda, 2020). The burgeoning field of digital health explores the application of digital technologies to augment and extend the provision of healthcare services to patients. Although multiple definitions of digital health exist, they commonly underscore the empowerment of patients in managing their healthcare experiences (Choun & Petre, 2022; Shaw et al., 2018).

Moreover, as discussed, digital health holds the potential to broaden the scope and impact of healthcare interventions, facilitating the delivery of superior care to a larger population (Murray et al., 2016). The increasing prominence of digital health in healthcare services delivery is evident, with numerous studies showcasing that technology-based therapeutic tools can effectively and acceptably contribute to various aspects of healthcare delivery while exerting a significant influence on costs (Kondylakis et al., 2022a). This underscores the transformative role that digital health can play in optimizing healthcare accessibility, delivery, and overall efficiency.

Personalised Interventions by having personalities in mind

Personalising healthcare interventions based on individual personality assessments has gained attention for its potential to enhance treatment effectiveness and patient satisfaction. This approach leverages psychological insights to cater interventions that align with individual behavioural tendencies, cognitive styles, patient education and emotional needs.

Given the variations in preoperative anxiety across different surgical procedures, tailoring interventions to specific contexts is paramount. For example, the anxiety associated with cardiac surgery may require specialized psychological support and education to alleviate concerns related to the perceived vulnerability in this particular setting. On the other hand, minor procedures may benefit from streamlined communication and emphasis on the routine nature of the intervention (P. Zhang et al., 2021). Understanding individual personality traits can significantly improve the effectiveness of patient education, leading to better health outcomes and enhanced patient satisfaction. Patient education is crucial in healthcare for ensuring patients understand their conditions, the necessary treatments, and the actions they must take to manage their health. Personalizing this education based on personality assessments can lead to more effective communication and better adherence to treatment plans (Oh et al., 2024).

Personality assessment using validated tools like the Five-Factor Model can help identify high-risk patients prone to elevated preoperative anxiety based on their personality profiles (Ji et al., 2022a; Oh et al., 2024). For example, patients exhibiting high levels of neuroticism may require additional preoperative counselling and targeted anxiety management strategies to better prepare for surgery and reduce stress (Oniszczenko & Turek, 2022). Understanding a patient's personality allows tailoring preoperative interventions to their specific needs and coping styles. Highly conscientious individuals may require less support for adherence, while those low in agreeableness may need additional interpersonal support (Kondylakis et al., 2022a). Personality assessment is valuable not just for predicting preoperative anxiety, but also for optimizing postoperative quality of life and psychosocial adjustment (Kumar et al., 2019). Certain personality traits like poor frustration tolerance and anxiety proneness are associated with poorer postoperative quality of life, even after accounting for surgical outcomes (Jaensson et al., 2019). To create personalized experiences that align with individual personality traits, consider these key strategies:

Age-Related Considerations:

The intricate relationship between age and preoperative anxiety necessitates a nuanced approach. Younger individuals may require focused attention on addressing fears related to the unknown, while older patients may benefit from comprehensive information addressing potential comorbidities and age-related concerns (Alanazi, 2014).

Gender-Specific Strategies:

Recognizing the gender-specific dynamics of preoperative anxiety, healthcare providers can implement strategies tailored to the unique needs of male and female patients. For example, providing additional emotional support to female patients or addressing specific concerns related to body image may be crucial in managing preoperative anxiety (Krist et al., 2017).

Cultural and Individual Differences:

Understand and respect cultural beliefs that may influence a patient's perception of surgery and care. This could involve providing multilingual resources, respecting cultural customs around privacy and modesty, or integrating traditional health practices when possible.

Educational Patterns

Some people are visual learners, others are auditory, and some learn best by doing. Understanding a patient's preferred learning style can help tailor the educational material to ensure it is as effective as possible. For instance, visual learners might benefit from diagrams and videos, whereas kinaesthetic learners might benefit from using models or simulations to understand their surgical procedure.

Psychoeducation and Coping Skills Training

Providing patients with comprehensive psychoeducation about the surgical process, potential challenges, and coping strategies is essential in reducing anxiety. 'Coping – skills' training, including relaxation techniques, mindfulness, and cognitive-behavioural strategies, can empower individuals to manage anxiety effectively (Horn et al., 2020)

2.5 Integrative summary

Chapter 2 lays out the essential healthcare foundation by thoroughly mapping the perioperative journey-preoperative, intraoperative, and postoperative phases-highlighting the complex, dynamic nature of patient experiences during surgery. It critically evaluates patient engagement and the use of patient-reported outcome and experience measures (PROMs and PREMs), emphasizing their role in capturing subjective patient perspectives that traditional clinical metrics often overlook. The chapter also explores perioperative anxiety as a critical determinant of surgical outcomes, discussing its physiological and psychological impacts and the necessity for tailored, personalized interventions that consider age, gender, culture, and individual differences.

This chapter's healthcare-centric insights are linked to the thesis's interdisciplinary framework by establishing the clinical and experiential challenges that design, and technology must address. It sets the stage for integrating human-centred design and digital therapeutic solutions by identifying gaps in current perioperative care-particularly the underutilization of patient-centred approaches and non-pharmacologic anxiety management. The chapter's detailed exploration of perioperative anxiety informs the subsequent design and technological interventions, creating a critical knowledge base that bridges clinical realities with design innovation. It attempts to establish the clinical "problem space" within an interdisciplinary dialogue, of immersive technologies, digital health solutions and service design in real-world patient needs and healthcare outcomes.

Chapter 3.

Design Thinking and Digital Therapeutics in Healthcare

This chapter investigates how design thinking enhances digital therapeutics in healthcare, focusing on user-centric, evidence-based approaches for optimizing patient care. It highlights the role of service design in transforming healthcare experiences and aligning with person-centered care principles. The chapter also compares participatory and human-centered design approaches to showcase their effectiveness in driving innovation and engaging stakeholders in healthcare projects.

Chapter 3: Design thinking and Digital Therapeutics in Healthcare

3.1 Introduction to Design Thinking in Healthcare

In these following sections, the typical design decision-making process and framework for the development of a digital intervention specifically related to healthcare is described based on present literature. This is done to gain insights into current practices in the formulation, design, and evaluation of digital tools and therapies related to healthcare. The research predominantly utilizes design decision-making terms and processes that are specifically tailored to the healthcare sector.

Design thinking and design processes are gaining prominence as essential tools in shaping the future of healthcare. In an era marked by rapid technological advancements and evolving patient needs, the integration of design principles into healthcare systems is proving to be a transformative approach. This innovative mindset goes beyond traditional problem-solving methods, emphasizing empathy, collaboration, and user-centered solutions to address complex challenges in the healthcare landscape (Abookire et al., 2020). At its core, design thinking in healthcare involves a human-centric approach that prioritizes understanding the unique perspectives, experiences, and needs of patients, healthcare providers, and other stakeholders. By empathizing with these diverse perspectives, designers can uncover valuable insights that inform the development of more effective and inclusive healthcare solutions (Kowatsch et al., 2019). This methodology encourages a shift from a one-size-fits-all model to tailored, patient-centric care that enhances both the quality of medical services and the overall patient experience.

Design process in healthcare encompasses a series of iterative steps, including research, ideation, prototyping, testing, and implementation. Through this approach, designers can continually refine and optimize healthcare solutions based on real-world feedback and evolving requirements (Jarrett et al., 2022). This iterative nature allows for the agility needed to adapt to the dynamic nature of healthcare, where advancements in technology, changes in regulations, and shifting demographics constantly influence the industry (Harper & Mustafee, 2023). Furthermore, the application of design thinking in healthcare extends beyond the development of medical devices and treatments. It also plays a crucial role in shaping healthcare environments, from hospital facilities to digital platforms (Banbury et al., 2021). By considering the physical and digital spaces where healthcare is delivered, designers can contribute to creating environments that foster healing, reduce stress, and enhance the overall well-being of patients (Attias et al., 2016).

Collaboration is a key aspect of the design thinking process in healthcare. Bringing together multidisciplinary teams, including designers, healthcare professionals, engineers, and patients, facilitates a holistic understanding of challenges and encourages innovative problem solving (Abookire et al., 2020). This collaborative approach ensures that diverse perspectives are considered, leading to solutions that are not only effective but also culturally sensitive and socially responsible. The integration of design thinking and design processes in healthcare represents a paradigm shift towards a more patient-centred, adaptable, and collaborative approach. By leveraging these methodologies, healthcare professionals and designers can work together to create solutions that address the complex and evolving needs of the healthcare ecosystem, ultimately improving patient outcomes and the overall healthcare experience.

Bill Moggridge, the renowned British designer and co-founder of the prominent design consultancy IDEO, outlined a series of processes that constitute the design process. The process involves several key steps: (1) defining and redefining the design problem and the desired objective; (2) generating alternative approaches to solve the problem; (3) evaluating and choosing among these alternatives, taking into account the project's limitations; (4) creating prototypes and refining them through iterations; and (5) integrating a solution that effectively meets the main project objectives while considering important constraints (Kowatsch et al., 2019). In the design process, instead of advancing linearly through the steps, there is iterative mobility between them. Iterations in the design

process involve alternating between different aspects of the project, trying out solutions, gathering additional data, and reevaluating one's understanding of project objectives (Figoli et al., 2022).

3.2 Design for Wellbeing: Contextualizing Perioperative Interventions

The application of design thinking to perioperative anxiety management must be situated within the broader field of design for wellbeing, an emerging interdisciplinary domain that extends beyond clinical symptom management to address holistic human flourishing. While traditional medical approaches to anxiety often focus on symptom reduction, design for wellbeing offers complementary frameworks that consider the complete human experience of healthcare encounters.

Design for wellbeing encompasses several interrelated approaches that inform this research. Desmet and Pohlmeyer's (2013) "Positive Design" framework proposes that design should address three components of wellbeing: pleasure (positive emotions), personal significance (pursuing goals), and virtue (being morally good). Applied to perioperative contexts, this suggests interventions should not merely reduce anxiety but also promote positive emotional states, support patients' life goals through improved recovery, and respect their autonomy and dignity throughout the surgical process.

Similarly, Calvo and Peters' (2014) work on "Positive Computing" provides valuable insights for digital health interventions by emphasizing technologies that support psychological wellbeing factors such as autonomy, competence, and relatedness. These principles directly inform how immersive technologies might be designed to enhance patient agency and social connection during vulnerable perioperative moments—factors identified as crucial in perioperative anxiety management (Hallgren et al., 2021).

Particularly relevant to perioperative anxiety is Niedderer's (2013) concept of "Mindful Design," which focuses on creating objects and experiences that promote mindful awareness rather than mindless interaction. This approach aligns with evidence-based anxiety management techniques such as mindfulness and presence-centered awareness, suggesting that digital interventions should foster attentional control rather than mere distraction.

The perioperative journey represents a concentrated period where wellbeing is significantly challenged, making it an ideal context for applying these design concepts. By positioning perioperative digital interventions within this broader wellbeing context, we recognize that surgical experiences are not isolated clinical events but embedded within patients' overall life narratives and emotional landscapes. This perspective informs the development of interventions that address not only immediate anxiety symptoms but also broader aspects of psychological wellbeing during significant healthcare transitions.

This research contributes to the design for wellbeing field by applying these frameworks specifically to perioperative anxiety management through immersive technologies. The RED Rules framework developed in this thesis (section 6.11) integrates clinical anxiety management approaches with wellbeing-centered design principles, demonstrating how digital interventions can simultaneously address pathological anxiety while promoting positive states of being during healthcare experiences.

3.3 Digital Therapeutic Design

Digital therapeutics (DTx) stands at the intersection of healthcare and technology, offering innovative solutions for the prevention, management, and treatment of various medical conditions. As the demand for accessible and effective healthcare grows, the development of digital therapeutics necessitates a meticulous approach that incorporates extensive design considerations and a robust

framework (Dang et al., 2020). The design of Digital Therapeutics is increasingly playing an important role in many healthcare contexts. Digital therapeutics refer to a category of evidence-based therapeutic interventions driven by high-quality software programs and technology platforms. These interventions are designed to prevent, manage, or treat medical disorders or conditions independently or in conjunction with conventional medical treatments. Digital therapeutics often leverage elements of cognitive behavioural therapy, behavioural science, and other therapeutic approaches to deliver personalized and interactive interventions through digital devices such as smartphones, tablets, or computers (Dang et al., 2020). They aim to improve health outcomes by addressing specific health issues, promoting behaviour change, and enhancing patient engagement, all within a digital or virtual environment. These interventions may be used to treat a wide range of conditions, including chronic diseases, mental health disorders, and various other healthcare challenges. Digital therapeutics can also be designed iteratively (Åsberg & Bendtsen, 2021; Lievesley et al., 2022).This allows for the development of a product that is more tailored to the user's needs and hopefully more accurate in terms of performance and use. Potentially allowing for more efficient problem-solving and more efficient use of resources.

In Digital Therapeutics, interventions are commonly administered beyond traditional clinical settings and treatments need to be designed to be supplied to individuals promptly, both long-term and short-term goals (Y. S. Lee et al., 2021). Long-term aims encompass the desired health outcomes of the intervention, such as promoting physical activity, managing blood sugar levels, or easing depressive symptoms. Increasingly these tools are being used with healthcare settings for monitoring blood sugar levels, employing coping mechanisms, or tracking significant symptoms etc. (Snoswell et al., 2020).

The effectiveness of digital therapeutics on health outcomes is influenced by several factors, including users' confidence and ability to engage with the technology, as well as their ongoing participation—an essential component of most digital treatments (Baumel et al., 2017). Moreover, both intervention and evaluation designs must carefully consider participant burden and associated costs (Dinsmore et al., 2021). High levels of burden, whether from the treatment itself or the evaluation process, can reduce a participant's involvement, thereby undermining the intended benefits of the intervention. Deployment costs, as noted by Fuerstenau et al. (2023), may also pose a barrier to access, particularly from the perspectives of patients and the healthcare system, especially when considering the large-scale implications. Additional limitations of digital therapeutic tools include privacy concerns, system usability, accessibility, and the availability of necessary internet connectivity and devices, which can further exacerbate health disparities in already vulnerable populations (Dang et al., 2020; Y. S. Lee et al., 2021).

The importance of optimisation for digital therapeutic design

Optimisation is perceived as a type of design practice that is driven by data. Existing scholarly works have emphasised the importance of optimisation in the context of intervention development in general and the specific domain of digital therapeutic development (DTx by Country, 2018). In the realm of interventions, optimisation is commonly understood as maximising effectiveness and social value while operating within the constraints imposed by available resources (Collins et al., 2018). Digital treatments have significant prospects for generating beneficial health outcomes by extending therapy beyond traditional clinical settings. For example, in the domains of mental health and substance abuse, efforts are being made to address significant obstacles commonly associated with conventional treatment methods, such as social stigma and financial burden. The use of Digital Therapeutics aims to enhance the customisation of treatment approaches and offer timely support when needed (Baumel et al., 2017; Gan et al., 2021; H. Lee et al., 2023).To take advantage of this potential, it is necessary to consider several elements of therapy administration, such as the timing, frequency, or location of treatment. Digital treatments frequently integrate many intervention components, which aim to address multiple aspects such as engagement and adherence.

What are the best delivery strategies for Digital Therapeutics?

According to Lee et al. (2021), Digital Interventions should be carefully crafted to ensure delivery occurs at the most opportune moments for the recipient while avoiding excessive frequency that may lead to user frustration and, ultimately, disengagement (Y. S. Lee et al., 2021). These are important

factors to consider while thinking about the use of digital technologies along perioperative patient journey.

The option to provide therapy beyond the confines of a clinical setting may necessitate some consideration for the environmental settings of where they will be used; this is the same for the potential digital interventions along the patient perioperative journey. Digital treatments are highly adaptable and customizable, and the framework known as 'just-in-time adaptive intervention' (JITAI) is designed to provide the most appropriate intervention to the patient at the optimal moment to maximize its effectiveness (Nahum-Shani et al., 2015); Smith et al. 2023).

When optimising interventions, the success of the intervention is frequently based on empirical data. However, the required quantity or quality of evidence may differ depending on the intervention. The design and evaluation of digital treatments provide a significant challenge due to the necessity of optimising two distinct objectives: the health outcomes resulting from the intervention and the collection of scientific data.

Design considerations for the development of Digital Therapeutics

Following the discussion on the formulation and evaluation of healthcare-related digital tools, we now turn to the key design considerations for developing effective Digital Therapeutics (DTx). These considerations are important for ensuring that digital interventions are not only well-designed but also capable of delivering meaningful and personalized therapeutic outcomes. The key factors to address in this process include:

1. Evidence-based approach: DTx must be based on rigorous clinical evidence from randomized controlled trials (RCTs) and published in peer-reviewed journals. This ensures the therapeutic interventions are clinically validated (Huh et al., 2022; Y. S. Lee et al., 2021).

2. Appropriate control conditions: Selecting the right control conditions, ranging from minimal digital controls to more complex sham applications, is crucial for evaluating the efficacy of DTx. This can be challenging compared to traditional drug or device trials (Lutz et al., 2022).

3. Consideration of user characteristics: The ability of users to effectively use digital devices and their cognitive level are important factors that impact the success of DTx interventions (H. Lee et al., 2023).

4. Regulatory oversight: DTx are considered software as a medical device (SaMD) and require regulatory approval, such as from the FDA, before commercialisation. Establishing clear regulatory frameworks is important (H. Lee et al., 2023).

5. Real-world evidence generation: Beyond clinical trials, collecting real-world data on the performance and safety of DTx is necessary to support their widespread adoption and integration into healthcare (M. Kim et al., 2024).
6. Ethical and privacy considerations: The development and use of DTx must address concerns around data privacy, security, health equity, and the potential unintended social impacts (Y. S. Lee et al., 2021)

Framework for Digital Therapeutics Development:

The framework for Digital Therapeutics Development presented in this section represents a synthesis of approaches drawn from multiple disciplines rather than a single established model from the literature. It integrates principles from software development methodologies (Dang et al., 2020), clinical validation processes (Huh et al., 2022), and human-centered design approaches (Y.S. Lee et al., 2021), consolidated through critical analysis of their applications in healthcare contexts. While individual elements appear across various studies, this comprehensive integration addresses the fragmented nature of current digital therapeutic development literature, which often emphasizes either technical, clinical, or design aspects in isolation.

This synthetic approach is particularly relevant for perioperative anxiety management, where digital interventions must simultaneously address clinical concerns (patient safety, medical validation), experiential factors (usability during heightened stress), and healthcare integration challenges (workflow compatibility, professional acceptance). The perioperative context presents unique complexities for digital therapeutic application due to the time-sensitive nature of interventions, the varying cognitive states of patients across the surgical journey, and the need to integrate with existing clinical protocols without disrupting care delivery.

Current applications of digital therapeutics for perioperative stress management remain limited, with most existing studies focusing on pediatric populations (Kondylakis et al., 2022a) or isolated intervention points rather than comprehensive perioperative support. This gap highlights the need for frameworks that specifically address the multifaceted nature of adult perioperative anxiety through coordinated digital interventions across the surgical journey.

User-Centric Design:

Persona Development: Create detailed user personas, considering demographic factors, technological literacy, and cultural nuances to inform the design process.

User Feedback Loops: Establish continuous feedback mechanisms through beta testing, focus groups, and user surveys to refine and optimize user interfaces and overall user experience.

Adaptive Design: Implement adaptive design principles, allowing for personalized experiences based on user preferences, progress, and feedback (Hardy et al., 2018).

Clinical Validity and Evidence-Based Design:

Clinical Advisory Boards: Form partnerships with healthcare professionals, specialists, and researchers to establish clinical advisory boards that guide the integration of evidence-based practices into the digital therapeutic.

Real-world Evidence (RWE): Leverage real-world evidence through observational studies and patient registries to supplement traditional clinical trial data, providing a more comprehensive understanding of the digital therapeutic's impact.

Behavioural Science Integration: Incorporate behavioural science principles to enhance user engagement and adherence, aligning the digital therapeutic with the psychology of behaviour change (Currie et al., 2022; Shelton & Lee, 2019).

Discovery and Needs Assessment:

Human-Centered Design Workshop: Conduct human-centered design workshop involving potential users, healthcare providers, and other stakeholders to identify pain points, preferences, and unmet needs.

Market Research: Conduct extensive market research to identify target demographics and assess competition, informing a strategic positioning and differentiating factors for the digital therapeutic (Melles et al., 2021).

Clinical and Scientific Validation:

Longitudinal Studies: Implement long-term, real-world longitudinal studies to capture the sustained impact and benefits of the digital therapeutic on patient outcomes.

Post-Market Surveillance: Establish robust post-market surveillance mechanisms to monitor safety, efficacy, and any potential adverse events after the digital therapeutic has been deployed at scale (Mathews et al., 2019).

Design and Prototyping:

Rapid Prototyping: Employ rapid prototyping methodologies to quickly iterate on design concepts, allowing for timely integration of user feedback.

Accessibility Audits: Conduct accessibility audits to ensure compliance with international standards and guidelines, addressing the needs of users with disabilities comprehensively (Donovan et al., 2022a).

Technology Development:

Edge Computing: Explore edge computing solutions to process data closer to the source, reducing latency and enhancing real-time processing capabilities.

Artificial Intelligence Governance: Implement ethical and responsible AI governance frameworks, addressing bias, transparency, and accountability in algorithmic decision-making processes (Bohr & Memarzadeh, 2020).

Regulatory Compliance:

Regulatory Sandboxing: Engage in regulatory sandboxes where available, collaborating with regulatory agencies to navigate the complexities of compliance while fostering innovation.

Global Harmonization: Strive for global regulatory harmonization to streamline the approval processes across different regions and markets (Shelton & Lee, 2019).

Deployment and Integration:

Health System Partnerships: Establish partnerships with healthcare systems and providers to facilitate seamless integration of the digital therapeutic into existing care pathways.

Telehealth Integration: Explore synergies with telehealth platforms, enabling synchronous and asynchronous communication between users and healthcare providers within the digital therapeutic interface (Currie et al., 2022).

Monitoring and Continuous Improvement:

Predictive Analytics: Implement predictive analytics to anticipate user needs, potential challenges, and areas for improvement.

Agile Development Methodology: Embrace agile development methodologies, allowing for continuous updates and enhancements based on real-time data, user feedback, and evolving clinical evidence (Boaz et al., 2018).

In summary the development of digital therapeutics demands a comprehensive and nuanced approach that encompasses user-centric design, clinical validity, interoperability, data security, scalability, and accessibility. By incorporating these detailed design considerations into a structured development framework, digital therapeutics can not only meet the highest standards of efficacy and safety but also resonate with users, healthcare providers, and regulatory bodies. This multifaceted approach ensures that digital therapeutics play a pivotal role in transforming healthcare delivery, promoting proactive health management, and improving patient outcomes on a global scale (Béranger & Rizoulières, 2021; Dang et al., 2020).

3.4 Studies on efficacy and effectiveness

Considerable literature exists regarding the distinction between efficacy and effectiveness studies. In essence, efficacy evaluations enable researchers to ascertain the intervention's functionality within the intended population under optimal conditions. Conversely, effectiveness evaluations address enquiries about the impact of the intervention within real-life circumstances. The design goals for efficacy and effectiveness studies differ due to two distinct evaluation goals (Graham et al., 2019). Specifically, when designing efficacy studies, prioritizing the establishment of robust data-gathering methods is vital. This ensures that potential signals or patterns can be effectively identified and analysed using the collected data. Similar to most clinical trials, it may be necessary to implement more stringent measures to regulate the study population, such as selecting individuals who meet particular criteria related to their medical condition or their proficiency in utilising technology (Smith et al., 2023).

Moreover, in digital therapeutics, this may also entail incorporating incentives not solely to gather study data but also for activities such as active involvement with the application, such as compensating users for daily interaction with the intervention or utilising essential features like mood monitoring. Likewise, choices can be made to allocate resources towards acquiring technological tools or enhancing capabilities for individual users or the entire system. This may involve the provision of new smartphones or tablets to users, aiming to mitigate potential challenges arising from real-world technology issues. Although these investments may not have the potential for scalability, their incorporation guarantees that if there is a detectable signal indicating the potential effectiveness of the intervention, the conditions will be favourable enough for it to be observed.

In contrast, effectiveness studies aim to identify the impacts of an intervention based on its real-world implementation. In general, this implies the exclusion of any incentives or components that would not be present in a more extensive implementation of the intervention (Gentili et al., 2022). For instance, there should be a lack of or minimal provision of technology and no compensation for participating in the intervention (although incentives may still be offered for data collection related to the study). Promoting everyday utilisation of the intervention necessitates the inclusion of effectiveness assessments, which play a crucial role in understanding comprehension of prolonged usage patterns, particularly in the context of digital therapies for controlling chronic illnesses. These evaluations also shed light on the obstacles that impede the usage (Y. S. Lee et al., 2021).

In the realm of study design, planning, and implementation, numerous approaches exist for assessing the research infrastructure, namely the operational aspects of the trial (Inan et al., 2020). This holds for all experimental undertakings but is particularly relevant in digital therapeutics trials. In such trials, interventions are typically composed of multiple components and exhibit high complexity. Moreover, data is gathered from various sources, including both passive and active streams, and the data collection process is longitudinal, often characterised by intensive monitoring of certain aspects of the intervention (Lane-Fall et al., 2019). In the context of these trials, it is feasible to incorporate diverse randomisation techniques to investigate the impact of trial procedures on factors such as adherence to data collection and engagement with the intervention. For example, one may employ randomisation techniques to determine the timing of automated adherence messages, the timing and method of communication between study staff and participants, or the frequency and duration of data collection methods (such as using less frequent but lengthier self-report instruments or more frequent but shorter instruments) (Damschroder et al., 2022). These experimental modifications have the potential to provide empirical data for the efficient execution of trials within the digital medicines field. Due to the typically constrained budgets for conducting trials, which are further strained in the case of digital therapeutics studies due to technological requirements, there is a need for further research in this field. This research seeks to optimize the balance between establishing robust evidence of intervention effectiveness and capturing the value of lived experiences. By using an ethnomethodological research method, the goal is to enhance the quality of evidence-based practice through these real-life insights.

Although effectiveness studies aim to bring intervention testing closer to real-world conditions, they frequently fail to fully comprehend the obstacles that hinder the widespread implementation or accessibility of an intervention at a population level (Lyon et al., 2016). In response to growing demands for improved accessibility to evidence-based interventions, the field of implementation science has emerged as a discipline dedicated to studying the methods that facilitate the systematic

integration of research findings and other evidence-based practices into regular practice. This integration aims to enhance the quality and effectiveness of health services and care (Shelton & Lee, 2019). Researchers interested in implementing healthcare services and practices often enquire about the factors that hinder or facilitate individuals' access to care or their willingness to adopt new practices. They also seek to determine which strategies for implementation are most successful in promoting the acceptance and adoption of these practices.

The review above outlines a range of techniques for undertaking a clinical research approach to the design, development and evaluation of a digital therapeutic intervention. In the next section, we will turn out attention to examining a range of human-centric ethnomethodological ideas, concerns and approaches.

3.5 Service Design and Service Design Thinking in Healthcare

Service design and service thinking represent the foundation of modern health service management. The service-based approach highlights both the customer's impression of service and the company's perspective on co-value development, considering the value of contributions made by the customer. From a managerial or entrepreneurial perspective, the implementation of service design approach in the healthcare sector comprises all the actions that are necessary to efficiently,

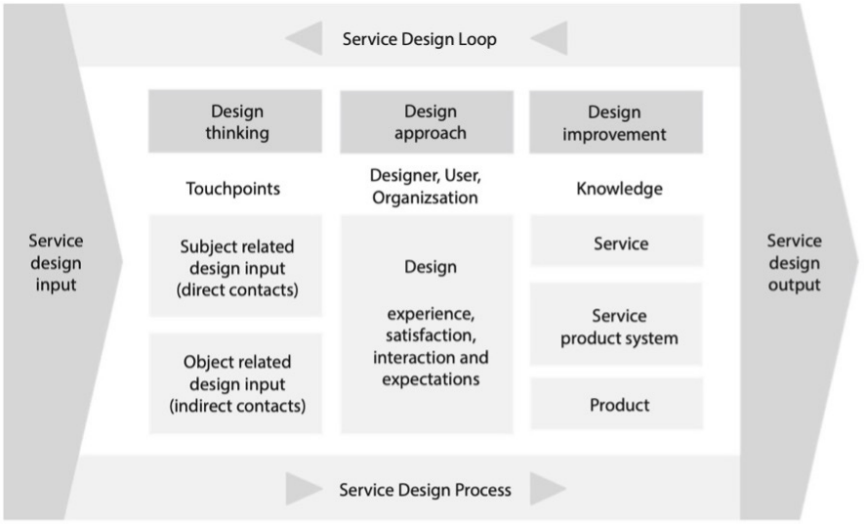

Figure 4 Holistic service design thinking (Pfannstiel & Rasche, 2019)

effectively, and innovatively meet the needs of both business-to-business (B2B) and business-to-consumer (B2C) clients (Pfannstiel & Rasche, 2019). Service design focuses on the structural elements of (networked) service architectures that optimise the utilisation of service assets, service processes, and the ultimate delivery of services in terms of timeliness, quality, convenience, and competitive pricing (Pfannstiel et al., 2022). On the other hand, service thinking pertains to exploring novel business development and innovation within the service sector (Pfannstiel & Rasche, 2019). In light of the urgency to digitalise, healthcare providers are compelled to question their deeply ingrained knowledge and business models influenced by past decisions. This questioning allowing for disruptive service innovations that frequently originate from service thinking projects. This can result in the development of radical, new service designs that provide enhanced healthcare value at reduced expenses and prices (Kurtmollaiev et al., 2018). Perceived service value encompasses more than mere considerations of prices, costs, or evidence-based quality results. In addition, a customer's pleasure or satisfaction also depends on other service physical and sociological characteristics, which contribute to the texture and tone of the experience and the perceived value of a service. The maintenance of service design in the digital realm is important due to its pervasive impact on our lives, habits, and characteristics and interconnected roles. This connectivity is particularly evident when thinking about wearables or body-implanted devices that regulate essential parameters (Shaw et al., 2018). In an optimal scenario, contemporary whole of service designs approaches can contribute to improving and enhancing our life health on personal and service-provider levels. However, on the down side, data collection, monitoring, and analysis may significantly encroach upon various aspects of our lives. Pfannstiel et al. (2022), advocates for integrating current technology into humanity-driven service design without compromising the values of intimacy and privacy.

Service thinking surpasses mere speculation due to its proactive approach towards future development. Rather than solely focusing on the present, using service design thinking healthcare practitioners can strive to foresee and achieve the seemingly impossible by challenging the established norms of their sector. For example, grappling with the implications for big data in health, which involve transitioning from multidimension data sets applications to artificially intelligent bots or machine learning algorithms that facilitate self-improving data flow exchanges among digital devices (Bohr & Memarzadeh, 2020). Intelligent healthcare services encompass a range of advanced technologies, such as adaptive therapeutic infrastructures, precision medicine, bot-assisted therapies, interactive service robots, and big data-assisted decision-making tools. The concept of aided ambient living promotes the notion of intelligent residences that autonomously attend to our welfare (Boström, 2020; Boström et al., 2017). Finally, it is important to highlight that creative service thinking can encompass providing consistent and superior healthcare services for individuals residing in remote locations improving access to services through distance-based healthcare methods. However, it is important to remember that service design and thinking should prioritise the patient, customer, or user's needs and experiences to prevent the negative consequences of excessive technical complexity and overly specialised health technology demonstrations (Malmberg et al., 2019).

The foundation of holistic service design in health and beyond lies in a synergistic and systematic approach, when applying design thinking and user-centred design principles. Malmberg et al. (2019) suggests a service design process model that incorporates collaborative workshops and design meetings that integrate the perspectives of both the designer and the user to achieve a mutually beneficial solution to assist in this thinking (Figure 4). To effectively implement service design blueprints in the healthcare industry, it is necessary to combine future thinking, pragmatic service design, and hands-on service engineering. This approach should address both strategic and piecemeal challenges, allowing for the translation of the blueprint into actionable steps. Additionally, it is important to develop sustainable healthcare business models to support the implementation process. In addition to employing innovative service designs and adopting a service-oriented mindset, healthcare organisations must also strive to develop flexible, resilient, and robust service architectures to effectively navigate the challenges posed by the evolving business landscape (Kurtmollaiev et al., 2018; Pfannstiel & Rasche, 2019).

Service Design as a Transformational Driver Toward Person-Centred Care in Healthcare

There is a growing trend among healthcare systems worldwide to shift towards person-centred care (World Health Organization, 2007). However, it is necessary to properly clarify how to facilitate this intricate change. This section explores the existing research on service design (SD) and person-centred care (PCC) to enhance our understanding of how an SD strategy can facilitate the move towards the PCC.

The healthcare industry is currently under increasing demands to enhance its ability to address the requirements of patients and integrate available resources effectively. Within this framework, the concept of person-centred care (PCC) is increasingly being recognised as a prevailing model for healthcare systems that are more comprehensive, efficient in their use of resources, and adaptable. PCC places significant focus on the patient as an individual, as highlighted by Mead and Bower (Philpot et al., 2019). In scholarly literature, SD is commonly characterised as a strategy prioritising human-centeredness, collaboration, creativity, and iteration (Pfannstiel et al., 2022; Weatherly & Reay, 2022). This approach aims to understand users' needs, desires, and behaviours to create products or services that meet their expectations (Aschmann et al., 2020) . By involving diverse stakeholders, such as users, designers, healthcare professionals and other relevant parties, the design process becomes more inclusive and ensures that multiple perspectives are considered (Boaz et al., 2018). Ethnographic research, which involves observing and interacting with users in their natural environments, can provide valuable insights into their experiences and behaviours (Blomberg & Darrah, 2015). As part of this Ethnographic approach, visualising user experiences through storyboarding or journey mapping can help designers better understand users' needs, experiences and emotions (Gualandi et al., 2019). A range of prototyping techniques also allows designers to create tangible representations of ideas, enabling the gathering of feedback to inform an iterate design process (Deininger et al., 2019). While resource-intensive, a user-centred design approach ultimately leads to the creation of products and services that are more closely aligned with user expectations and preferences, resulting in long-term benefits.

According to Malmberg et al. (2019) the capacity of (SD) to be inclusive and generative is the driving force behind change and transformation. This potential extends beyond the scope of individual service offerings. Numerous healthcare organisations are allocating resources towards implementing service design (SD) to develop new services. However, it is essential to note that SD often necessitates transformation across multiple levels, as the nature of service inherently involves the organisation, its employees, and users (Malmberg et al., 2019).

In addition, the concept of Service Design (SD) draws upon established design traditions, such as participatory design, to pursue a range of inclusion goals and engage diverse stakeholders (Harper & Mustafee, 2023; Malmberg et al., 2019). In healthcare settings, the concept of shared decision-making is widely recognised as a means to actively engage patients and incorporate their viewpoints throughout the development of healthcare interventions patient (Cooper et al., 2023). This engagement serves as a mechanism to ensure that the views of patients and their family members are acknowledged and taken into consideration (S. Kim et al., 2021). However, the objectives and subsequent participation exemplified through using experience-based co-design, as demonstrated by Ramos et al. (2020) also recognize the value to different stakeholders in this process beyond shared decision-making.

The utilisation of participatory practices in service design facilitates the acquisition of diverse information about future services. This approach helps to ensure that subsequent solutions are purposefully aligned with the identified needs (Poot et al., 2023). The process of comprehending and effectively responding to demands is facilitated by actively engaging with user or patient situations and including relevant stakeholders in co-design endeavours (Lievesley et al., 2022). According to the perspective of service design (SD), it is essential to comprehend the information possessed by all stakeholder representatives regarding various service processes. This understanding is critical in determining the resources and knowledge that can be integrated in the process (Lyon et al., 2016).

Adopting sustainable service design principles can be a highly effective method for driving transformative processes within the healthcare sector. By emphasizing collaborative and participatory methods, these principles enhance human needs and experiences (Kruk et al., 2018). The following section provides a concise overview of the existing literature on person-centred care (PCC) and outlines the transition from the current state to the envisioned primary care paradigm.

3.6 Person-Centred Care (PCC)

There has been a growing emphasis on the acquisition, comprehension, and enhancement of patients' experiences inside the healthcare systems they utilise. The enhanced patient experience yields significant results, such as excellent patient safety, reduced hospital-related problems, improved care for medical disorders, better surgical outcomes, decreased hospital readmission rates, and improved survival rates for specific types of cancer (Hallgren et al., 2021; Malmberg et al., 2019). These factors have made the patient experience a fundamental component of patient-centred care. It is now a critical indicator of healthcare quality, influencing both public policy and organizational incentives (Tian, 2023).

The existing literature on patient experience presents several definitions, resulting in a certain degree of ambiguity (Kingsley & Patel, 2017; Tian, 2023). The concept of patient experience, which has gained widespread acceptance and has been established and verified by The Beryl Institute, posits that it encompasses all encounters influenced by an organisation's culture and impacts patient perceptions along the entire continuum of care (Oben, 2020). In their study, Wolf et al. (2021) aimed to enhance the existing definition of patient experience. They determined that a comprehensive understanding of the patient experience should drive the implementation of tailored services that address patient requirements while including patients as active participants in their treatment (Krist et al., 2017). Building on a conceptual framework developed by McCormack and McCance (2006) and the dimensions outlined by Mead and Bower (2000), (Cooper et al. (2023) have developed a comprehensive conceptual framework that aims to explain the shift towards Person-Centred Care (Figure 5). The diagram illustrates the transition from the biological model to patient-centred care (PCC), emphasising four critical aspects of this transformation: context, process, roles, and outcomes. In the subsequent sections, we will delve into a comprehensive analysis of these characteristics.

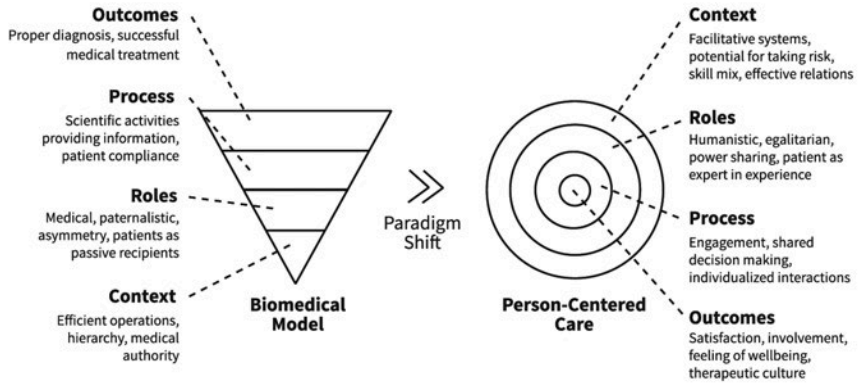

Figure 5 The paradigm shift toward person-centred care (Malmberg et al., 2019).

Contexts and settings

The approach above encompasses both the environment in which individuals encounter health and illness and the setting in which care is provided. This biopsychosocial view posits that the determinants of illness extend beyond purely biomedical considerations. From this particular standpoint, it is evident that instances of disease do not consistently correlate with physical ailments, as the causes and interpretations of illnesses might be attributed to psychological and sociological factors (Malmberg et al., 2019). Although the biological model provides insights into specific dimensions of sickness, it is imperative to comprehensively address the holistic knowledge of an individual's illness experience within their daily existence. Individuals afflicted with identical ailments may exhibit varying responses and levels of functionality within comparable circumstances (Pfannstiel et al., 2022). Examining the subjective significance of illness and other aspects of an individual's life deepens our understanding of how disease impacts different people, placing these experiences within a broader framework. This framework includes the setting in which healthcare is delivered and involves a combination of skills, effective interpersonal connections among staff, supportive organizational processes, and the ability to foster innovation and embrace calculated risks (Malmberg et al., 2019).

Roles

PCC proposes an interaction between medical workers and patients characterised by humanistic values and equitable principles. Power and responsibility sharing depart from the traditional paternalistic perspective on the patient's role and relationship with healthcare practitioners (Kwame & Petrucka, 2021). Conversely, the significance of the patient's non-professional understanding and personal encounter with their ailment is underscored as being of equal importance to the proficiency of healthcare professionals. Therefore, throughout the shift towards a patient-centric approach, the patient transforms from a passive recipient to an engaged participant and potential evaluator (Kwame & Petrucka, 2021). The current power dynamics are transforming, creating a more equitable dynamic between patients and healthcare providers. This transition enables the incorporation of patients' "voice of life response" alongside the traditionally dominant "voice of medicine" (Malmberg et al., 2019).

The shift away from the biomedically-focused notion of care also raises enquiries regarding the function of healthcare professionals. Within the framework of the biomedical model, the physician operates objectively by employing therapeutic and diagnostic tools. On the other hand, the concept of patient-centeredness inevitably implies the incorporation of subjective evaluations (Gartner et al., 2022). The physician, nurse, and other medical professionals serve as vehicles for providing optimal treatment rather than just executors of ubiquitous practical solutions. The concept of person-centeredness mandates that medical personnel need to also possess a high level of professional competence to cultivate essential interpersonal skills and demonstrate unwavering dedication to their vocation (Malmberg et al., 2019).

Nevertheless, opening up the potential for more subjectivity can have advantageous and disadvantageous effects on the connection between patients and healthcare professionals. Adopting a patient-centred care (PCC) approach necessitates the establishment of a therapeutic alliance rooted in shared values and beliefs, which is crucial for fostering effective interactions between patients and healthcare professionals (Kwame & Petrucka, 2021 This alliance involves not only the interpersonal connection between the patient and provider but also the patient's trust in the provider's compassion, empathy, and attentiveness, as well as the confidence that the interventions align with their treatment goals and are effective (Hallgren et al., 2021).

Process

Historically, the diagnosis and treatment of medical conditions have been regarded as matters of decision-making and procedural responsibility primarily held by healthcare professionals. The primary emphasis under the biomedical model lies in patient adherence. PCC is the collaboration between healthcare workers and patients to identify and understand the patient's beliefs, values, and needs. This process aims to establish a comprehensive understanding of the patient's priorities and assist them in comprehending their current circumstances (Abdulrahman Mohammed Al et al., 2018). This is also related to shared decision-making, in which healthcare professionals can engage patients by offering pertinent information and incorporating newly formed perspectives into their existing approach. The implementation of PCC is contingent upon medical practitioners' participation, which according to Philpot et al. (2019) can range from active involvement to disinterest.

Outcomes

The biomedical model places significant focus on biological results within its framework. In this context, medical professionals prioritise the treatment of patients to eliminate a particular disease. The attainment of an accurate diagnosis and the effective implementation of medical interventions are crucial determinants of favourable results. In the process of shifting towards person-centred care, there is a shift towards considering broader and potentially more subjective outcomes (Abdulrahman Mohammed Al et al., 2018). The emphasis transitions focus from eradicating the illness to promoting the well-being of patients. Patient happiness and the extent of patient and carer engagement in their healthcare are significant indicators of Person-Centred Care. In addition to individual achievements, PCC attempts to achieve broader outcomes, including establishing a therapeutic culture.

3.7 Alignment Between Person-Centered Care and Service Design

Drawing upon the previously discussed model of the paradigm shift towards person-centred care (Figure 5) and its sustainable development (Van Der Veen, 2023), there are several key areas of alignment and convergence identified between the principles and methods of person-centred care (PCC) and service design (SD) (Malmberg et al., 2019). Recognising the connection between SD and PCC is important in understanding why SD is a suitable facilitator and catalyst for the transition towards PCC. The four themes identified in the analysis below demonstrate a commonality between PCC and SD, suggesting they might be considered fundamental to both systems (Pfannstiel et al., 2022).

Expert of One's Own Life and a Holistic Mindset

This initial theme and subsequent themes are closely related to the contextual element within the Patient-Centred Care (PCC) paradigm. The idea that patients' perceptions of illness can differ due to factors beyond just symptoms is consistent with the SD theory, which asserts that individuals have valuable expertise regarding their own lives and personal experiences. In this context, 'expertise' refers to the deep, personal knowledge and understanding individuals have about their own health and well-being, gained through their unique experiences and self-awareness. In the context of service design, it is essential to consider and comprehend the user's needs, desires, and motivations, together with the necessary knowledge, to create a solution that holds significant value (Kelly et al., 2022). SD emphasises the expertise of every person by considering the individual as the initial

point of reference. In most systems development processes, a significant portion of the first efforts is dedicated to comprehending the requirements and motivations of the user within a broader system. Likewise, within the framework of Person-Centred Care, it is imperative for the carer to actively engage in attentive listening to the patient's narrative and gain a comprehensive understanding of their unique experiences. This approach acknowledges the patient as the primary authority in their own lives.

Understanding that both pathological symptoms and other factors shape a patient's perception of illness requires a broad and inclusive perspective on the disease and its management. Embracing such a comprehensive viewpoint is essential for identifying potential improvements and fostering sustainable development. To fully grasp service utilization, it's important to develop a thorough understanding of the factors and needs that impact a user's experience throughout their service journey (Pfannstiel et al., 2022). The application of the Service Design (SD) approach involves participants in the design process aiming to get insight into the user's experiences both before and during the utilisation of a service. As a result, the focus is on more than just the service situation itself (Ramos et al., 2020).

Co-creation of Value

According to Malmberg et al. (2019) the PCC models emphasise that achieving a person-centred outcome is contingent upon a collaborative process involving the patient and healthcare workers. According to Østbye et al. (2018), patient-centred care can be characterised as a form of "two-person medicine" in which the doctor and the patient continually influence one another and cannot be regarded as separate entities. The co-creation of value in healthcare occurs through the collaborative efforts of the clinician and the patient. This concept should be broadened to encompass the physician and the patient, the complete care team, and the network of family and friends associated with the patients (Fusco et al., 2023; Teisberg et al., 2020).

Co-creation holds significant importance in service design management and sustainable development. The generation of value is acknowledged to occur through the relationship between the provider of a service and the recipient, as well as through utilising the service within a particular environment and goes beyond joint decision making as mentioned earlier. This concept has been supported by various scholars, including Fusco et al. (2023), Philpot et al. (2019) and Vargas et al. (2022). Value production is central to Service Design and may mean different things to the service provider, service recipient, and their respective contexts, as these elements collectively contribute to the value of the co-creation process. Hence, it is imperative to comprehensively understand the viewpoints of all relevant stakeholders, including service users, frontline employees, and other supporting actors, to design a service that facilitates value co-creation effectively.

In summary, the operationalisation of PCC involves incorporating patients' views and values as a basis for decision-making (Vargas et al., 2022). This statement aligns with the notion that a service design team invests significant time and effort in understanding users' and service providers' needs and motivations. This acquired knowledge facilitates the development of comprehension regarding the circumstance at hand and the identification of viable avenues for implementing solutions (Malmberg et al., 2019).

A Shift in Power

Patient-centred care (PCC) entails a transformative dynamic involving a redistribution of power and the emergence of novel roles for healthcare professionals and patients alike. From a patient-centric standpoint, it is imperative to refrain from perceiving the patient solely as a consumer of healthcare services but as a collaborator and an individual of equal importance (Aschmann et al., 2020). In the realm of design, the emergence of user-centred design and co-creative methodologies

has resulted in a parallel transformation of the roles and power dynamics among designers, users, and service providers. Including diverse stakeholders in the design process through co-creative methods has transformed the designer's position and reconfigured stakeholder power dynamics (Petkovic et al., 2020). According to Nakarada-Kordic et al. (2020), in co-creative processes, the designer's role has shifted from being an authoritative expert who provides solutions to becoming a facilitator who takes stakeholders through the design process and ensures that diverse perspectives are acknowledged and considered. In this model the primary responsibility of a designer is to gather, attentively consider, and integrate diverse viewpoints to facilitate the creative endeavours of non-designers and steer the many inputs towards a valuable and effective solution (Philpot et al., 2019).

This human-centric approach plays a crucial role in sustainable development. As a result, service designers have devised several tools and methodologies to enhance the engagement of diverse stakeholders in the design process. The utilisation of co-design and more broadly co-creative approaches and processes in sustainable development endeavours aims to engage actively and include diverse stakeholders, hence facilitating the expression and incorporation of their unique viewpoints and views. This encompasses stakeholders who typically require increased empowerment in service improvement (Vink et al. 2018). If engaged with meaningfully these outcomes can have a significant impact. Collaborative practices in sustainable development can foster a shared comprehension of value generation among many stakeholders, encompassing different roles. Interestingly the involvement of a coach and the experience of being coached in SD procedures have demonstrated the ability to modify stakeholders' mindsets, and enhance their recognition of patients' knowledge (Boström, 2020).

Focus on Needs, Not Only Solutions

The shift from a biomedical perspective to the person-centred care (PCC) perspective entails a transition in emphasis from eradicating disease to promoting patient well-being. Therefore, the desired results in PCC have a broader scope than those in the conventional biological approach (Kwame & Petrucka, 2021). This observation highlights the necessity of adopting a comprehensive perspective, wherein the resolution does not solely entail the most direct course of action, such as the complete elimination of the ailment. This aligns with the methodology employed in SD, wherein the pursuit of a predetermined solution to a problem does not necessarily dictate the trajectory of the progress (Shaw et al., 2018). The primary emphasis often lies in enhancing existing systems and processes in conventional quality enhancement and administration methodologies. Hence, the initial answer may remain uncertain and can undergo modifications that deviate from the original conception (Malmberg et al., 2019)

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3.8 Activating the Transformation to Person-Centered Care through Service Design

As previously mentioned, the correlation between person-centred care (PCC) and service design (SD) is a fundamental basis for justifying SD as a suitable catalyst for the paradigm shift towards PCC. The transformative approach of SD provides healthcare with many strategies and instruments that can facilitate the move towards Person-Centred Care (PCC) (Van Der Veen, 2023). These can be grouped across four key dimensions: settings, roles, processes, and results. Table number 1 provides a comprehensive overview of the alignment of transitions facilitated by SD.

To facilitate the broader transition towards person-centred care (PCC), SD presents a methodology that stimulates contextual transformation. According to Kurtmollaiev et al. (2018) existing research indicates that SD can facilitate transformations in organisations' fundamental reasoning processes. Rodrigues and Vink (2016) argue that Service Design (SD) can influence the social frameworks within the healthcare environment. They suggest that engaging with SD processes and receiving coaching can encourage stakeholders to shift their perspectives and improve their ability to recognize and value the expertise of patients, particularly in the context PCC. According to Krist et al. (2017), service walk-throughs provide a thorough method for understanding and implementing services. These techniques help stakeholders gain a complete view of a service and can positively impact the current service environment.

According to Malmberg et al. (2019), there is a correlation between SD processes and the transformation of organisational functions. As previously stated, implementing patient-centred care (PCC) requires a fundamental change in the traditional roles of physicians as authoritative figures and patients as passive recipients. Instead, patients are empowered as experts in their own lives and experiences (Abdulrahman Mohammed Al et al., 2018). Lumivalo et al. (2024) assert that various SD methodologies can assist stakeholders in delineating the current roles within a service system and proposing alternative future roles. According to Park and Choo (2022) stakeholder maps serve as a visual tool for actors to depict the current roles and relationships of associated actors, facilitating the process of reflection.

Dimensions of PCC	Context	Roles	Process	Outcomes
Alignment between PCC and SD	User expertise and holistic mindset	Shift in power	Co-creation of value	Focus on needs
Transition catalyzed by SD	Institutional and structural change (Kurtmollaiev et al. 2018; Rodrigues & Vink, 2016)	Role change (Overkamp & Homlid, 2017; Peltonen, 2017)	Change in habits and routines (Welter-Edman et al. 2018)	Change outcomes and experience (Trischler, Pervan, Kelly, & Scot, 2017; Zomerdijk & Voss, 2010)
Supportive methods (examples)	Coaching, service walkthroughs	Role-play, stakeholder maps, co-design sessions	Contextual interviews, co-design dessions	Co-design sessions, service blueprints
Facilitator	Design capability (Malmberg, 2017)			

Table 1 SD methods to support the four dimensions of the transformation (Malmberg et al., 2019)

There is an acknowledgement of the necessity to modify existing procedures to facilitate increased involvement and collaborative decision-making in the transition towards person-centred care (McCormack & McCance, 2006). This necessitates modifying the behaviours and routines of the individuals engaged to facilitate enhanced the value of co-creation.

Another method for gaining new insights into patient care is through contextual interviews, commonly employed in Service Design. This approach combines observation with questioning to gather valuable information (Trischler et al., 2017). By engaging primary healthcare personnel in these interviews, they can view patients from a fresh perspective, challenging their existing assumptions and facilitating the exploration of alternative methods for co-creating value with patients (Nakarada-Kordic et al., 2020).

Lastly, the application of SD can also contribute to improving service user experiences. While PCC emphasizes the importance of enhancing outcomes such as choice, previous research acknowledges that service design processes can also play a significant role in improving user experiences and promote more participation (Cooper et al., 2023). Using co-design sessions, as Trischler et al. (2017) suggested service design can potentially enhance the value of service concepts for end users, particularly in healthcare when patients are involved. Service design procedures can contribute to achieving patient-centred care (PCC) by actively involving end users to gain a deeper understanding of their needs and mapping out their journey and supporting processes.

It is suggested that to effectively implement and sustain these changes, healthcare organisations must develop design competency. This entails acquiring the necessary skills and knowledge to employ the SD approach effectively and utilising the associated methodologies and tools. For a healthcare organisation to effectively employ SD as a catalyst for the transformation to PCC, it must comprehensively understand SD and its potential contributions in addressing contextual shifts, role modifications, procedural adjustments, and results. The design capability of an organisation, which refers to its ability to utilise service design (SD) effectively, is influenced by its access to design resources. As demonstrated by previous research, these resources include individuals with service design competence. These competent individuals can apply and facilitate SD methods and tools, thereby supporting the necessary understanding and development for person-centred care (PCC) (Aschmann et al., 2020; Pfannstiel et al., 2022).

The development of design resources inside healthcare organisations can be achieved through many approaches, such as procuring service design consultants, recruiting individuals with service design competence, or training current workers in service design (Malmberg et al, 2019). An imperative component of a healthcare organisation's design capabilities involves cultivating a culture and establishing structures that facilitate the use of SD (Caulliraux & Meiriño, 2015). The anticipated modifications resulting from the transition to PCC will not be accomplished through a limited number of service design initiatives. Therefore, for service design to effectively drive patient-centred care (PCC), Healthcare companies must develop strategies to integrate sustainable development into their portfolio and ensure its seamless incorporation across the entire organization (Malmberg et al., 2019; Waring et al., 2014a). Frequently, the task necessitates the establishment of frameworks that facilitate the allocation of time for comprehending the problem at hand and the underlying incentives of various stakeholders. Additionally, it entails the implementation of support methodologies that actively engage users in the process.

3.9 Participatory Design and Design Thinking in Health

The literature has documented research on participatory design since the 1960s and 1970s. The origins of participatory design (PD) are widely recognized as rooted in the Scandinavian workplace democracy movements of the 1960s and 1970s, particularly through pioneering projects that foregrounded democratic participation and worker empowerment in technology development. Contemporary scholarship, such as Simonsen and Robertson's Routledge International Handbook of Participatory Design (2013), provides a comprehensive overview of these foundational efforts and their enduring influence on current PD practices. Bannon (2011) and Bødker (2006) further analyze how the principles established during this formative period—such as the prioritization of skill enhancement and the democratization of technological change—continue to shape participatory methodologies across diverse domains, including healthcare.

The utilisation of Participatory Design (PD) is becoming more prevalent within public health domains as healthcare systems and policymakers grapple with the challenges posed by a growing elderly population, a rise in the prevalence of chronic illnesses, and the spread of communicable disease (Harper & Mustafee, 2023). The obstacles above also necessitate novel approaches to incentivise individuals as well as organisations to modify their behaviour, which demands the collaborative efforts of experts in behavioural science, medicine, and design (Nilsen et al., 2020).

Design and service design often prioritize innovative concepts to address unmet needs, while public health tends to value established approaches backed by rigorous examination. This creates a tension between the emphasis on novel solutions and the importance of proven methods. Légaré et al. (2018) highlight the need for further research into the implementation and design of new healthcare interventions. Despite this, design remains crucial in developing new solutions to tackle the complex and persistent public health issues faced by society (O'Cathain et al., 2019). Ethical considerations naturally emerge when influencing behaviour, as such efforts may encroach upon individuals' rights, autonomy, or responsibilities, leading to the crucial issue of who holds the authority to determine what is considered appropriate action (N. J. Brown et al., 2021)

One potential approach to addressing concerns is to incorporate the participation of individuals whose behaviour is the focus of the intervention in the design process. This allows for validating the relevance and applicability of approach within the specific local context (Constantin et al., 2021). To accomplish this, public health researchers are progressively engaging in partnerships with PD researchers, as highlighted by Holetzek and Holmberg (2022). Integrating participatory design (PD) within the development of interventions allows for the alignment of insights derived from previous evidence with the input provided by those who have personal knowledge of the matter (Harper & Mustafee, 2023). Nevertheless, it is imperative to consider the incorporation of empirical data and theoretical frameworks as inputs to professional development, as well as the documentation and evaluation of the evidence generated, in conjunction with other kinds of knowledge (Collins et al., 2018).

Participatory design (PD) is founded on the principles of active and democratised involvement of users in the design process. While assumptions based on their past knowledge might be recognized, the concept of mutual learning and future thinking is essential, as discussed by Vandekerckhove et al. (2021). Through the active involvement of users and stakeholders who possess expertise in their respective knowledge and experience domains (Petkovic et al., 2020), it becomes possible to obtain genuine insights into their specific settings and issues. This collaborative approach facilitates sharing these understandings and empowers individuals to assume a central position in the design process (Barker Scott & Manning, 2024).

Additionally, design/service interventions created through participatory design (PD) may only be easily transferrable to some contexts (Poot et al., 2023). Nevertheless, public health interventions are designed to affect a larger scale, specifically the population. Therefore, it is necessary to comprehend the connection between the perspectives of local participants in public health programmes and the broader body of data and the potential need for localisation strategies (Vargas et al., 2022).

Design thinking

Using the design-thinking methodology in problem-solving presents a viable strategy for addressing the disparity between assessing patient experience and implementing interventions to enhance it (Smiechowski et al., 2021). The design-thinking technique employs a comprehensive range of innovative approaches inside a framework centred around human-centred design principles (Sanders et al., 2010). This strategic approach has enabled other industries, by intense competition and rapid evolution, outside the healthcare sector to continually provide practical and marketable solutions that effectively satisfy consumer expectations and enhance the overall customer experience. However, its potential for improving healthcare delivery through integrating innovative, transdisciplinary, and patient-centric approaches has only lately been acknowledged (Pfannstiel & Rasche, 2019). Numerous notable instances exist where the design-thinking approach has been effectively employed to address healthcare challenges, as evidenced by several research studies showcasing its superiority compared to conventional problem-solving interventions (Abookire et al., 2020).

The design-thinking method places significant emphasis on cultivating a profound sense of empathy towards the aspirations, experiences, and challenges of end-users. This empathetic understanding is crucial in acquiring an informed understanding of an issue, which can serve as a foundation for developing inventive strategies to address identified unmet needs.

Once the identification and comprehension of these needs has taken place, a collaborative interdisciplinary team usually initiates a process of ideation or prototyping to assist in creating solutions that can be tested. These designs may undergo multiple iterations of feedback. A commonly used process model for illustrating this progression is the Design Council's Double Diamond design process model, which was employed in the present study (Banbury et al., 2021) (Figure 5).

Principles in Participatory Design

In their study, Hamzah and Wahid (2016) identified several significant concepts that should be taken into account by healthcare designers and management teams throughout the implementation of participatory design approaches.

Initially, it is important to carefully contemplate the interplay and dynamics among the various individuals involved. They may connect to the hospital as internal members or external entities (Ferguson & Bibby, 2012). The nature of their relationship might vary, ranging from formal structures characterised by professional hierarchies to informal dynamics influenced by personal preferences. This matter should be considered when assembling a representative team. A growing consensus is that both healthcare professionals and patients should play a more significant role in the design process (van der Velden & Mörtberg, 2015). This can include patients' family members or support community (Neuhauser, 2017). Consideration needs to be made on availability of both service providers and patients as involvement may sometimes be limited due to various causes, notably among the older population or work commitments for professional healthcare staff.

It also important to acknowledge that various demographic groups may exhibit distinct habits, interests, or cultural backgrounds. Acknowledging and upholding the many ideas held by the individuals engaged in each situation is imperative if equity, diversity and inclusion policies are to be followed. Patients' perspectives may diverge from those of healthcare professionals or carers (Caulliraux & Meiriño, 2015). Moreover, medical professionals may be more familiar with offering input on fully developed solutions instead of prototypes with limited functionality. Additionally, they may have developed a personal connection with an existing system or way of doing something (Légaré et al., 2018). The preferences of older people and youngsters about how they are approached to interact, and how comfortable they are with change may also vary (Raine et al., 2016).

Acknowledgement should be given that co-created new interventions must live in complex systems that can be subject to varying and contradictory interpretations. For example, healthcare professionals may fulfil many tasks, such as practitioners, educators in academic institutions, or administrators in healthcare facilities, each of which may require distinct professional frameworks and roles. It is vital to consider the organisational culture equally, including professional values, already within the system (van der Velden & Mörtberg, 2015).

Participatory Design activities should ideally engage users starting from the initial stages of the design phase if possible. The significance of this aspect lies in its ability to allow the team to assess the level of urgency and intricacy associated with the emerging system and to help make sure that the right problem is being addressed in the correct way (Inan et al., 2020). To do this, facilitators must understand and have experience in how to apply a range of Participatory Design methods and tools for facilitating user engagement in the design process in conjunction with traditional methodologies such as interviews, observation, and workshops. Participatory Design facilitators should, if possible, possess a knowledge of the language of their participants to effectively communicate throughout the development process. This includes specialised terminology, community terms, and acronyms (Baas et al., 2014). An understanding of familiar terms among different participants is important, as failure to address this can affect their level of participation (Lindberg, 2013).

As indicated above, when applying Participatory Design (PD) principles in the context of healthcare, there are several considerations specific to the unique challenges and intricacies of this domain (Hamzah & Wahid, 2016). Based on Hamzah & Wahid, 2016 review a synthesis of current literature, and the researcher's reflections and practice, the following interconnected considerations emerge when applying Participatory Design (PD) principles within healthcare contexts. These considerations represent a complex, interdependent framework that informs effective participatory design for health:

Patient-Centred Care: Recognizing patients as experts in their own health experiences, the principle of patient-centred care emphasizes active involvement in the design process. This approach ensures that healthcare solutions resonate with patient preferences and priorities.

Collaborative Healthcare Teams: Fostering interdisciplinary collaboration is key to understanding the complexity of healthcare challenges. By including diverse perspectives from healthcare professionals, patients, and caregivers, participatory design promotes holistic solutions (Ferguson & Bibby, 2012).

Ethical Considerations: Prioritizing patient privacy and data security is integral to ethical participatory design in healthcare. Solutions must adhere to ethical standards and legal regulations to safeguard patient confidentiality and integrity.

Accessibility and Inclusivity: Considering diverse user abilities is paramount in designing healthcare solutions. The principle of accessibility ensures that technologies and interventions are inclusive, catering to individuals with varying physical, cognitive, and sensory abilities (van der Velden & Mörtberg, 2015).

Cultural Sensitivity: Acknowledging and addressing cultural differences in healthcare practices and beliefs is crucial. Culturally sensitive solutions enhance patient engagement by respecting diverse backgrounds and values (Neuhauser, 2017).

Health Literacy: Promoting health literacy involves presenting information in clear and understandable language. By empowering patients with the knowledge to make informed decisions, participatory design supports active patient involvement in their healthcare (Neuhauser, 2017).

Coordinated Care: Facilitating the integration of healthcare services and information ensures seamless communication and coordination among healthcare providers. This principle aims to reduce fragmentation and enhance the overall patient experience.

Community Involvement: Extending participation beyond individual patients, community involvement recognizes the importance of local perspectives. Involving communities in the design process ensures healthcare services are relevant and responsive to the specific needs of the population (Harper & Mustafee, 2023).

Support for Caregivers: Empowering caregivers is vital in the healthcare ecosystem. Solutions should provide tools and resources to support caregivers in their roles, acknowledging their significant contribution to patient care.

Iterative Patient Feedback: Establishing mechanisms for continuous patient feedback is integral to the participatory design process. By involving patients throughout, the design can iteratively improve based on real-time insights, needs, and challenges (Deininger et al., 2019).

Technology Integration: Designing user-friendly interfaces and tools is essential for seamless technology integration into healthcare workflows. Technology should enhance, not hinder, the patient and provider experience (Pathak et al., 2021).

Shared Decision-Making: Facilitating shared decision-making between healthcare providers and patients encourages collaboration. Solutions should support discussions that enable patients to actively participate in decisions about their healthcare plans.

Resilience and Adaptability: Acknowledging the dynamic nature of healthcare, solutions should be resilient and adaptable. This principle ensures that designs can evolve to meet changing circumstances, such as health conditions, medical knowledge, and healthcare policies (Krist et al., 2017).

Applying these principles in participatory healthcare design can contribute to the development of patient-centred, culturally sensitive, and technologically appropriate solutions that address the complex

challenges within the healthcare landscape. By actively involving all stakeholders, including patients, healthcare professionals, and communities, Participatory Design can lead to more effective, accessible, and equitable healthcare services and system.

3.10 Human-Centered Design

Although end user engagement will often still exist, HCD is more heavily framed on the skill sets of the design / research team and precedent knowledge.

While participants may not always play a central role in human-centered design, this approach remains highly effective in addressing contemporary care challenges through its focus on human needs and creativity. Human-centred design still involves comprehending the requirements of individuals and how design may effectively address and accommodate these needs but this understanding may not necessarily be framed around end user engagement along the course of the process (Melles et al., 2021).

The discipline of Human-Centered Design (HCD) is closely associated with Human Factors (HF), and both names are frequently utilised interchangeably (Dul et al., 2012). Moreover, it is worth noting that several design disciplines exist that closely or more flexibly align with ideas and methodologies of human-centred design (HCD), albeit without explicitly adopting the HCD label. These disciplines include user-centred design, design thinking, service design, experience-based design, and participatory systems approach to design (Melles et al., 2021). In Human-Centered Design (HCD), like other design disciplines that employ HCD concepts, designers largely depend on the tools, methods, and insights derived from the Human Factors (HF) discipline. This reliance is exemplified by the definition of HCD provided by the International Standards Organisation (ISO): Human-centred design (HCD) is a methodology employed in developing interactive systems to enhance usability and utility. This approach emphasises users' specific wants and requirements by incorporating principles from human factors/ergonomics, usability expertise, and associated methodologies. The HCD methodology aims to increases a system's efficacy and efficiency, enhance welfare, improve user contentment, accessibility, and sustainability, and mitigate potential negative impacts on human health, safety, and performance (Lindberg, 2013). The emergence of Human-Centered Design (HCD) and Human Factors (HF) may be traced back to the post-World War II era, during which they were recognised as methods to enhance the effectiveness of industrial manufacturing through tailoring tasks to suit the capabilities of workers. Subsequently, the emphasis has shifted from users' physical and cognitive attributes to encompass their organisational, social, and emotional requirements and enjoyable encounters (Dul et al., 2012; Van Der Bijl-Brouwer & Dorst, 2017). Numerous healthcare companies acknowledge the imperative of adopting a human-centred approach in addressing the prevailing care difficulties of the present era. Human-centred design (HCD) is becoming more widely acknowledged as a significant asset in tackling the intricate healthcare concerns of our day. Weatherly and Reay (2022) effectively articulate the significance of human-centred design (HCD) in redesigning healthcare to align with individuals' needs. They emphasise the crucial aspect of redirecting our attention from accommodating individuals within the existing care delivery system to designing a care delivery system that aligns with individuals' lifestyles, encompassing their residential, occupational, educational, recreational, and healthcare environments. Nevertheless, despite the growing adoption of Human-Centered Design (HCD) in healthcare, a dearth of literature discusses the specific components and processes involved in applying an HCD approach to digital health and healthcare treatments (Baas et al., 2014).

Similar to participatory design approaches, HCD adopts three key principles in considering sociotechnical care systems. First, it is important to develop a comprehensive understanding of individuals and their needs (Tsekleves & Cooper, 2017). Second, stakeholders should be involved in the design process. Last, a systems approach should be adopted, which involves addressing the interactions between different elements of sociotechnical care systems.

3.11 Exploring the Participatory Design vs. Human-Centered Design

Design methodologies play a pivotal role in shaping the development of products, services, and systems to meet the needs of users effectively. Two prominent approaches, Participatory Design (PD) and Human-Centered Design (HCD), share the common thread of involving end-users in the design process. However, a closer examination reveals nuanced differences that impact their application and outcomes.

Participatory Design

Participatory Design is rooted in democratic principles, emphasizing the importance of involving end-users in the decision-making process from the outset. The philosophy behind PD is one of co-creation, recognizing that those who will be impacted by a design should have an active role in shaping it. In the realm of Participatory Design, collaboration extends beyond user interfaces to encompass broader organizational and social aspects.

In PD, a diverse range of stakeholders, including end-users, designers, and other relevant parties, come together as equals. This collaborative approach fosters a sense of ownership and empowerment among users, leading to solutions that resonate with their unique perspectives and requirements. By involving the broader community, Participatory Design strives for inclusivity and addresses not only immediate usability concerns but also wider societal implications (Harper & Mustafee, 2023; Holetzek & Holmberg, 2022).

Human-Centered Design

Human-Centered Design, on the other hand, takes a comprehensive approach that places emphasis on understanding users, their needs, and the entire context of product or system usage. While users are actively involved throughout the design process, the degree and nature of their involvement may vary at different stages. HCD incorporates iterative cycles of prototyping and testing, ensuring that the end product aligns with users' evolving expectations (IDEO, 2015).

HCD goes beyond the immediate involvement of users in decision-making; it seeks to create solutions that not only meet functional requirements but also cater to the emotional and experiential aspects of user interactions. The approach is characterized by empathy, as designers strive to put themselves in the users' shoes, gaining insights into their motivations, frustrations, and aspirations. Human-Centered Design aims for holistic user satisfaction, acknowledging that successful designs extend beyond mere usability (Melles et al., 2021).

Comparative Analysis

While both Participatory Design and Human-Centered Design involve user participation and collaboration, their differences lie in their underlying philosophies, scopes of involvement, and the timeline of user engagement. Participatory Design, with its democratic ideals, is characterized by early and continuous user involvement, often extending beyond individual users to encompass communities or organizations. In contrast, Human-Centered Design offers a more flexible approach, with user engagement occurring throughout the design process but with varying levels of intensity (Qureshi & Wong, 2019).

3.12 Critical characteristics of design led practices in healthcare

As noted, both Participatory Design (PD) and Human-centred design (HCD) strongly emphasise identifying and understanding human needs and explores how design can effectively address and meet these requirements. Before initiating the development of an intervention, it is necessary to possess a comprehensive understanding of individuals, encompassing their cognitive processes, behavioural patterns, and susceptibility to external influences, particularly within their sociotechnical system. In the HCD Toolkit developed by IDEO, a prominent design organisation based in the United States, it is said that Human-Centred Design involves thoroughly examining the requirements and behaviours of the individuals impacted by the proposed solutions (Design Council, 2024).

The HCD designer initiates the process by critically examining the problem. They broaden the scope of the problem, engaging in a divergent approach to thoroughly investigate the foundational concerns that underpin it. Subsequently, the individuals come together to reach a consensus on a particular issue or challenge that needs attention (Melles et al., 2021). The acquisition of knowledge about users and their contextual factors is utilised to formulate appropriate solutions. The essence of discovery lies in comprehending the problem through a process of understanding rather than relying on mere assumptions.

Figure 6 illustrates the Double Diamond Model, a widely used framework for the Human-Centered Design (HCD) process. It was established in 2004 by the British Design Council and has since been widely utilised and modified by other designers. The double-phased model emphasises the fundamental idea of Human-Centered Design (HCD): initially identifying the appropriate problem and addressing human needs through design. The diamond structure highlights the design process's distinct phases, encompassing divergent and convergent thinking Fields (IDEO, 2015). Divergent thinking pertains to exploring an issue broadly, while convergent thinking involves the deliberate and focused decision-making and implementation of solutions (Niburski et al., 2020). The model has since been updated to recognise the roles of leadership, engagement, methods and principles that may also be considered within a Participatory Design model.

The HCD designer initiates the process by critically examining the problem. They broaden the scope of the problem, engaging in a divergent approach to thoroughly investigate the foundational concerns that underpin it. Subsequently, the individuals come together to reach a consensus on a particular issue or challenge that needs attention (Norman, 2013). The acquisition of knowledge about users and their contextual factors is utilised to formulate appropriate solutions. The essence of discovery lies in comprehending the problem through a process of understanding rather than relying on mere assumptions.

The Double Diamond Model, depicted in Figure 5, is a commonly employed depiction of the Human-Centered Design (HCD) process. It was established in 2004 by the British Design Council and has since been widely utilised and modified by other designers. The double-phased model emphasises the fundamental idea of Human-Centered Design (HCD): initially identifying the appropriate problem and addressing human needs through design. The diamond structure highlights the design process's distinct phases, encompassing divergent and convergent thinking Fields (IDEO, 2015). Divergent thinking pertains to exploring an issue broadly, while convergent thinking involves the deliberate and focused decision-making and implementation of solutions. The initial diamond is commonly denoted as the problem space, while the subsequent diamond is the solution space. These names originate from the design thinking methodology, strongly associated with the Human-Centered Design (HCD) (Niburski et al., 2020). The model has since been updated to recognise the roles of leadership, engagement, methods and principles that may also be considered within a Participatory Design model.

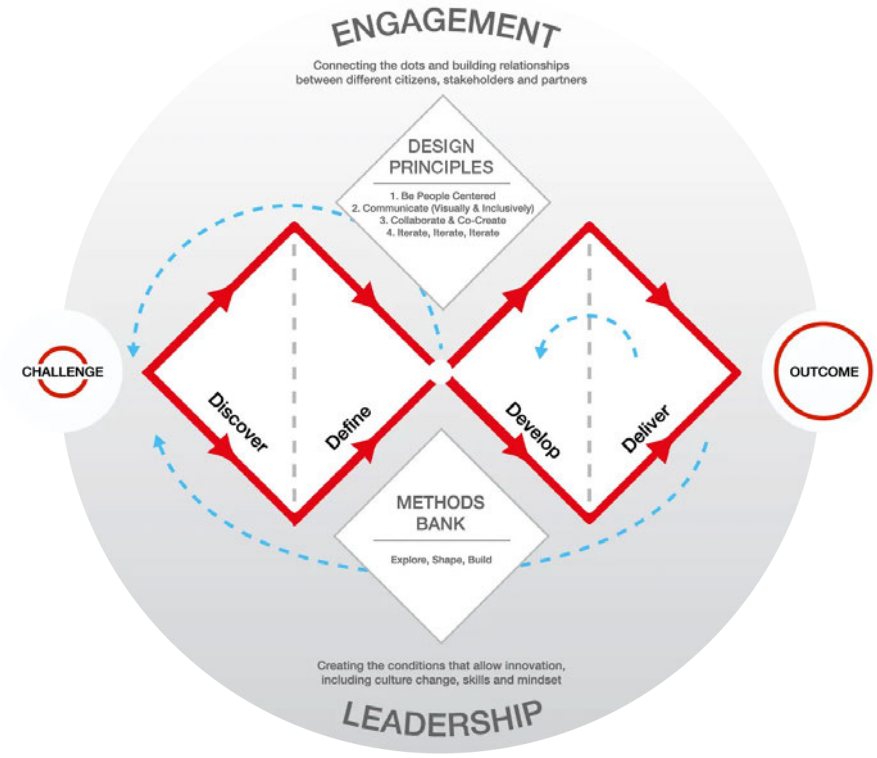


Figure 6 British Design Council Double Diamond diagram (Framework for Innovation - Design Council, 2024)

The initial diamond symbolises the process of divergence and convergence, which is employed to understand the problem. The initial phase of the second diamond, known as "Develop," entails exploring many solutions inside the solution space. Designers are encouraged to seek inspiration from external sources and co-design with diverse stakeholders to generate multiple potential responses to the identified problem. The delivery process entails doing small-scale user testing on alternative solutions, eliminating ineffective ones, and enhancing those demonstrating efficacy (Banbury et al., 2021). The four processes, namely discover, define, create, and deliver, are subject to iteration and are repeatedly performed cyclically. Each iteration of these activities leads to the acquisition of further insights and brings the solution closer to the desired outcome (Banbury et al., 2021).

Stakeholder Engagement in Patient-centered Interventions

Typically, designers are charged with creating interventions, such as goods, services, and strategies, that are accessible and usable by individuals with skills and experiences that the designer must effectively understand. This statement holds special validity for designers operating within the healthcare sector, when focusing on treatments and service interventions that can impact patients and medical practitioners (Aschmann et al., 2020). Acquiring a well-informed understanding of the physical and mental attributes of users, as well as their wants, behaviours, and in the sociotechnical environment in which medical professionals operate, or patients navigate, is crucial in the development of enduringly functional and worthwhile products (Hardy et al., 2018). According to Lievesley et al. (2022), to understand human behaviour comprehensively the fundamental values and motives that drive individuals must be examined within their real-life circumstances. This can be achieved by incorporating the actual user representatives in the design process and engage with other relevant stakeholders throughout the human-centred design (HCD) process. The discipline of human-centred design (HCD) offers a wide range of tools and methodologies that facilitate stakeholders' active participation and engagement (Currie et al., 2022).

Moreover, preliminary investigations have indicated that the active involvement of stakeholders as research partners has influenced both study protocols and the rates at which participants are enrolled in the study. The participation of stakeholder partners has significantly impacted the acceptability, practicality, rigour, and relevance of the investigations (Petkovic et al., 2020).

Over the past few years, significant changes have been observed in the strategic planning, implementation, dissemination, and assessment of healthcare research. There is a growing expectation to include stakeholders, whether individuals or groups, involved in or impacted by health- and healthcare-related choices, programmes, or policies (Petkovic et al., 2020). These service-user stakeholders are now seen as crucial in the various stages of healthcare research, including planning, implementation, communication, adoption, and assessment. Multiple organisations, such as the World Health Organisation (WHO) and the National Institute for Health and Care Excellence (NICE), recommend stakeholder involvement should be ensured throughout the entirety of the guideline creation process and advocate for the inclusion of stakeholders in the process of guideline formulation (Currie et al., 2022).

The involvement of multiple stakeholders in care delivery necessitates carefully selecting pertinent stakeholders when initiating a design project. In the human-centred design (HCD) context, stakeholders play a significant role in shaping the intended end-users of a novel design. Therefore, these stakeholders should be representative of a broad cross-section of end-users.

The preferred approaches for exploring the problem space, specifically identifying human requirements, involve ethnography-based research. This typically entails employing methods such as observation and interviews, which are often supplemented with other techniques aimed at acquiring deeper, implicit information about users (Dul et al., 2012; Melles et al., 2021; Van Der Bijl-Brouwer & Dorst, 2017).

Moreover, during the ideation phase, including stakeholders in evaluating ideas by utilising prototypes is standard practice. These prototypes can vary in form, ranging from rudimentary drawn storyboards to more advanced paper-based or functional prototypes. The specific choice of the prototype is contingent upon the particular stage of the design process and the research enquiry at hand (Caulliraux & Meiriño, 2015). Prototype can be used to replicate the user experience, enabling stakeholders to envision utilising the novel design to the greatest extent possible. This, in turn, stimulates a more profound extraction of information from the study participants.

The Use of Co-design During Service Design Innovation Projects in Healthcare

Efforts to promote patient partners' involvement in research have been driven by various stakeholders, including funding organizations, patient advocacy groups, and government initiatives. These collaborative efforts aim to achieve meaningful improvements in research outcomes that are directly relevant to patients (Bird et al., 2021). The literature increasingly provides practical ways for implementing patient collaboration in health research, as seen by the growing number of calls to action and the expanding body of literature on the subject (Hallgren et al., 2021). In a systematic review conducted in 2019, Greenhalgh et al. examined a collection of more than 65 frameworks developed to facilitate, assess, or document patient partnerships in health research. A taxonomy of five distinct categories was derived from the various frameworks examined. These categories encompass frameworks that centre around power dynamics, priority setting, study processes, reporting, and fostering patient partnerships (Greenhalgh et al., 2019). In parallel with the growing endeavours to incorporate patient partners in the research above, there is an increasing recognition of the imperative to involve other end-users in health innovation initiatives. This encompasses the involvement of other stakeholders who have a vested interest in the results of health innovations such as the design of healthcare goods, systems, and services (Greenhalgh et al., 2019; Hallgren et al., 2021).

Co-design refers to the significant involvement of end-users in the process of research design, so ensuring their active engagement and contribution. As discussed, the phenomenon encompasses several forms of involvement throughout the research process, from less active and passive to more active and engaged forms. The Patient-Centred Outcomes Research Institute (PCORI) has established a taxonomy encompassing several phases of the research process, stakeholder groups,

and other pertinent topics (Concannon et al., 2012; Slattery et al., 2020). The term 'research co-design' was operationalised in their study as the active engagement of research users in the initial planning stage of a research project (Greenhalgh et al., 2019) The concept of 'meaningful involvement' was understood as the participation of research users in a clearly defined and auditable role or task that is essential for the planning and execution of health research. The term 'research users' was also used to refer to individuals or groups, such as consumers, physicians, or other non-researcher entities, who possess a vested interest in the outcomes of health research (Neuhauser, 2017). The term "study planning phase" was also coined to represent the collection of actions that occur before the finalisation of the research topic in a research study. The emphasising of the study planning phase recognises that establishing a collective comprehension of the research question, which represents the problem to be investigated, holds utmost importance within the research endeavour. Choices made during this phase will significantly impact all following research procedures (Donovan et al., 2022; Nakarada-Kordic et al., 2020).

To effectively address all the complex societal and economic difficulties associated with healthcare service provision, the public sector relies on establishing novel partnerships and facilitating networked collaboration to achieve policy and programme objectives (Currie et al., 2022). The medical culture, characterised by entrenched institutional practises and compartmentalised knowledge, poses significant challenges to fostering collaboration and implementing organisational change as espoused by the participatory design approach. Collaborative actions required for the co-development of healthcare services may encounter various challenges, including the absence of a defined objective, incongruent working cultures and professional terminologies, and a need for more mutual comprehension (Vargas et al., 2022). Service design and co-design practises are increasingly utilised to facilitate collaborative processes and foster service innovation in developing patient-centric care. Using tangible co-design communication tools in service design has demonstrated its efficacy in enhancing co-design processes by enabling multimodal communication on subjects that are otherwise challenging to express (Bird et al., 2021; Nakarada-Kordic et al., 2020).

Moreover, the healthcare system is frequently described as being in a state of crisis. Public administrators have become reliant on partnerships and networked collaboration to achieve policy and program goals due to many issues, including an ageing population, a rise in patients with chronic conditions, and shortages in available resources (Kruk et al., 2018). The shift towards developing patient-centric services that emphasize connectivity in healthcare exemplifies this advancement. The concept of connected care builds on the interconnected health model introduced by MacMahon and Richardson. It involves using digital touchpoints and online networks to give patients greater accountability for their well-being. The development and delivery process of complex solutions necessitates the involvement of a broad network of stakeholders. As the number of digital touchpoints within a service increases, there is a corresponding demand for professionals specialising in various disciplines such as human-computer interaction design, software development, and multiple design fields, including industrial, graphic, communication, and interaction design (Pfannstiel & Rasche, 2019). These professionals are responsible for designing the physical products utilised as integral components of the service. Multidisciplinary partnerships challenge prevailing notions of innovation networks and models since they extend beyond several sectors, including public, commercial, and third-sector organisations (Schot & Steinmueller, 2018).

Despite various obstacles in interactions among diverse stakeholders—such as internal team culture issues, communication challenges, and differing understandings and visions of development objectives—multidisciplinary teams in the healthcare sector must still demonstrate effective and collaborative innovation in providing care services (Bendowska & Baum, 2023). This is where the field of service design characterised by its focus on human-centeredness, creativity, and iteration as a means to drive service innovation can play a role (Meroni & Sangiorgi, 2011). There is a growing demand for service design to provide techniques and methodologies that promote cooperation and effectively utilise existing resources (Castañer & Oliveira, 2020).

According to Meroni and Sangiorgi (2011), modern services can be characterised as intricate and multifaceted entities that encompass various components such as physical objects, locations, communication systems, and interactions, as well as individuals and their respective organisations. Waring et al. (2014) suggests that by establishing horizontal links and diversifying resources and knowledge within networks, public organizations can significantly enhance their capacity to address

complex problems beyond their usual capabilities. Nevertheless, the dynamics of these horizontal links, which impact the collaborative practice involved in service development, need to be readily discernible and effectively dealt with within the conventional healthcare frameworks, organizational project meetings, correspondence and delivery (Pfannstiel et al., 2022). The utilisation of service design communication tools is seeing a growing trend in facilitating communication and fostering novel approaches to collaboration across diverse fields. These tools are particularly effective in supporting the less apparent connections and interactions among stakeholders (Malmberg et al., 2019; Shaw et al., 2018).

Many communication / collaboration tools also pertain to their application within the ambiguous first stages of an innovation process, commonly called the fuzzy front end (FFE) (Martins Pacheco et al., 2021). Inside the FFE context, actors engage in several stages of the service creation process, including problem definition, idea generation, and concept development. These activities are typically led by service designers inside a co-design workshop environment. In the context of innovation initiatives involving different organisations and sectors, service designers often face challenges related to communication and understanding among diverse stakeholders. These challenges can impede the progress of co-design activities (Pfannstiel & Rasche, 2019; Vargas et al., 2022).

In healthcare, co-developing services frequently entails compulsory joint endeavours wherein the initial involvement of stakeholders and the shared vision or objective of the team may need to be more readily discernible. While existing co-design tools facilitate communication and foster a shared understanding regarding the development's focal point (i.e., the service and its intended beneficiaries), there need to be more tools specifically designed to support communication and foster a shared understanding concerning the collaborative network itself (Bird et al., 2021). The research on networked collaboration in developing product-service systems acknowledges three key factors contributing to collaborative networks' effectiveness. These factors include the stakeholders' comprehension of the value derived from the network, their ability to articulate their needs effectively, and their understanding of the expectations held by other stakeholders (Boaz et al., 2018).

Finally, the significance of creativity in the design process of novel health advances should be considered. Creativity can be conceptualised as generating novel ideas, whereas design encompasses a systematic approach by which these creative ideas are converted into tangible goods, systems, or services (Lievesley et al., 2022; Pfannstiel & Rasche, 2019). From this perspective design can be seen as the intermediary between creativity and innovation. A correlation exists between environments that foster and support highly creative ideas and the strength of research and development endeavours, leading to more successful outputs in the innovation (Bird et al., 2021). Including innovation end-users, such as patients, carers, clinicians, and healthcare decision-makers, as partners in creative innovation endeavours adds to this mix and ensures that the knowledge and expertise of end-users, who possess valuable insights as "experts of their experiences," are incorporated into the development of innovations (Bird et al., 2021; Pfannstiel et al., 2022).

Experience-based Co-design and Healthcare Improvement

As we have seen, in recent years, there has been an increasing focus on the potential benefits of incorporating design theory and practice to enhance the quality of public services. Experience-based co-design (EBCD) is a popular inclusive research methodology that leverages design tools and methods to facilitate collaboration between healthcare professionals and patients (Donetto et al., 2015). This method aims to restructure the power dynamics between patients viewed as consumers and healthcare professionals (Ramos et al., 2020).

The EBCD (Experience-Based Co-Design) approach is a methodology utilised in healthcare organisations to enhance the quality of healthcare services. This approach draws inspiration from participatory and user experience design principles. By incorporating these principles, EBCD aims to facilitate the improvement of healthcare services within organisations. The origins of this technique can be traced back to 2005-2006, when it emerged as a participatory action research methodology

influenced by design theory (Cama, 2011). The first implementation of the intervention occurred within a head and neck cancer service at Luton & Dunstable Hospital, as documented by Bate and Robert (2007). The EBCD approach is a collaborative design process where staff, patients, and carers reflect on their experiences with a particular service. They work together to identify areas for improvement, develop and implement improvements, and subsequently engage in joint reviews to assess their accomplishments. The EBCD cycle, which typically spans 9 to 12 months, consists of six distinct stages (Figure 7) (Ramos et al., 2020). These stages include: (1) project initiation and setup; (2) collection of staff experiences through observational fieldwork and in-depth interviews; (3) collection of patient and carer experiences through observation and 12-15 filmed narrative-based interviews; (4) convening a first co-design event where staff, patients, and carers come together to share their experiences of service and identify areas for improvement, facilitated by a 20-30 minute edited "trigger" film featuring patient narratives; (5) ongoing co-design work in small groups focused on addressing the identified priorities; and (6) a concluding event for celebration and review (Cama, 2011). Known initially as Experience Based Design (EBD), the subsequent change in terminology to Experience Based Co-Design (EBCD) was prompted by the recognition that early projects, while incorporating comprehensive efforts to comprehend patient experience (many of which were pioneering at the time), were neglecting the crucial co-design stage. Instead, staff members relied on conventional, limited methodologies to enhance services without actively engaging patients (Ramos et al., 2020).

According to Ogundele (2018), the initial programs addressing emotional and behavioural disorders were driven mainly by local administrators of specific services. This led to distinct power dynamics during the co-design process and subsequent implementation of modifications. This also highlights the need for designers to be aware of the impact of assuming leadership roles, providing assistance, or offering guidance in executing co-design initiatives within healthcare institutions and to consider the best approach for situating oneself within the power structures that can make these processes more difficult.



Figure 7 The six stages of the EBCD approach (Ramos et al., 2020).

Design ideas are used throughout the Experience-Based Co-Design (EBCD) practice. The methodology is founded upon prioritising experiential aspects, a fundamental principle in user-centric methods employed in various domains, including product design and human-computer interaction design. Additionally, this approach incorporates established design concepts and practical tools (Shelton & Lee, 2019) (Figure 7). According to Donetto et al. (2015) the emphasis on the experience of patients and staff is based on the underlying principle that effective quality improvement in healthcare must address all three dimensions of "good design" performance, engineering, and aesthetics. It is important to note that aesthetics, including experience analysis, is not this triad's "soft" component. Instead, it encompasses essential aspects of a product or service, such as utility, usability, and interactivity (Bate & Robert, 2007). Moreover, the convergence of design-based and social science perspectives (ethnographic) offers a valuable opportunity to understand individuals' and social groups' meanings and meaning-making practices. This integration of perspectives can contribute theoretical insights to a change intervention that effectively addresses practical concerns of performance engineering (Ramos et al., 2020).

In addition to emphasising performance, another fundamental aspect of EBCD is the utilisation of a participatory approach in co-design processes, which strives to facilitate enhancements in quality. The concept of participatory design emphasises the importance of human agency and individuals' rights to actively engage in forming the environments in which they operate. In this context, participation denotes a significant shift in the role of users, moving beyond mere sources of information to becoming recognised and legitimate contributors in the design process (Robertson et al., 2017). Participatory design methodologies are regarded as a means for public services to effectively address the mounting pressures posed by current societal challenges, as well as to tackle the issues of citizen disengagement and disillusionment about politics, democracy, and social justice (Harper & Mustafee, 2023). Nevertheless, in addition to its significant advantages, implementing co-design, as proposed in EBCD, poses both conceptual and practical obstacles. By incorporating participatory design principles, the co-design component in EBCD seeks to expand the scope of healthcare service design by involving additional stakeholders and diverse forms of expertise (Ramos et al., 2020). This approach encourages patients to contribute their specialised knowledge and actively participate in the design process, starting from the initial stage of idea generation (M. Kim et al., 2024). Within the design discipline, there has been a notable transition towards a redefined role for designers, wherein the notion of creating is no longer limited to individuals in the professional design field (Concannon et al., 2012). Additionally, Vargas et al. (2022) introduced the concept of 'co-creation,' which involves leveraging distributed resources and engaging service users in the design and implementation of services. This approach emphasizes the importance of designers collaborating with professionals and front-line staff to develop effective solutions (Vargas et al., 2022). The definition of co-design, as proposed by Bradwell and Marr (2008), allows for several interpretations of its practical implementation. However, it primarily revolves around four key components: participation, development, ownership and power, and outcomes and intent. In the context of EBCD, the operationalisation of these aspects would be as follows:

Participation: Co-design embraces a collaborative approach, inviting input from various stakeholders and ensuring their voices are heard and valued.

Development: Co-design is an ever-evolving process, continuously maturing and adapting as it progresses, driven by the dynamic interactions of participants.

Ownership and Power: Co-design fosters a transformative shift in power dynamics among stakeholders, striving to cultivate a sense of collective ownership over the outcomes.

Outcomes and Intent: Co-design maintains a pragmatic orientation, emphasising practical outcomes while acknowledging that unplanned processes and transformations may naturally emerge as consequential aspects of the co-design journey (Donetto et al., 2015; Ramos et al., 2020; Vargas et al., 2022).

3.13 Integrative Summary

Chapter 3 transitions from clinical context to design and technology, presenting design thinking as an essential methodology for innovating healthcare solutions. It articulates a comprehensive framework for digital therapeutic development, emphasizing user-centric design, clinical validation, regulatory compliance, and iterative improvement. The chapter critically evaluates delivery strategies and service design thinking, positioning them as transformative drivers that align closely with person-centred care (PCC) principles.

This chapter bring together design and healthcare by demonstrating how design and design thinking can be used to better understand the patient-centred challenges identified in Chapter 2. It explicitly connects the clinical insights on perioperative anxiety to the design and use of digital technologies as tools to address emotional and psychological patient needs through immersive, personalized experiences

Chapter 4.

Digital Health and new ways of healthcare delivery

This chapter explores the transformative impact of digital health innovations on healthcare delivery. It outlines the evolution and categories of digital health, then delves into emerging technologies like virtual reality (VR), augmented reality (AR), artificial intelligence (AI), and more. The chapter highlights their potential to revolutionize healthcare through patient-centric immersive solutions and interventions for stress relief in perioperative care, addressing both the opportunities and challenges of these advancements.

Chapter 4: Digital Health & new ways of healthcare delivery

4.1 Introduction to Digital Health Innovations

The concept of 'digital health' has gained recognition as a newly coined phrase despite the absence of a universally acknowledged definition and limited clarity over the categorisation of digital health technology (Kondylakis et al., 2022a). The phrase 'digital health' encompasses various concepts and technologies. These terms include digital medicine, digital therapeutics, eHealth, connected health, health information technology (HIT), telehealth, telemedicine, mHealth, and virtual care. The terms are commonly interchangeably and frequently employed to denote the utilisation of technology in healthcare services, as well as the associated functionalities of healthcare technology.

Within this specific framework, digital health encompasses a broad range of technologies that actively involve patients in managing their health and overall well-being. This includes various concepts such as mobile health (mHealth), telehealth (commonly referred to as telemedicine), smart devices, sensors and wearable technology, health information technology, and personalised medicine (Dang et al., 2020; Kondylakis et al., 2022a).

Despite distinct technical distinctions, the terms above are frequently employed to refer to 'digital health' or as substitutes for 'digital health'. The absence of a universally accepted definition and lack of consensus among authorised disciplines or professional entities presents significant challenges in health communication and its impact on patient outcomes.

The evolutionary concept of digital health

In the past, digital health was primarily focused on disseminating information through various technological tools such as hardware, software, telecommunications, and electronic platforms like emails, patient admission systems, and electronic health records (Béranger & Rizoulières, 2021). The field of digital technology has experienced significant growth since its inception in the early 1960s. One area that has seen tremendous development is digital health, which has expanded beyond its initial focus on administrative records to encompass many applications in the sector.

Digital health was closely linked to the emergence of Web 2.0, sometimes known as the 'social web' (Baumel et al., 2017). New intelligent analytics and big data handling capabilities led transformative changes driven by integrating information and communication technologies (ICT) inside health systems (Rollin, 2021). Contemporary understanding of digital health aligns it with the Industry 4.0 revolution distinguished by swift and profound changes resulting from advancements in information technology, the proliferation of big data, robotics, AI and virtual reality technologies (Bohr & Memarzadeh, 2020) (Figure 8). The driving factor behind the advancement of digital health is its ability to gather, retain, and analyse vast quantities of health and medical data (Woźniak et al., 2014). This data may be utilised for various objectives such as research, security, commercial ventures, and governmental initiatives (Rollin, 2021).

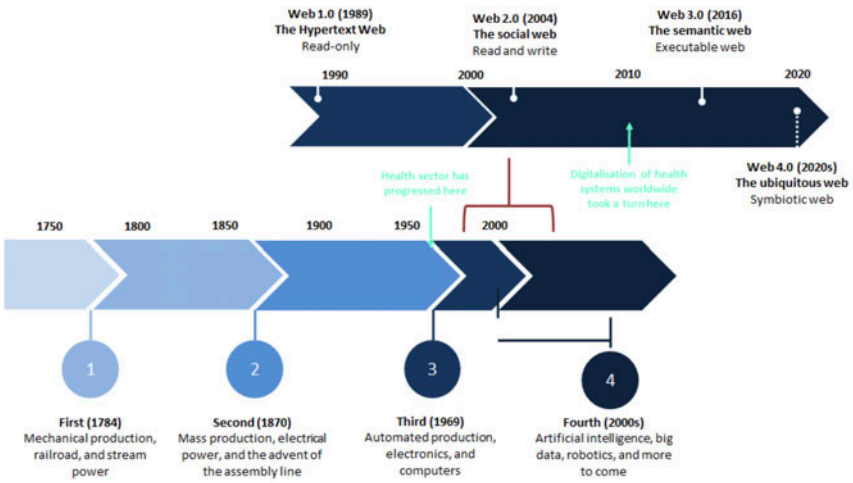


Figure 8 Digital Health as an 'Era' (Rollin, 2021)

In academia, digital health is commonly understood to embrace various technological advancements, including AI, big data analytics, robotics, cloud computing and genomics. Here is summary of a few chosen definitions of digital health:

"Digital health is thought to spark innovation in health care by providing better tools and solutions which empowers the end-users, patients and providers" (Mumtaz et al., 2023).

"Digital health, which broadly refers to the convergence of digital tools with health and healthy living"(Rivas, 2018)

"Digital health broadly refers to the use of information and communication technologies to improve human health, health care services, and wellness for both individuals and populations" (Adjekum et al., 2018).

The Healthcare Information and Management Systems Society (HIMSS) conducted a comprehensive analysis of existing definitions of digital health found in both empirical and grey literature from 2014 to 2020 (Hamzah & Wahid, 2016). From this a total of twenty-two scholarly articles were identified, which provided comprehensive definitions of digital health encompassing the following aspects:

- The specific types of digital technologies employed and their applications.
- The enhancement of healthcare through various means such as adopting a comprehensive approach to patient care, enhancing the skills of healthcare professionals, implementing evidence-based therapeutic interventions, monitoring patient progress, and delivering personalised care;
- The strategic approach to transforming healthcare systems to prioritise patient-centric care and democratise access to healthcare services.

categories of Digital Health

The United States Food and Drug Administration (FDA) defines Digital Health Technologies (DHTs) as "computing platforms, connectivity, software, and sensors [used] for health care and related uses" (Food and Drug Administration, 2020).

FDA has established six distinct areas of digital health, as mentioned below.

mHealth, also known as digital mobile health, falls under the broader category of eHealth and involves utilising mobile wireless technologies for public health purposes. These technologies encompass wearables, text messages, mobile apps, and handheld imaging devices, providing a convenient communication channel between healthcare providers and patients. Through mHealth, patients can gain empowerment by accessing increased knowledge and promoting self-management and health monitoring. However, concerns have been raised regarding safety, privacy, content quality, and regulatory aspects of mHealth.

eHealth, or electronic health, involves using information and communication technology (ICT) to support health-related fields. Originally, eHealth was used for distant communication and information exchange between patients and healthcare providers using electronic platforms such as emails, electronic health records, and web-based tools. Over time, eHealth has expanded to include technologies like mHealth, telehealth, and digital gamification tools.

Telehealth is a healthcare delivery approach where patients and providers are separated by distance and rely on ICT to exchange information. This method includes synchronous and asynchronous care through remote telecommunications and virtual technologies such as videoconferencing, e-consultation, and store-and-forward platforms. Telehealth is a time- and cost-effective solution, enhancing communication and information sharing between patients and healthcare providers and improving coordination among healthcare professionals.

Personalised healthcare is closely linked to personalised medicine, an innovative approach that tailors' disease prevention and treatment considering individuals' genetic, environmental, and lifestyle differences. Personalised healthcare is a broader concept encompassing genetics, genomics, and other biological information to predict patient disease risk and treatment responses. The ultimate goal is to deliver targeted therapies to suitable patients at the right time.

Remote or wearables including patient monitoring devices encompass non-invasive remote monitoring devices that measure standard physiological parameters and non-invasive devices that wirelessly transmit patient information to healthcare providers or other monitoring entities.

Digital therapeutics refer to evidence-based therapeutic interventions delivered through high-quality software programs to treat, manage, or prevent diseases or disorders. They can be used independently or in combination with medications, devices, or other therapies to optimise patient care and health outcomes. Examples of digital therapeutics include immersive technologies like virtual reality (VR), augmented reality (AR), and mixed reality (MR), which have been utilised in treating psychological and physiological pain, anxiety, phobias, stress disorders, social readaptation, and stress management. Additionally, immersive technologies have found applications in some physical therapies and mindfulness programs. Scientific evidence supports using VR and AR for medical education and defends healthcare providers in their day-to-day practice (Figure 9).

Digital health technologies are also increasingly playing a role in the training and upskilling of healthcare workers and in public literacy and information mobilisation

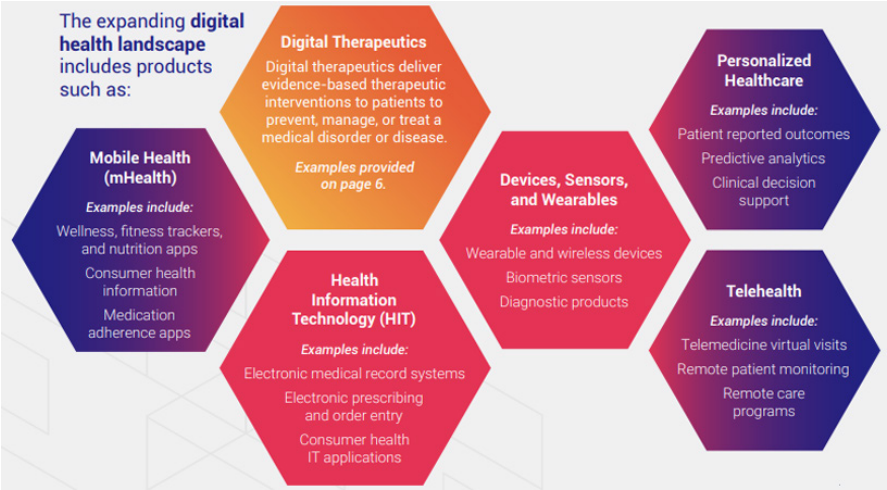


Figure 9 Digital health landscape (Molnar, A. (2024).

4.2 Emerging Technologies and healthcare innovation

Healthcare is undergoing a transformative journey fuelled by technological advancements. Among the myriad innovations, immersive technologies stand out as promising tools to revolutionize patient care, medical training, and therapeutic interventions (Carroll, 2020). In this exploration, we delve into the integration of emerging immersive technologies, including virtual companions and holographic solutions, to understand how they collectively shape the future of healthcare (Alqudimat et al., 2021).

Immersive technologies encompass a spectrum of innovations that engage human senses to create simulated environments or augment the real world. Artificial Intelligence (AI), Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), and gesture control have already demonstrated their potential in healthcare (Bohr & Memarzadeh, 2020). These technologies enhance medical training, improve patient outcomes, and offer novel solutions for addressing diverse healthcare challenges.

Over time, advancements in healthcare technologies have demonstrated a consistent improvement in patient treatment outcomes, the enhancement of care quality, and a reduction in costs. In the realm of technology, several innovative advancements, such as immersive technologies, are being employed for various purposes (Alqudimat et al., 2021). These include augmented reality (AR) training, interacting with healthcare data in different context e.g. medical imaging, personalising the patient-customer experience, conducting big data analytics, and retrieving health outcomes from data. On the treatment side, immersive technologies enable patients to experience physical presence within a virtual environment through visual and auditory inputs. This experience has been used extensively in paediatrics and pain management contexts.

The affordability, user-friendliness, and pervasiveness of these technologies are increasing as the healthcare sector embraces these innovations (Chén & Roberts, 2021; Kondylakis et al., 2022a). According to Bohr & Memarzadeh (2020), artificial intelligence (AI), precision medicine, and immersive technology have emerged as highly promising advancements in the field of health technologies. The convergence of artificial intelligence (AI) and immersive technology developments presents significant prospects for consumers in the health domain, which have the potential to revolutionise their existing experiences

The increasing diversity of health data also necessitates the development of tools that enable the interactive, adaptable, and integrative visualisation of complicated, extensive data. Immersive interfaces are being designed to foster authentic interactions between humans and machines, incorporating additional sensory dimensions such as music. These interfaces move beyond traditional data visualization methods, which typically include static charts, graphs, and maps, to create a more engaging and multi-dimensional experience. Combining artificial intelligence (AI) with novel data visualisation tools can enhance their efficacy in handling intricate datasets and human cognition (Bohr & Memarzadeh, 2020; Wolff et al., 2021). The following sections outline a potential number of Industry 4.0 digital technologies and how they might play a role in next generation healthcare. Some of these technologies are already finding a use while others are still in developmental or trial phases.

Virtual reality (VR)

The AR & VR market is expected to produce revenues of US$40.4 billion in 2024 (Statista, 2024). The introduction of more affordable virtual reality (VR) headsets is anticipated to expedite the expansion of the VR business and undoubtedly, healthcare will also benefit from these advances. As well as making the experience of VR more commonplace, making the virtual reality (VR) experience more seamless and every day is paramount to facilitate widespread acceptance and integration within the market (Vles et al., 2020). The healthcare sector is now in the early stages of using immersive technology, and its full potential remains untapped. Currently, a significant number of these initiatives focus on addressing the clinical management needs of paediatric or geriatric populations (Qu et al., 2022).

However, Virtual Reality (VR) has already made significant inroads in healthcare more generally, transforming medical training, patient care, and therapeutic interventions. VR-driven medical simulations enable healthcare professionals to hone their skills in a risk-free environment. This immersive approach extends to patient care, where VR is utilized for pain management, distraction therapy, and mental health support (Brown & Foronda, 2020) (Figure 10).

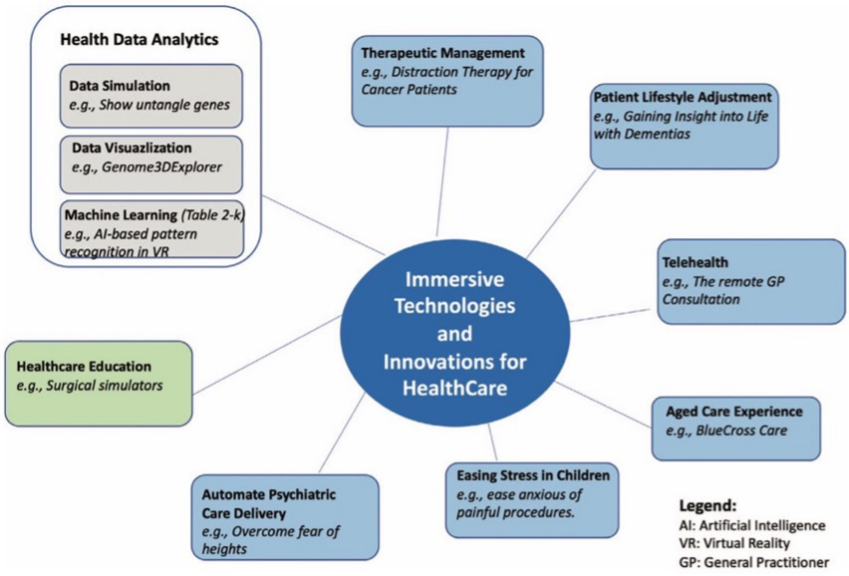


Figure 10 Application of immersive technology in different healthcare aspects (Qu et al., 2022)

The advent of virtual companions powered by AI also marks a new frontier in healthcare. The potential of virtual entities to provide emotional support and companionship is only recently beginning to be explored. These entities can be particularly beneficial for patients dealing with mental health issues, prolonged hospital stays, or loneliness. Virtual companions can engage in conversations, offer encouragement, and guide users through mindfulness exercises, contributing to overall mental well-being (Bohr & Memarzadeh, 2020).

Virtual reality offers consumers an immersive experience, isolating them from their immediate physical environment. This technology can replicate real-world scenarios that are often difficult or dangerous to experience directly, providing unique opportunities for exploration and interaction. As a result, VR improves learning outcomes, reduces performance errors, and enhances accuracy. Compared to other forms of media, virtual reality provides fewer distractions, increased spatial capacity, and better opportunities for naturalistic interactions. Additionally, VR allows us to experience phenomena beyond our physical limitations, such as changes in our sense of time or scale, and viewing normally solid objects (Dhar et al., 2023; Scates et al., 2020). All other usual Euclidian spatial constraints can be adapted and reimagined. Virtual reality (VR) technologies are constantly undergoing portability, immersion, and visual quality advancements, expanding its use across several medical fields (Dhar et al., 2023). These applications encompass neurological diseases and in other areas, including education and construction safety.

Augmented reality (AR), Mixed Reality (MR)

Augmented reality (AR) is a technology that overlays digital elements onto the user's physical environment, typically using a digital screen or increasingly through video see-through glasses. Augmented Reality (AR) integrates digital content with the real-world environment, providing real-time, contextually relevant information to users (Alqudimat et al., 2021). In surgical settings, AR enhances precision by projecting medical imaging data—such as CT scans or MRIs—onto the surgeon's field of view, enabling better visualization of anatomical structures and surgical landmarks. This technology facilitates more accurate and efficient procedures by allowing surgeons to access critical information without diverting their attention from the operating field. Beyond the operating room, AR transforms medical education by creating interactive simulations and virtual scenarios, allowing students to practice and understand complex medical concepts in a highly engaging manner (Burin et al., 2022).

Innovations in AR extend to remote healthcare consultations, enabling healthcare professionals to appear virtually at a patient's location. This immersive telepresence enhances the quality of remote consultations, fostering better doctor-patient interactions. Moreover, AR-enhanced virtual companions can be integrated into the real-world environment, providing patients with lifelike interactions and support (Adapa et al., 2020).

Increasingly, there is an interplay in technologies and experiences between AR and VR leading to the concept of Mixed reality (MR). Mixed reality (MR) is a technological concept combining the virtual and real worlds, incorporating the user's physical surroundings. Immersive technology systems can convert bodily actions into their virtual counterparts using senses and tangible devices. Virtual reality (VR), augmented reality (AR), and mixed reality (MR) collectively fall under the umbrella term of extended reality (XR) (Burin et al., 2022). Mixed Reality (MR) combines elements of both VR and AR, offering a versatile platform for healthcare innovation. For example, the integration of holographic technologies with MR provides a three-dimensional, interactive experience. This hybrid approach is particularly valuable in medical education, allowing students to physically interact with holographic representations of anatomical structures (Burin et al., 2022).

In patient care, MR with holographic and projected digital content can enhance rehabilitation exercises, for instance. Patients can engage in interactive exercises guided by holographic interfaces, promoting adherence to rehabilitation plans and providing real-time feedback. The dynamic combination of MR and holograms contributes to a more engaging and effective therapeutic environment (Chytas & Nikolaou, 2021).

By visualizing a sophisticated immersive game engine architecture, it becomes possible to create experiences that simulate unique physical behaviors, such as grasping a data point and visualizing data within a virtual environment (Burin et al., 2022).

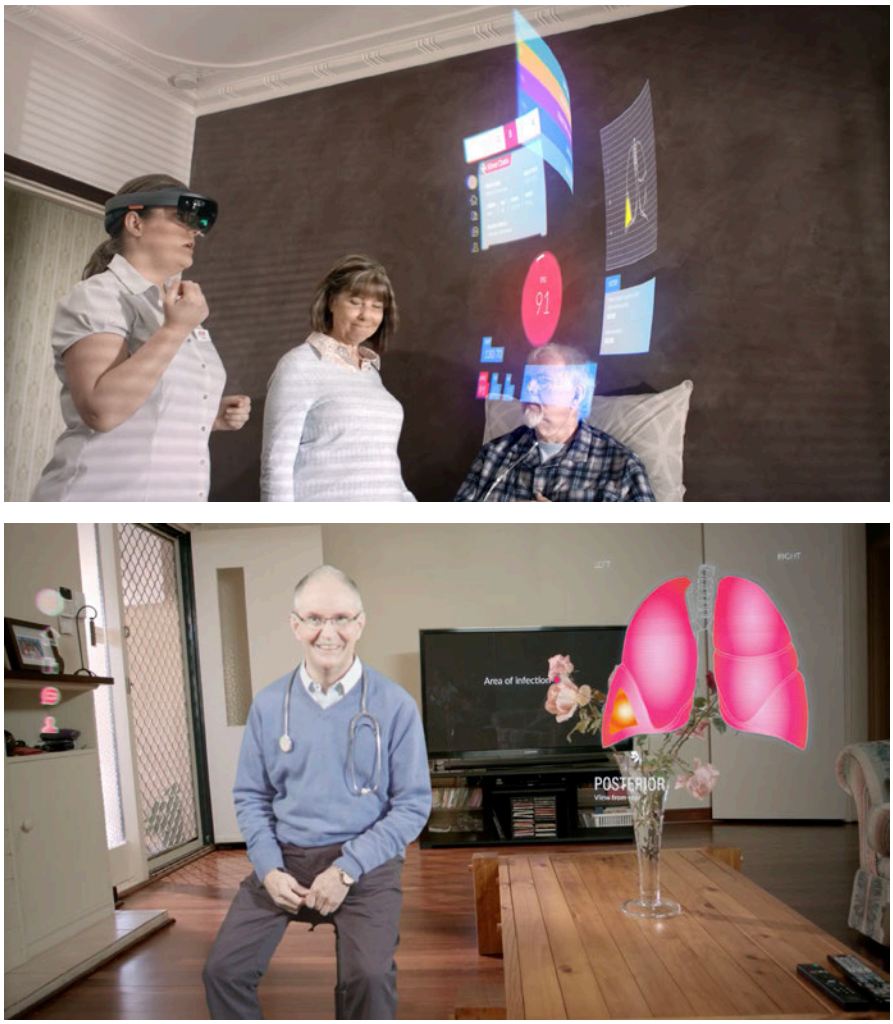


Figure 11 Examples of Immersive technology in healthcare (Silverchain, 2017)

Machine learning and artificial intelligence (AI)

Machine learning, along with artificial intelligence (AI), is a prominent technological advancement in the healthcare industry. It plays a crucial role in enhancing the precision of clinical insights, optimising decision-making processes, mitigating errors such as misdiagnosis and unwarranted procedures, facilitating the appropriate ordering and interpretation of tests, and providing recommendations for treatment modalities (Ahuja, 2019). Machine learning techniques have been applied in precision medicine for over a decade. The integration began gaining traction around the early 2010s as advancements in data analytics, computational power, and access to large-scale genomic and clinical datasets enabled more sophisticated modelling and predictions. These techniques have progressively evolved to enhance the accuracy of personalized treatment plans, predict patient responses to therapies, and identify potential biomarkers for disease, contributing significantly to the field of precision medicine (Quazi, 2022; Wolff et al., 2021). Precision medicine is a developing methodology for treating and preventing diseases, considering each individual's unique genetic, environmental, and lifestyle factors (Quazi, 2022). Precision medicine allows healthcare providers to tailor individualised treatments for patients by analysing many characteristics, such as the patient's genetic background, geographical location, environmental influences, lifestyle choices,

and behaviours, rather than employing a standardised strategy for all patients. Machine learning can also enhance the dynamism of data visualisations by integrating real-time analytics. Additionally, it enables the identification of more detailed and actionable insights, facilitates the development of improved search functionalities for visualisation dashboards, and enhances the accuracy of prediction models (Ahuja, 2019).

Data Visualisation

Data visualisation in healthcare has evolved significantly with the advent of immersive technologies such as Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR). These technologies offer a new medium for visualizing complex biomedical data, providing a more intuitive and engaging way to interact with information (Stoumpos et al., 2023). This section explores the applications, benefits, and future potential of immersive data visualization in healthcare.

Applications of Immersive Data Visualization

Clinical Trials Immersive data visualization is transforming the way clinical trials are conducted and analyzed. By using VR and AR, researchers can create interactive visualizations of patient data, allowing for a more holistic understanding of clinical trial results (Inan et al., 2020). This approach can help visualize patient anatomy and physiology, identify potential trial sites, and present multidimensional data on adverse events more comprehensively than traditional methods. For example, immersive visualizations can show the intensity, gravity, recurrence rate, and timing of adverse events, reducing bias and improving data interpretation (Ng et al., 2023).

Medical Education and Training Immersive technologies are also being used to enhance medical education and training. VR simulations allow medical students and professionals to practice diagnostic and treatment planning skills in a safe, controlled environment. These simulations replicate real-life scenarios, helping users to improve critical reasoning skills without risking patient safety. For instance, virtual patient models can be used to train medical students, providing an engaging way to practice clinical skills and gain insights into diagnostic and treatment decision-making (Dhar et al., 2023).

Biomedical Data Analysis The complexity and volume of biomedical data necessitate advanced visualization techniques. Immersive environments enable users to interact with data in ways that traditional screens cannot (Y. S. Lee et al., 2021). VR environments allow users to alter their perspective naturally, grasp and pull visualizations closer, and explore data from the inside out, revealing hidden information that would be difficult to discern otherwise. This capability is particularly beneficial for analyzing large datasets, such as gene expression and clinical data in oncology, where understanding intricate patterns is crucial for disease diagnosis and treatment (Ng et al., 2023; Rea, 2019).

Benefits of Immersive Data Visualization

Enhanced Comprehension and Decision-Making Immersive data visualization improves comprehension by allowing users to interact with data in a more natural and intuitive manner. This interaction helps in recognizing patterns, understanding complex relationships, and making informed decisions (Elwyn et al., 2012). For example, VR dashboards can display multivariate data through coordinated views, enabling users to switch from an overview to detailed analysis seamlessly. This holistic analysis was previously thought impossible with traditional visualization methods.

Improved User Experience Studies have shown that immersive environments can enhance user performance and experience (H. Lee et al., 2023). For instance, a usability study comparing exocentric (outside-in) and egocentric (inside-out) views of biomedical data in VR found that the exocentric view provided faster performance times and higher ease-of-use scores. This suggests that immersive visualization tools can be designed to optimize user interaction and efficiency in clinical and educational settings (Ng et al., 2023).

Future Potential The future of immersive data visualization in healthcare looks promising, with ongoing advancements in VR, AR, and MR technologies. These tools have the potential to revolutionize various aspects of healthcare, from clinical trials and medical education to patient care and biomedical research. As immersive technologies become more accessible and sophisticated, their integration into healthcare practices will likely continue to grow, offering new ways to visualize, understand, and utilize complex medical data. Immersive data visualization represents a significant technological breakthrough in healthcare, providing powerful tools for better understanding and analyzing complex data. By leveraging the capabilities of VR, AR, and MR, healthcare professionals can enhance their decision-making processes, improve patient outcomes, and advance medical research and education.

Holographic Technologies

Holographic technologies are emerging as powerful tools in healthcare, offering unique opportunities for visualization and interaction. Surgeons leverage holographic representations for detailed preoperative planning, gaining insights into complex procedures. Medical education benefits from holographic displays, providing students with three-dimensional models for better understanding.

The incorporation of holographic interfaces in remote monitoring allows healthcare professionals to visualize real-time patient data in an immersive manner. Decision-making is enhanced, and treatment adjustments become more informed as holographic representations offer a holistic view of patient conditions. There are a number of holographic technologies under development which can be used to achieve these effects and this approach holds promise for improving the quality of a number of forms of healthcare including remote healthcare delivery (Bajwa et al., 2021). The convergence of virtual companions and holographic technologies presents a fascinating synergy in healthcare. Virtual companions, enhanced by holographic elements, can provide patients with context-aware interactions in the real world. This amalgamation can be particularly valuable in patient education, as holographic representations complement virtual companions' efforts to explain medical conditions, treatment options, and surgical procedures (Strohmann et al., 2023).

In rehabilitation, the interplay between virtual companions and holographic interfaces can create immersive therapeutic experiences. Patients receive guidance and support from virtual companions while engaging in interactive exercises guided by holographic representations. This collaborative approach contributes to a more holistic and personalized rehabilitation process (Qu et al., 2022).

Gesture Control and Hands-Free Interaction

Gesture control technologies add another layer to the immersive healthcare landscape. These systems enable hands-free interaction with digital interfaces, reducing the risk of contamination and enhancing accessibility. In rehabilitation, gesture-controlled systems are utilized to track and assess patient movements, offering a personalized and interactive approach to therapy (Diederich et al., 2022).

Virtual Health Assistants and Biofeedback Integration

Virtual health assistants incorporating biofeedback and immersive technologies can contribute to patient education and monitoring. These assistants leverage virtual reality for educational modules and immersive analytics for visualizing complex health data. Biofeedback integration (from the patient) can enhance stress reduction programs by providing real-time information on physiological responses, creating a more personalized approach to mental health support (Morrow et al., 2023).

4.3 Challenges and Future Perspectives

While the integration of immersive technologies in healthcare holds immense promise, challenges must be addressed. Data security and privacy concerns, regulatory frameworks, and ethical considerations surrounding AI applications in healthcare are pivotal issues. Balancing innovation with patient safety is critical for the responsible implementation of new technologies like immersive technology in healthcare. This includes addressing infection control concerns associated with the use of shared devices, ensuring these technologies do not compromise the patient experience or safety.

As technology continues to advance, the synergy between virtual companions, holographic technologies, and other immersive solutions will shape the future of healthcare. Predictive analytics, enhanced diagnostics, and personalized treatment plans are on the horizon, driven by the immersive and collaborative nature of these technologies. Research and development will further refine applications, making healthcare more accessible, efficient, and patient-centric.

The convergence of virtual companions, holographic technologies, and other immersive innovations represents a paradigm shift in healthcare (Strohmann et al., 2023). From personalized patient care to transformative medical education, the synergistic integration of these technologies offers unprecedented opportunities. As the journey unfolds, ongoing research, ethical considerations, and collaborative efforts will shape a future where immersive technologies play a central role in advancing healthcare innovation.

4.4 Patient-centric Immersive Solutions in the Healthcare Domain

As discussed, patient-centric design refers to an iterative design approach that integrates consumers across all stages of the design process to develop products that are highly usable and accessible to users (Fabi et al., 2022). Several immersive technology applications have been developed for patient-centric immersive solutions (Abdulrahman Mohammed Al et al., 2018). For example, immersive technologies have been used to assist with distraction therapy, including patients who frequently experience anxiety from interacting with medical professionals, commonly referred to as white coat syndrome (Schneider & Hood, 2007). Immersive technology has the potential to facilitate an immersive encounter for patients, enabling them to visually explore a healthcare facility, alleviate pain, and mitigate fear among paediatric patients (Qu et al., 2022). Samsung conducted a project called Distraction Therapy for Cancer Patients in partnership with Start VR and Chris O'Brien Life House (Fabi et al., 2022). Utilising a virtual reality (VR) application allows patients to alleviate their concerns regarding uncertain results during the waiting periods associated with treatment. It gives individuals a temporary escape from their immediate reality by immersing them in a perceptual experience of blended three-dimensional space. Moreover, utilising an immersive experience before surgical procedures serves as a means of diverting patients' attention and fostering a positive mindset (Schneider & Hood, 2007; Vles et al., 2020).

Virtual reality (VR) also has the potential to be utilised for remote general practitioner (GP) consultation. An illustration of this type of project is the Remote GP Consultation initiative, which the Silver Chain Group administers (Qu et al., 2022). This project facilitated the utilisation of augmented reality (AR) technology to enable a nurse to access and review the patient's health data and consult remotely with a holographic doctor. This research initiative explores strategies for assisting nurses who face challenges communicating with doctors due to their hectic schedules attending to patients. The proposed solution involves utilising Microsoft HoloLens technology, which enables nurses to access patients' data and engage in virtual conversations with holographic representations of doctors. HoloLens VR/AR/MR technology allows medical professionals to remain in their present location while effectively providing assistance and completing tasks. The idea has the potential to significantly reduce both time and financial costs inside the healthcare system. Subsequently, patients would have the opportunity to get comparable healthcare services within the confines of their residences, Field (Qu et al., 2022).

The application of immersive technology in aged care can be seen in a project by BlueCross Care, a senior care facility based in Melbourne. In this project Virtual Reality (VR) technologies

are employed to allow older adults to virtually partake in various experiences such as travel, adventure, aquatic activities, classical concerts, and theatrical performances. This technology enables customers to engage in these activities from the convenience of their homes or care centres, overcoming the limitations imposed by their advanced age. Staff and family members can concurrently engage in the virtual reality (VR) experience by utilising an additional device or screen (Dang et al., 2020).

4.5 Digital Health Intervention for Stress and Anxiety Relief in Perioperative Care

Healthcare professionals employ various stress-coping mechanisms to manage stressors that adversely affect surgical performance and lead to complications. Research has demonstrated the effectiveness of psychological support and patient education in reducing stress and anxiety levels in individuals (Kondylakis et al., 2022b). Additionally, effective communication during a patient's surgical procedure has been shown to be a crucial component of the preoperative process for both patients and their carers. This practice not only reduces anxiety levels but also minimizes the occurrence of postoperative complications (Croke, 2020). Patient empowerment practices have also positively affected self-care management, motivating patients to manage their diseases actively. This approach also has the potential to enhance several outcomes, including patient satisfaction, cost-effectiveness, overall health status, and functional abilities (Greene & Hibbard, 2012). However, we are still in the early adoption phase and there are still a number of cost and implementation issues still to be resolved and patient stress and anxiety remain a major issue as outlined in chapter one.

Digital health interventions have significantly contributed to improving health condition awareness and managing mental health. These interventions encompass non-immersive systems, such as smartphone apps, and immersive systems, such as virtual reality (VR) (East & Havard, 2015). Virtual reality (VR) systems are increasingly being utilized across a range of healthcare settings. These applications include stress and pain management, training for medical practitioners, patient counselling, cognitive rehabilitation, and physical therapy. Additionally, VR is being employed in dentistry for diagnostic and treatment purposes, in mental health management, and during surgical procedures (Dhar et al., 2023; Kondylakis et al., 2018, 2022b). For example, using an Interactive Voice Response (IVR) intervention in the context of paediatric patients for pain and anxiety management presents a novel, convenient, and economically efficient approach that can be extended to other medical procedures that include pain and stress and in adult groups too (Kondylakis et al., 2022a; Scates et al., 2020). Pain is an exceedingly distressing symptom experienced by patients across various therapeutic contexts, with its intensity being subject to modulation by levels of stress and worry. Virtual reality (VR) applications have demonstrated efficacy in alleviating stress and managing pain primarily due to their capacity to provide distraction (Bohr & Memarzadeh, 2020).

Digital health interventions also provide significant quantities of data that can be utilised for customisation purposes using artificial intelligence (AI) methodologies, which also extend to perioperative care consumers (Bertoncello et al., 2018; Bohr & Memarzadeh, 2020; Wolff et al., 2021). One specific category of artificial intelligence (AI) systems is the health recommender systems (HRSs). These systems facilitate the customisation of patient interventions by considering their behavioural patterns and health requirements (De Croon et al., 2021; De Vries, 2017). The perception of perioperative stress varies significantly among patients and is influenced by factors such as the severity of the illness and the type of operation being performed. Hence, it is imperative to undertake an evaluation of stress levels and interventions aimed at cultivating the necessary skills for improved stress management. This process should be tailored to individual needs and grounded in health behaviour theories. Healthcare record systems (HRSs) utilising behavioural change models, such as I-Change, can be used to facilitate the customisation of educational and behavioural interventions (Choun & Petre, 2022; Kondylakis et al., 2022a, 2022b).

The objective of this thorough review extends beyond the synthesis of existing knowledge. It serves as a foundational platform for the practical research conclusions of the current study, which is centred around formulating a set of guiding principles and practices. Specifically, these principles aim to leverage immersive technologies to mitigate anxiety throughout the patient's perioperative journey effectively. Incorporating cutting-edge technologies in perioperative care aligns with

recent advancements and ongoing efforts to enhance patient experience and well-being and the ongoing adoption of Digital Health systems and services. This approach is anticipated to not only contribute to a deeper understanding of the intricate interplay between personality traits, anxiety, and postoperative outcomes but also provide innovative solutions to optimize patient care in surgical settings.

In the last 3 chapters (Section 1) we have also looked at multidisciplinary set of current thinking around digital healthcare interventions, including the impact in the changing philosophy towards PCC and the potential of adopting Human centric and design Digital Health technologies to assist in new practices of healthcare provision.

In Section 2 we will address the empirical research methods and activities that were undertaken within this project.

4.6 Research Gap and Study Rationale

The comprehensive review of literature across perioperative anxiety (Chapter 2), design thinking in healthcare (Chapter 3), and digital health innovations (Chapter 4) reveals a significant research gap at their intersection. While each domain has developed substantially as individual fields of inquiry, their integration represents an underdeveloped area with significant potential for improving patient care.

Systematic searches across healthcare databases (PubMed, CINAHL, Medline), design research repositories (Design Research Society, ACM Digital Library), and technology innovation journals (Digital Health, Journal of Medical Internet Research) using combinations of key terms including "perioperative anxiety," "immersive technology," "augmented reality," "virtual reality," "design thinking," and "patient experience" revealed limited research specifically addressing the integration of these domains. The search was restricted to English-language peer-reviewed publications from 2010-2023, with additional hand-searching of reference lists from relevant articles.

This review identified three critical gaps in current knowledge:

First, while numerous studies document perioperative anxiety prevalence and impact (Abate et al., 2020; Kumar et al., 2019), interventions remain predominantly pharmacological or limited to conventional approaches, with minimal exploration of digital innovations specifically designed for this context.

Second, design thinking has been increasingly applied in healthcare settings (Abookire et al., 2020; Malmberg et al., 2019), but rarely with specific focus on perioperative anxiety management. Participatory design approaches that engage patients in developing technological interventions for this specific context remain notably absent from the literature.

Third, although immersive technologies have demonstrated potential in managing anxiety in various healthcare contexts (Brown & Foronda, 2020; Dhar et al., 2023), systematic frameworks for their integration into perioperative care pathways are lacking. Most existing studies present isolated technological applications rather than comprehensive approaches grounded in patient experience.

This research directly addresses these gaps by investigating how design thinking methodologies can facilitate the development of immersive technology interventions specifically tailored to perioperative anxiety management. The study's central research question—"How can immersive technologies be effectively integrated into perioperative care to not only reduce patient stress and anxiety but also revolutionize healthcare delivery and improve surgical outcomes?"—emerges directly from this identified knowledge gap.

By bridging these domains, this study aims to contribute a novel framework that not only advances theoretical understanding of the intersection between design, technology, and healthcare but also provides practical guidance for implementing patient-centered technological interventions in perioperative settings.

4.7 Integrative summary

Chapter 4 advances the interdisciplinary synthesis by focusing on the application of immersive technologies-Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (XR), virtual companions, and holograms-as innovative digital therapeutics to reduce perioperative anxiety.

This chapter explicitly links the clinical challenges of perioperative anxiety (Chapter 2) and the design principles and frameworks (Chapter 3) by connecting them with digital, immersive solutions that enhance patient-centred care. The chapter also critically reflects on implementation factors such as timing, content delivery, and access within the perioperative pathway, acknowledging real-world constraints and opportunities for integration into clinical practice.

By synthesizing healthcare needs, design methodologies, and technological innovation, Chapter 4 represents the culmination of the thesis's interdisciplinary framework. It outlines how the design and use of immersive digital therapeutics can be embedded as core components of a responsive, patient-centred perioperative care model, thus fulfilling the thesis's overarching objective to consider surgical patient experiences through cross-disciplinary knowledge integration.

SECTION 2

Ethnographic, participatory research activities

In the previous Section, we explored the complexities of our research challenge. This section now introduces the innovative methodological approach employed in our study: a combination of Co-Design and Delphi methodologies. The chapter outlines a novel framework that integrates insights from both approaches, setting the stage for subsequent chapters and guiding the narrative of our research journey.

Chapter 5.

Introduction to the methodology and methods

This chapter provides the logic that connects the theory with the design practice in this study. This chapter provides the methodological frameworks which is applied within the study.

Chapter 5: Introduction to the methodology and methods

5.1 Foundations of Methodological Approaches

Building upon the current discourse and literature on perioperative anxiety and digital health and the interdisciplinary knowledge established in the previous Section, this chapter outlines a description of the methodology, research design and methods that have been adopted in this study to encourage more thinking about possibilities addressing perioperative patient anxiety through the application of immersive technologies.

This study employed the Delphi method and Co-Design to gather original data on patient needs, concerns, and experiences in surgical procedures. The primary goal was to obtain firsthand perspectives on the perioperative process from both healthcare providers—including anaesthetists, surgeons, and nurses—and patients themselves.

Initially, a Policy Delphi survey was conducted to gather insights from healthcare professionals. The purpose was to identify critical issues and key drivers of patient anxiety based on the experiences and perspectives of these professionals. Following this, the study engaged in collaborative session with patients who had surgical experience to share their experiences. This included detailed discussions about their entire perioperative journey, emphasizing specific key moments or situations identified as relevant. Additionally, the session explored these patients' feelings, beliefs, and expectations or fears about their upcoming surgical procedures. The insights gathered from the co-design participants are invaluable for shaping future research and implementing strategies to enhance the patient experience in perioperative care. These patient-derived perspectives are particularly valuable when compared with the views and comments of healthcare professionals, as detailed in Section 6.5

5.2 Rationale for Methodological Choices

The central challenge addressed in this thesis-reducing perioperative anxiety through immersive digital interventions-exists at the intersection of healthcare, design, and technology. This inherently complex, multi-stakeholder problem requires methodologies capable of capturing and synthesizing diverse perspectives, values, and forms of expertise. To these ends:

- Policy Delphi was employed to systematically gather, compare, and critically analyze the insights of healthcare professionals (including anaesthetists, surgeons, and nurses) and digital health experts. This method is particularly appropriate for areas where there is not yet consensus or established best practice, as is the case with the integration of immersive technologies into perioperative care. The Delphi process encourages honest, reflective contributions and helps surface both consensus and areas of disagreement, providing a robust foundation for policy and practice recommendations.

- Co-Design was selected to directly involve patients-the ultimate end-users-in the design and evaluation of proposed interventions. This participatory approach ensures that solutions are not only clinically sound but also meaningful, usable, and acceptable from the patient's perspective. Co-Design operationalizes the principles of person-centred care, which is a core value underpinning this thesis.

Bridging Disciplinary Boundaries

- Traditional research methods often privilege either expert or user perspectives, but rarely both. The combination of Policy Delphi and Co-Design was intentionally chosen to bridge this gap wherein ,Policy Delphi integrates expert, clinical, and policy perspectives, surfacing tacit knowledge and priorities that may not be visible in the literature, while Co-Design is used to bring in the lived experience of patients, ensuring that technological and design innovations are grounded in real-world needs and preferences.

This dual-method approach supports the thesis's interdisciplinary framework by enabling the synthesis of knowledge across healthcare, design, and digital technology, and by ensuring that both top-down (expert-driven) and bottom-up (user-driven) insights inform the research outcomes.

5.3 Interpretivism Paradigm & Research Philosophy

The interpretivist paradigm is a research approach in sociology that emphasizes understanding the subjective meanings and experiences of individuals within their social contexts. This paradigm contrasts sharply with positivism, which seeks objective truths through quantifiable data. Interpretivism, rooted in idealistic philosophy, posits that reality is constructed through social interactions and shared meanings, making it essential for researchers to delve into the beliefs, motivations, and reasoning of individuals to decode the meaning of social phenomena (Irshaidat, 2022).

Key Concepts

Subjective Reality: Interpretivism asserts that reality is not an independent entity but is subjectively constructed by individuals through their experiences and interactions. This relativist ontology implies that multiple realities exist, shaped by the perspectives and contexts of different individuals.

Qualitative Focus: Interpretivist research predominantly employs qualitative methods to explore the depth and complexity of human experiences. Methods such as interviews, participant observations, and case studies are commonly used to gather rich, detailed data that reflect the participants' viewpoints and contexts.

Social Constructions: Interpretivists believe that access to reality is mediated through social constructions such as language, consciousness, and shared meanings. This perspective underscores the importance of understanding the cultural and social contexts in which individuals operate (Ryan, 2018; Worku Tegegn et al., 2023).

Influential Approaches

Several interpretivist approaches have significantly influenced sociological research:

Hermeneutics: Focuses on the interpretation and understanding of texts, particularly in historical and cultural contexts.

Phenomenology: Seeks to understand phenomena through the direct experiences of individuals.
Symbolic Interactionism: Examines how individuals create and interpret symbols in social interactions to construct reality (Irshaidat, 2022)

Differences from Positivism

Interpretivism diverges from positivism in several key-ways:

Epistemology: While positivism relies on objective measurements and observable phenomena, interpretivism emphasizes subjective understanding and the co-construction of knowledge between the researcher and participants.

Ontology: Positivism views reality as a fixed, external entity, whereas interpretivism sees it as fluid and constructed through social interactions.

Methodology: Positivist research often uses quantitative methods to test hypotheses and predict outcomes, whereas interpretivist research uses qualitative methods to explore meanings and understandings in depth.

Applications and Implications

Interpretivist research is particularly valuable in contexts where understanding the nuances of human behaviour and social interactions is crucial. For example, in cross-cultural studies, interpretivism allows researchers to appreciate the unique cultural contexts and subjective experiences of participants, leading to more nuanced and valid insights.

The interpretivist paradigm offers a robust framework for exploring the complexities of human experiences and social interactions. By focusing on subjective meanings and the social construction of reality, interpretivist research provides deep, contextually rich insights that are essential for understanding the intricacies of social phenomena. This paradigm's emphasis on qualitative methods and the co-construction of knowledge makes it a powerful tool for researchers seeking to uncover the underlying meanings and motivations that drive human behaviour. This section provides a comprehensive overview of the interpretivist paradigm and its significance in research philosophy, suitable for inclusion in the nature of this research. It highlights the key concepts, influential approaches, and differences from positivism, offering a clear understanding of how interpretivism shapes research methodology and outcomes.

5.4 Study Design

A four-phased study was undertaken to capture a comprehensive understanding of the day surgery patients' needs, fears and experiences/perceptions in the perioperative journey at private medical settings (Figure 12). The selection primarily reflected accessibility and my professional experience as an anaesthetic nurse in private hospital settings, which provided established relationships with healthcare professionals and an in-depth understanding of these specific contexts. This insider perspective enabled richer data collection and more nuanced interpretation of findings.

Additionally, same-day elective procedures present a particularly interesting research context as they combine high patient turnover with limited time for traditional anxiety management interventions, creating a distinct need for innovative approaches. These procedures also typically involve patients who are not severely ill, allowing for clearer focus on anxiety management without the confounding variables of acute medical distress.

Based on 2022 Australian national data, the patient can be placed on the waiting list from around 40 days to two years for elective surgery provided by public hospitals (AIHW, 2023). A large number of elective surgeries are also performed in private hospitals in Australia

While public hospitals and emergency procedures represent valuable contexts for future research, they introduce additional variables such as unpredictability in patient flow, more complex ethical considerations regarding patient vulnerability, and institutional approval processes that were beyond the scope of this initial investigation. This PhD research focuses on private hospitals rather than public hospitals, a future study is required to examine how longer waiting lists affects public patients' anxiety levels.

Interestingly, during the course of this research, I engaged in discussions with a neurosurgeon who identified a similar need for anxiety management interventions in MRI scanning contexts. This represents a particularly compelling application area given the substantial costs associated with failed scans due to patient anxiety and the current reliance on sedation teams to manage severe cases. This highlights how the principles developed in this research could potentially extend to other healthcare contexts beyond the specific setting studied.

The framework developed through this research is conceptually applicable to broader perioperative contexts, though adaptation would be necessary to address the unique characteristics of different healthcare settings.

This included participatory design methods to collaborate with patients and other stakeholders to understand the lived experience of the service. Adopting Findeli's (2010) design research model, this research focuses on the effective integration of immersive technologies into perioperative care. The ultimate goal is to alleviate patient stress and anxiety, revolutionize healthcare delivery, and enhance surgical outcomes. This approach was used to address the research questions, which are restated below.

Central Research Question:

How can immersive technologies be effectively integrated into perioperative care to not only reduce patient stress and anxiety but also revolutionize healthcare delivery and improve surgical outcomes?

Supporting Subsidiary Questions:

1. **Patient-Centered Care Assessment:**

    • What are the key tensions, challenges, and problems encountered by patients during the perioperative experience?

2. **Methodological Approaches:**

    • What methods can be employed to apply immersive digital health interventions effectively along the perioperative patient journey from the healthcare provider's perspective?

3. **Sector-Wide Communication and Impact:**

    • How can findings from digital health research and practice on the perioperative patient experience be communicated effectively to inspire change across the healthcare sector?

To achieve the goals of this study, four research phases were undertaken:

Phase 1 contextual literature review, examining multiple disciplinary perspectives on the subject

Phase 2 Policy Delphi study; a Policy Delphi method combines a round of expert interviews with one or more distributed thematic-building bands.

Phase 3 A co-design workshop are facilitated to obtain input from patient representatives with the lived experience of perioperative anxiety to ensure the priorities and needs of perioperative patients are recognized.

Phase 4 is a triangulation and consolidation of evidence from phases 1 -3 to devise guiding principles and practices for applying immersive technology interventions in the perioperative journey. From this process a prototype design for a service intervention was designed (chapter 7).

PHASE 1	PHASE 2	PHASE 3	PHASE 4
REVIEW OF EXISTING LITERATURE	QUALITATIVE RESEARCH (Policy Delph)	QUALITATIVE RESEARCH (CO-DESIGN WORKSHOPS)	CONSOLIDATION OF EVIDENCE To devise a set of guiding principles and practices

Figure 12 Study design sequence

Reflective practice based on the researcher's experience

Humans are the only living creatures on Earth able to think deeply internally and express those thoughts outwardly through language and actions. Humans can feel and think about thinking because our higher-order cognition involves memory and reflection (Koshy et al., 2017). The ability to reason sets humans apart from all other species of animals. It is the mechanism to direct our intentions towards our fellow humans, animals, plants, and the physical world of matter (Frederick, 2015). We can also turn our attention inwards, focusing on our inner selves, making sense of what is happening at any given moment, our lives, our relationships with others and the contexts in which we live (Kinsella, 2001).

Whether we perpetuate self-limiting thoughts or open ourselves up to imagining unlimited possibilities, our inner world of thoughts significantly informs both our present identity and our future possibilities. This concept aligns with Carol Dweck's research on mindsets, where she illustrates how our cognitive perceptions shape our actions and ultimately our success (Buchanan & Kern ,2017). Our ability to imagine and reflect on ideas allows us to contemplate abstractions, such as infinity and a world beyond this world (Patrick et al., 2016). This ability can be used as a powerful and insightful research tool.

In the expansive domain of my PhD research, the examination of reflective practice emerges as a crucial element, offering a critical lens to explore the intricate interplay between immersive technology and its potential to alleviate surgical patient anxiety. This exploration is particularly meaningful given my dual background as both a designer and a nurse, providing a unique perspective to examine the intersections between creativity and healthcare.

As a designer, my professional focus lies in crafting immersive experiences that go beyond aesthetics, contributing significantly to patient well-being. Simultaneously, my nursing background brings a profound understanding of the human element in healthcare. This fusion of design and nursing expertise positions me at the intersection of two distinct yet interconnected domains, fostering a deep appreciation for the holistic nature of patient care.

Reflective practice serves as a guiding tool in this multifaceted journey, enabling me to scrutinize and integrate these dual perspectives. This introspective process refines not only my research methodology (reflection in action) but also enriches the potential impact of my work by forging connections between design innovation and compassionate patient care (reflection on action). The synthesis of these perspectives underscores the importance of holistic thinking in integrating immersive technology within surgical settings, recognizing the symbiotic relationship between form and function, aesthetics, and healing (Deng et al., 2023). In essence, my research journey involves navigating a delicate dance between the reflective nuances of personal experience and the structured objectivity required for scholarly inquiry. By integrating reflective practice as a core principle within a broader methodological framework, I aim to forge a path that leverages unique insights from my dual professional background and advances the discourse on the role of immersive technology in enhancing patient well-being within surgical contexts.

Criticisms of reflective practice

Reflective practice, despite its demonstrated successes in various fields like nursing, where it has evolved significantly past its initial phases, has faced substantial criticism. As Bassot (2019) discusses, while reflection promotes deep thinking, critics argue that the nursing profession has excessively embraced it without fully addressing its inherent limitations. Cultural barriers, as highlighted by Mann et al. (2020), can hinder the effectiveness of reflection, and the pressure on practitioners to engage in this process can lead to negative outcomes, a concern also raised by Ng et al. (2021).

Fundamental flaws in the concept have been pointed out, such as the risk involved in expressing private thoughts within public spheres, which can lead to severe repercussions, as Donaghy and Morss (2019) suggest. Despite these limitations, reflective practice remains relevant due to its ability to scrutinize micro-level human interactions and personal knowledge. However, Taylor's criticism, echoed by Schön in his revised 2021 edition, argues that reflective practice is often seen as an overly simplistic or idealistic approach that overlooks how reflective accounts can construct and distort the reality of practice.

Consequently, there is a pressing need to integrate reflective practice with other research methodologies, particularly in health contexts, to enhance its validity and application. This integrated approach, advocated by the cited authors, aims to foster a nuanced understanding of reflective practice, ensuring it contributes effectively to professional education and practice.

5.5 First-hand data Collection Research Methods

While there is research interest in the use of digital health in different aspects of healthcare, to this researcher's knowledge, there are few if no other studies currently focusing on investigating the potential benefits of immersive digital health in the perioperative elective same-day surgery adult patient journey in Australia using a patient-centred care approach.

The study is intended to comprehensively understand and reveal the day surgery patients' needs, fears, and experiences/perceptions in their perioperative journey. This will be achieved by triangulating and consolidating findings from data analysis. The following research methods were used in this study to collect original data. The contextual literature review outlined in Chapter 2 supported this research, and it provided the foundational data for analysis presented in Chapter 4 (refer to Figure 10 for an overview of the research design). The findings from this analysis were then utilized to develop guiding principles and practices for implementing immersive technology interventions. Two forms of first-hand data collection were undertaken: First, a Policy Delphi method was used to gather information from healthcare experts, and second, Co-design workshop and service user conversations were used to capture information from people with lived experience.

Expert interview using Policy Delphi method

The Policy Delphi method is a structured approach used to generate diverse perspectives and potential resolutions for complex policy issues. The number of rounds in a Policy Delphi study can vary, but most sources suggest 2-4 rounds is typical and sufficient for achieving (Nasa et al., 2021). Data from expert interviews with anaesthetists, surgeons and nurses was used to establish a baseline understanding of the level of comprehension and interest in using immersive technologies to address perioperative anxiety in patients. As part of the expert interview, participants were asked to qualitatively reflect on their understanding of patients' perioperative anxiety and potential interventions to address this issue through the semi-structured interview questions. The interviews were conducted face-to-face with COVID-19 safety measures in place. Healthcare professionals were recruited though research contacts and the snowball method (see sampling and recruitment section for further details).

The following two topics were posed:

Topic 1: Participants were asked to describe the perioperative environment and processes through their professional experiences which, in their opinion, caused anxiety.

Topic 2: Participants were asked to describe their understanding of augmented and virtual reality technologies and how they thought they might be used to help reduce perioperative anxiety in patients.

Co-design workshop

The second stage of the first-hand data collection aspect of this research involves the facilitation of co-design workshop. The co-design session was up to 2.5 hours long and asked participants to respond to a set of tasks and prompts (photo collage activity). These tasks and prompts were designed to help them share their surgery experience and explore perspectives on the potential role of Augmented and Virtual Reality in addressing perioperative stress. This section describes the details of the codesign workshop, focusing on patient journey mapping and the incorporation of a photo collage activity. These methodologies were instrumental in capturing diverse perspectives and enhancing the creative and user-centric development of immersive technology solutions in surgical patient care.

The co-design session was used to explore perspectives and opinions for the participants with lived experience, to share and understand at what points along the patient journey they felt particularly anxious and in what situations. To achieve this a patient journey mapping process was used to identify potential pinch points in the experience.

Specific activities were developed for the co-design participants that included

Icebreaker Session:

The icebreaker session was designed to establish a comfortable environment. Activities included introduction rounds where participants shared their names, roles, and brief personal or professional backgrounds. Engaging games like two truths and a lie fostered a sense of camaraderie.

User Scenario Development and Patient Journey Mapping:

Realistic scenarios and patient journey maps were constructed, emphasizing the identification of touchpoints and emotional aspects of the patient perioperative journey. Group discussions revolved around potential use cases, challenges, and mapping out patient journeys. Photo collage activities were incorporated to visually represent emotional touchpoints within the patient journey.

Brainstorming Session:

Creative idea generation was facilitated through group brainstorming sessions and idea generation exercises. Small groups collaborated on whiteboards, generating ideas for integrating immersive technology into the surgical patient experience. “How Might We” prompts stimulated innovative thinking around the experience.

Collaborative Sketching from Journey Map:

Participants commenced the session by revisiting the patient journey map. They identified key emotional touchpoints and use collaborative sketching to visualize potential solutions that directly address these moments.

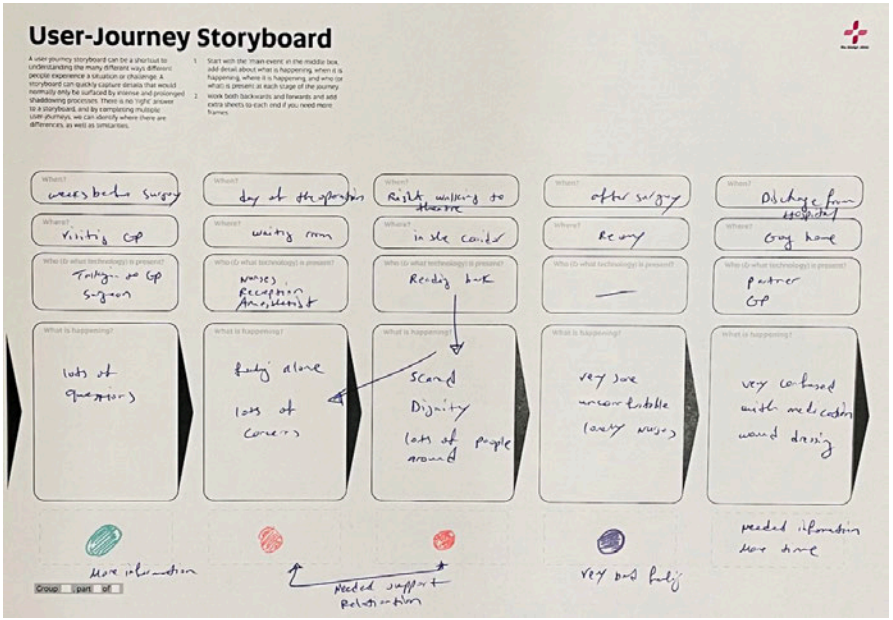
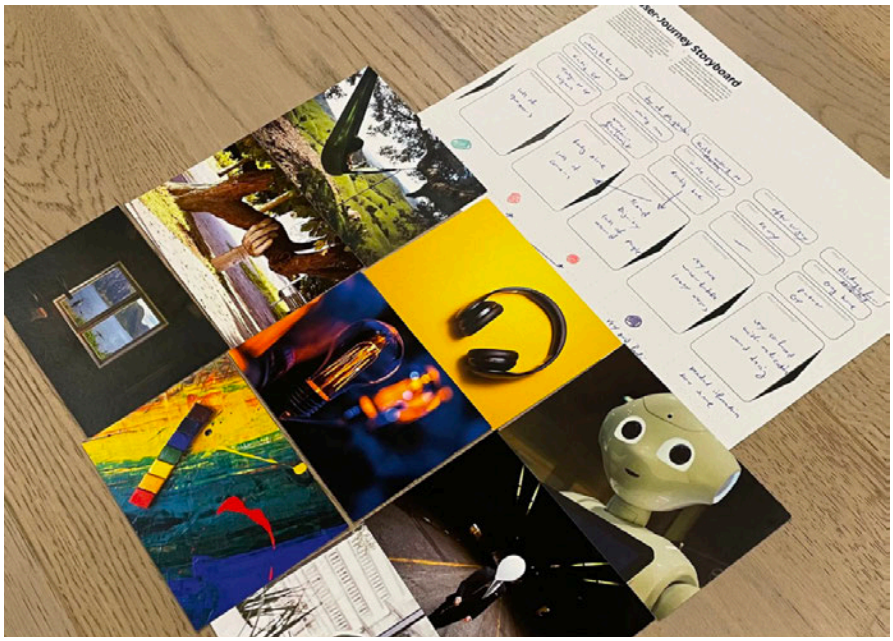


Photo Collage Activity:

The photo collage activity involved participants selecting images representing key emotional moments in the patient journey. These collages served as visual aids during journey mapping, enhancing the communicative power of the participants' perspectives.

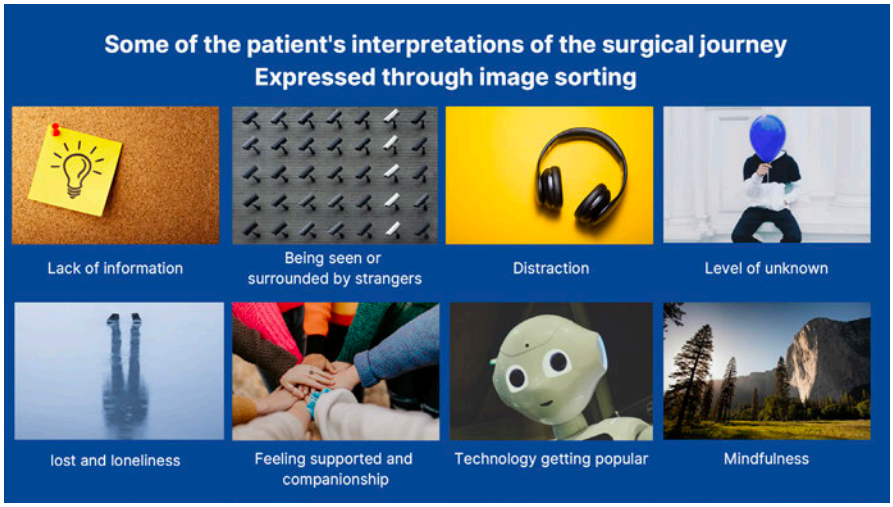


Iterative Refinement Based on Insights:

The brainstorming undergo iterative refinement, guided by the emotional touchpoints and insights identified in the patient journey map. Participants revisit initial concepts, adapting and enhancing their suggestions to better align with the identified needs and challenges.

Group Discussions and Guided Critiques:

Group discussions were interspersed throughout the session, allowing participants to share insights, discuss design choices, and collaboratively contribute to the evolution of each prototype. Guided critiques focus on specific aspects related to the emotional touchpoints identified in the patient journey map.



Documentation and Reflection:

Participants document their insights, challenges encountered, and potential improvements during the feedback and prototyping activities. This documentation becomes a valuable resource for further iterations and the ongoing design process.

Debriefing and Follow-Up:

The workshop concluded with a debriefing session, summarizing key outcomes and addressing participant queries. Details about subsequent research steps were communicated, ensuring participants were informed about the ongoing research trajectory. The facilitated reflection and open group discussions provided participants with an opportunity to share personal insights. Open conversations identified common themes, fostering a deeper understanding of the collaborative process and its impact.

5.6 Sampling/Recruitment

Thirty participants were recruited for this study, including 15 healthcare professionals (Policy Delphi Study) and 15 patients (co-design service user study). Participants were recruited through outpatient visits at private hospitals using flyers and via referrals from healthcare professionals, who obtained consent beforehand. Health professionals were recruited through flyers advertising the project and through presentations on the research by the research team. Purposive sampling was utilised to ensure a good representation of participant characteristics to meet the requirements of the research question. Potential participants were provided with a copy of the participant information sheet and consent form for their review, and the research team followed up with interested individuals for screening and consenting procedures.

In previous qualitative studies, saturation point (when no new or different information is being revealed) was often used to justify the sample size. However, for every research project, the saturation point may vary (Hallgren et al., 2021).

With the research team's extensive experience, the sample size was deemed to be appropriate based on the project timeline. It is important to ensure that the sample size is large enough to gather a range of responses to the research questions while being small enough to be manageable. Finally, the sample size selected was monitored during the planning and implementation stages to ensure it was still appropriate for the project. Consideration for the resources available and the cost of data collection was also given.

Given the qualitative nature of this study, the appropriate sample size is determined by the concept of 'saturation,' which is reached when additional data yields little new information. Most research suggests:

- Aim and methodology of the study
- Quality of recruiting and screening to ensure appropriate participants
- A minimum of 12-15 participants is sufficient to reach saturation, especially for homogeneous populations with narrowly defined objectives (Hennink & Kaiser, 2022; Vasileiou et al., 2018).

Inclusion criteria

Inclusion criteria for health professionals:

Health professionals were eligible for inclusion in this study if they have been practising in their respective fields for at least 12 months, have access to a smartphone, and are English-speaking/able to understand written English.

Inclusion criteria play a crucial role in shaping the parameters of a study, ensuring that the participants selected meet specific qualifications that align with the research objectives. In the context of health professionals, the inclusion criteria serve as a set of guidelines to identify eligible individuals for participation in a particular study.

The specified inclusion criterion in this instance focuses on the experience level of health professionals. By requiring a minimum of 12 months of practical experience in their respective fields, the study aims to include participants who have garnered a foundational understanding of their roles and responsibilities. This duration threshold serves as a proxy for a certain level of professional competence, acknowledging that individuals with at least a year of practical experience are likely to have encountered a variety of scenarios, developed problem-solving skills, and honed their clinical or professional expertise.

This inclusion criterion reflects a commitment to capturing insights from seasoned practitioners who have navigated the complexities of their roles over an extended period. It suggests an interest in understanding the perspectives, challenges, and nuanced insights that professionals with at least a year of experience can bring to the study. Moreover, this criterion may enhance the reliability of the study's findings by ensuring that participants possess a baseline level of practical knowledge, potentially minimizing the impact of novice-related variability on the results.

The rationale behind setting a 12-month threshold also implies a recognition of the initial learning curve associated with entering the healthcare profession. Health professionals typically undergo a period of adaptation and skill development during their early months of practice.

Inclusion criteria for the patient / service users (co-design activities)

Service users were eligible to participate in this study if they met the following criteria: they had undergone elective day surgery in a hospital, self-identified as having limited exposure to healthcare environments, were aged 18 or older, and had access to a smartphone. The inclusion criteria for patients or service users in a study are vital to ensure that the selected participants align with the research objectives.

The first criterion specifies that service users must have recent experience with elective day surgery in a hospital. This criterion is crucial as it ensures that participants have firsthand knowledge and recent exposure to the specific context under investigation. Patients who have undergone elective day surgery can offer unique perspectives on the process, recovery, and overall experience, contributing valuable information to the study's findings. Their experiences may encompass pre-operative preparations, interactions with healthcare professionals, the surgical procedure itself, and post-operative care, providing a comprehensive view of the elective day surgery process.

The second criterion highlights the importance of service users self-identifying as having limited general exposure to healthcare environments. This inclusion criterion aims to focus on individuals who may not be as familiar with routine healthcare settings, potentially capturing the experiences of those who are navigating healthcare systems for the first time or infrequently. This subgroup of participants can offer insights into the challenges and perceptions of individuals who may find healthcare environments less familiar, providing a nuanced perspective that may differ from those more accustomed to medical settings.

The third criterion, specifying an age greater than 18, is a standard eligibility requirement in many research studies. It ensures that participants are legally competent adults capable of providing informed consent. This criterion also acknowledges that the experiences and perspectives of adult patients may differ from those of minors, particularly in the context of elective day surgery.

The final inclusion criterion emphasizes that participants must have access to a smartphone. This requirement reflects the increasing role of technology in healthcare and research. Having access to a smartphone may facilitate communication, data collection, or participation in the study. It also acknowledges the contemporary reliance on mobile devices for various aspects of healthcare, including post-operative follow-ups, appointment reminders, and accessing health information.

The inclusion criteria for patients or service users in this study are carefully considered to ensure that the selected individuals possess relevant experiences related to elective day surgery. By considering recent surgical experiences, limited general exposure to healthcare environments, age, and smartphone access, the study aims to capture a diverse and representative sample that can provide valuable insights into the specific context under investigation.

Exclusion criteria

These criteria were principally to accommodate participants safely and ethics.
Criteria included:

- Circumstances that might interfere with the participant's ability to give informed consent (diminished understanding or comprehension, or a language other than English spoken and an interpreter unavailable),
- Emergency procedures for which no preoperative visit had been scheduled
- Pregnancy
- History of psychological disorders
- History of seizures, epilepsy or other contraindications for immersive technology
- Paediatric patients
- Any existing relationship (beyond the professional) of a potential participant with the primary investigator as a perioperative nurse

5.7 Data Handling/Analysis

A thematic analysis was used to interpret the data from the Delphi study. Thematic analysis is a flexible qualitative analysis method that supports researchers in exploring perspectives among participants (Braun & Clarke, 2014). This research used an inductive approach to ensure the coding was emergent from the participants' contributions rather than assigned based on a pre-determined set of values (Kiger & Varpio, 2020). Each interview was read and initially coded at the sentence level. These codes were grouped to create themes and were adjusted after each discussion. After coding the first three interviews, the coding shifted to longer text segments. An effort was made to move from descriptive to interpretive codes to identify the broader connections among participants' experiences. After each interview was coded, the coding matrix was reviewed to determine the salient elements in the participants' experiences. At the end of the coding process, the findings were shared with the expert group, and an agreed set of outcomes from the process was established to take forward into the project's next stage. A thematic analysis was undertaken for both Delphi and Co-Design following the coding process outlined by Gioia and colleagues (2013). This resulted in coding both 1st order concepts and 2nd order themes and aggregate dimensions to effectively integrate the findings from both the co-design workshop and the Delphi study: I compiled a comprehensive comparison in Section 6.5. This section presents the findings from each method side by side, detailing themes, insights, and highlighting key differences or agreements between the two sets of findings. Additionally, I carefully analysed the table to identify overlaps where both methods produced similar results. These overlaps were crucial as they reinforced the validity of these findings. I also pinpointed gaps where one method provided insights that the other did not cover. Identifying these gaps was essential for understanding unique perspectives and addressing areas that might require further investigation.

5.8 Ethical Considerations

This study was approved by the University of South Australia Human Research Ethics Committee (application ID: 203279) as required by the Australian government research requirements, specified in the National Statement on Ethical Conduct in Human Research (2007 - updated 2018). This has been developed to protect the interests of people who agree to participate in human research studies.

As a nurse who conducted the workshop as part of my PhD research, my approach prioritized the well-being of participants throughout the entire process. Before the workshop commenced, I took deliberate steps to prepare participants for potential stressors by clearly outlining the objectives, themes, and activities. This proactive communication aimed to establish transparency and foster open dialogue about expectations, providing participants with a sense of control and understanding.

Recognizing the potential impact of stress on individuals, I developed an introduction that emphasized inclusivity, respect, and the significance of each participant's unique perspective. Icebreakers and team-building activities were integrated into the workshop to create a supportive atmosphere and encourage connections among participants.

Throughout the workshop, I maintained a vigilant approach to participants' well-being by reiterating clear guidelines and expectations. I designated safe spaces within the workshop venue, including physical areas and identified individuals, such as myself, whom participants could turn to for support if they experienced stress or discomfort.

Mindfulness and relaxation techniques were woven into the workshop agenda, providing participants with practical tools to manage stress in real-time. Deep breathing exercises and scheduled breaks for self-reflection contributed to a holistic approach to address participants' mental and emotional states.

Recognizing the importance of individualized care, I scheduled regular check-ins throughout the workshop, using various methods such as informal conversations, anonymous feedback mechanisms, and designated moments for participants to express concerns. This personalized approach allowed me to address stressors promptly and tailor support to individual needs, fostering trust and safety.

Group dynamics were also a focal point, with activities designed to encourage collaboration and open communication among participants. Group discussions, shared reflections, and collaborative problem-solving enriched the learning experience.

Positioning myself as a readily available resource, I informed participants that I was accessible for one-on-one discussions if they required additional support.

As the workshop concluded, my commitment to post-workshop support remained steadfast. I shared resources related to stress management, self-care, and additional reading materials, extending an open invitation for continued communication. This post-workshop support emphasized my availability for follow-up discussions or inquiries, ensuring a las0ng impact on par0cipants' personal and professional growth. This post-workshop support emphasized my availability for follow-up discussions or inquiries, ensuring a lasting impact on participants' personal and professional growth.

Chapter 6.

What we found?! analysis, findings & responses

This chapter presents the core results of the research, detailing the comprehensive analysis, key findings, and the consequent responses. This chapter synthesizes the data gathered through various methods, interpreting how these findings impact the broader field of study. It also evaluates the implications of these results for both theory and practice, suggesting potential applications and future research directions. This section is pivotal in understanding the effectiveness of the methodologies employed and the innovative contributions of the study to existing knowledge.

Chapter 6: What we found; analysis, findings and responses

This chapter presents both the findings from the research and relevant analytical processes that shaped data interpretation. While Chapter 5 outlined the overall methodological approach, this chapter includes specific analytical techniques and participant characteristics that directly influenced how findings were generated and interpreted. This integration of analytical process with findings follows Bazeley's (2013) recommendation for qualitative research where the boundary between method and analysis is often fluid, particularly in co-creative approaches where participants actively contribute to data interpretation. As mentioned, two forms of first-hand data collection were used: A. a Policy Delphi method, which was used to gather information from healthcare experts, and B. Co-design workshop, which were used to capture information from service users with lived experience. This enabled us to

6.1 Coding process/ Thematic analysis

This section discusses the coding process and thematic analysis approach to this data collection applied to both the co-design workshop and the Policy Delphi.

Thematic analysis is a versatile qualitative analysis approach that assists researchers in examining the various views expressed by participants (Nowell et al., 2017). Despite its inherent complexity and potential for uncovering new insights, qualitative research has faced criticism for frequently needing more scholarly rigour. How can one ensure that an inductive study maintains "qualitative rigour" while preserving its capacity for creative and revelatory outcomes, typically associated with generating novel concepts and ideas? In inductive research, scholars employ a systematic approach encompassing both conceptual and analytical disciplines. This demanding methodology aims to provide reliable interpretations of data while also persuading readers of the plausibility and defensibility of the results produced. These enquiries exemplify an approach to research employing qualitative methodologies. Gioia et al. (2013) were among the pioneering scholars who developed an inductive research methodology to uncover novel concepts and formulate compelling theories. Over the past two decades, there has been significant advancement in the use of this methodology to conduct qualitative and interpretive research. This approach has guided the analysis and interpretation of research findings effectively.

The field of qualitative research has a rich past, particularly in terms of its capacity for generating insightful findings (Hennink & Kaiser, 2022). However, qualitative research has also been subject to criticism over the necessity to sufficiently substantiate its claims, resulting in concerns about the extent to which qualitative researchers engage in imaginative theorising based on limited evidence (Rose & Johnson, 2020). To help mitigate these criticisms both a "1st-order" analysis (which employed terms and codes centred around the informants) and a "2nd-order" analysis (which utilises researcher-centric concepts, themes, and dimensions) is often used. The labelling of these analyses as "1st-order" and "2nd-order" was inspired by Van Maanen's work in 1979. The combined reporting of both the informant and the researcher can help provide a comprehensive and rigorous demonstration of the connections between the data and the development of the concept of sense-giving. This approach also facilitates the generation of valuable insights, which are essential characteristics of qualitative research of high quality. Over time, implementing this methodical technique has demonstrated its utility in facilitating our research endeavours and those of others. It enhances the comprehensiveness of our idea formulation and theory construction. While acknowledging that this particular approach does not assert itself as the definitive method for showcasing statistical based evidence offered through quantitative research, it is deemed valuable to reveal socially constructed knowledge and as a means to explore its capacity to enhance the process of concept development in the context of organisational studies (Gioia et al., 2013).

Multiple scholars in the field of qualitative/interpretive research have observed that it is somewhat contrived to separate the process of conducting interviews from the subsequent analysis, as these two activities typically occur in tandem (Busetto et al., 2020). In this initial analysis, which aims to

represent the terminology used by informants accurately, we refrain from extensively consolidating categories, resulting in a significant increase in the number of categories at the beginning stages of the study. The initial set of 15 interviews yielded a substantial number of 1st-order categories (100 codes), which can be overwhelming in quantity. As the research advances, there is a growing inclination to identify commonalities and disparities among several categories, akin to the axial coding proposed by Gioia et al. (2013). Over time, this procedure reduces the number of relevant categories to a more manageable amount. Typically, this would be around 25 to 30 categories, but in our case, it resulted in 13 distinct codes. Subsequently, we assigned labels or phrasal descriptors to these categories, with a preference for maintaining the terminology used by the informants. We then analysed the arrangement of these categories, with a particular focus on emerging ideas that are not yet well-established in existing literature. For example, we examined 'identity ambiguity,' a concept proposed by Corley and Gioia in 2004. Additionally, we explored existing concepts that are gaining relevance in new fields, such as 'optimal distinctiveness,' introduced by Gioia et al. in 2010. Our research aims to build on these foundational theories and expand their application. After obtaining a coherent collection of themes and concepts, which satisfied the attainment of "theoretical saturation" as defined by Saunders et al. (2018), our objective was to examine the feasibility of further refining the emerging 2nd-order themes into second-order "aggregate dimensions" (Gioia et al., 2013). Once created, the collection of 1st-order terms, 2nd-order themes, and aggregated dimensions, we possessed the fundamental components necessary for constructing a data structure. This critical stage serves as a crucial element within our overall research methodology. The utilisation of a data structure not only facilitates the organisation of data into a coherent visual representation (Figure 11) but also offers a graphical depiction of the progression from raw data to terms and themes during the analysis phase. This is crucial in showcasing the thoroughness of qualitative research (Gholizadeh et al., 2018). By adopting this approach, designing a data structure necessitates a shift towards conceptualising the data theoretically rather than solely focusing on the practical aspects.

Concurrently with data collection and subsequent preliminary analysis, we engaged in a cyclical examination of emergent data, themes, concepts, and dimensions alongside pertinent scholarly literature (see chapters 2, 3 and 4). This dual approach served the purpose of determining if our findings aligned with existing knowledge and helped in identifying potential novel concepts that may have been uncovered or overlooked. I must admit that a certain degree of merit exists in embracing a state of partial or deliberate unfamiliarity with the existing body of literature. At this juncture of the research, we purposefully refrain from acquiring an extensive understanding of the existing literature. This deliberate approach is adopted to prevent the imposition of preconceived notions and confirmation bias, which may result from prematurely delving into the literature. After conducting a thorough review of the relevant literature, our selection criteria focused on sources that introduced pivotal concepts or significantly critiqued existing theories. This allowed us to streamline the literature by excluding sources that did not directly contribute to developing or understanding the key concepts under investigation. Over the course of the research, our methodology evolved from a predominantly inductive approach, aimed at generating theories directly from the data to an abductive approach. This shift entailed a simultaneous consideration of both new evidence and established theories, enhancing our analytical depth and theoretical integration (Shelton & Lee, 2019). Indeed, it is essential to acknowledge that we are never completely devoid of knowledge regarding previous research. Therefore, one may refer to this perspective as a "willing suspension of belief" or a conscious decision to remain unaware of prior theoretical developments within the relevant field. Integrating knowledge and ignorance presents a nuanced endeavour that facilitates exploration while avoiding redundant efforts.

6.2 The policy Delphi method results

The participant composition and analytical approach significantly shaped the themes that emerged from this research. Understanding these analytical choices provides essential context for interpreting the findings presented in this chapter. The thematic analysis revealed patterns across participant groups that illuminate both shared and divergent perspectives on perioperative anxiety.

Anaesthetists, surgeons, and nurses were chosen as the healthcare experts for Policy Delphi because they have longitudinal contact with patients in and around the surgical process and are significantly responsible for patient outcomes.

There is no best practice sample size advocated for Delphi studies (Nasa et al., 2021). The number of participants depends upon the topic under investigation, the relevant perspectives required, resources available and the range of expertise needed. Twenty participants were recruited and interviewed, 10 of whom were registered experienced anaesthetists, five experienced surgeons and five senior nurses.

A purposive sample method was employed. Also called a judgmental or expert sample, this is a type of nonprobability sample that aims to produce a sample that can be logically assumed to represent the population. Purposive sampling was used in this part of the study to target a group of healthcare experts who were likely to be able to represent the views of a wider professional group. Purposive sampling is often used in qualitative and mixed methods research and involves an iterative process of selecting research subjects rather than starting with a predetermined sampling frame (Hennink & Kaiser, 2022). This allowed a snowballing recruitment process that used the professional networks of initial participants to identify further healthcare professionals interested in addressing the research question.

The following two topics were posed in a semi-structured interview that lasted between 45 minutes and 1 hour, depending on the complexity and detail of each participant's response.

Policy Delphi discussion topics

1. Participants were asked to describe the perioperative environment and processes through their professional experiences, which, in their opinion, caused anxiety.

2. Participants were asked to describe their understanding of augmented and virtual reality technologies and how they thought they might be used in the future to help reduce perioperative anxiety in patients.

Data collected from the Policy Delphi process was used to identify the knowledge gap and critical patterns regarding perioperative anxiety from the expert perspective. This data was also used to establish a baseline understanding of the level of comprehension and interest in using augmented and virtual reality to address perioperative anxiety in patients. The thematic analysis identified four main periods where anxiety may be triggered:

- Hospital period (covering both pre-arrival and the arrival experience)
- Preoperative phase
- Intra-operative phase and
- Post-operative phase

These four periods illustrate the broad multidimensional nature of perioperative anxiety. An overview of the themes that emerged through the Policy Delphi study within each of these periods is presented in Figure 13 below.

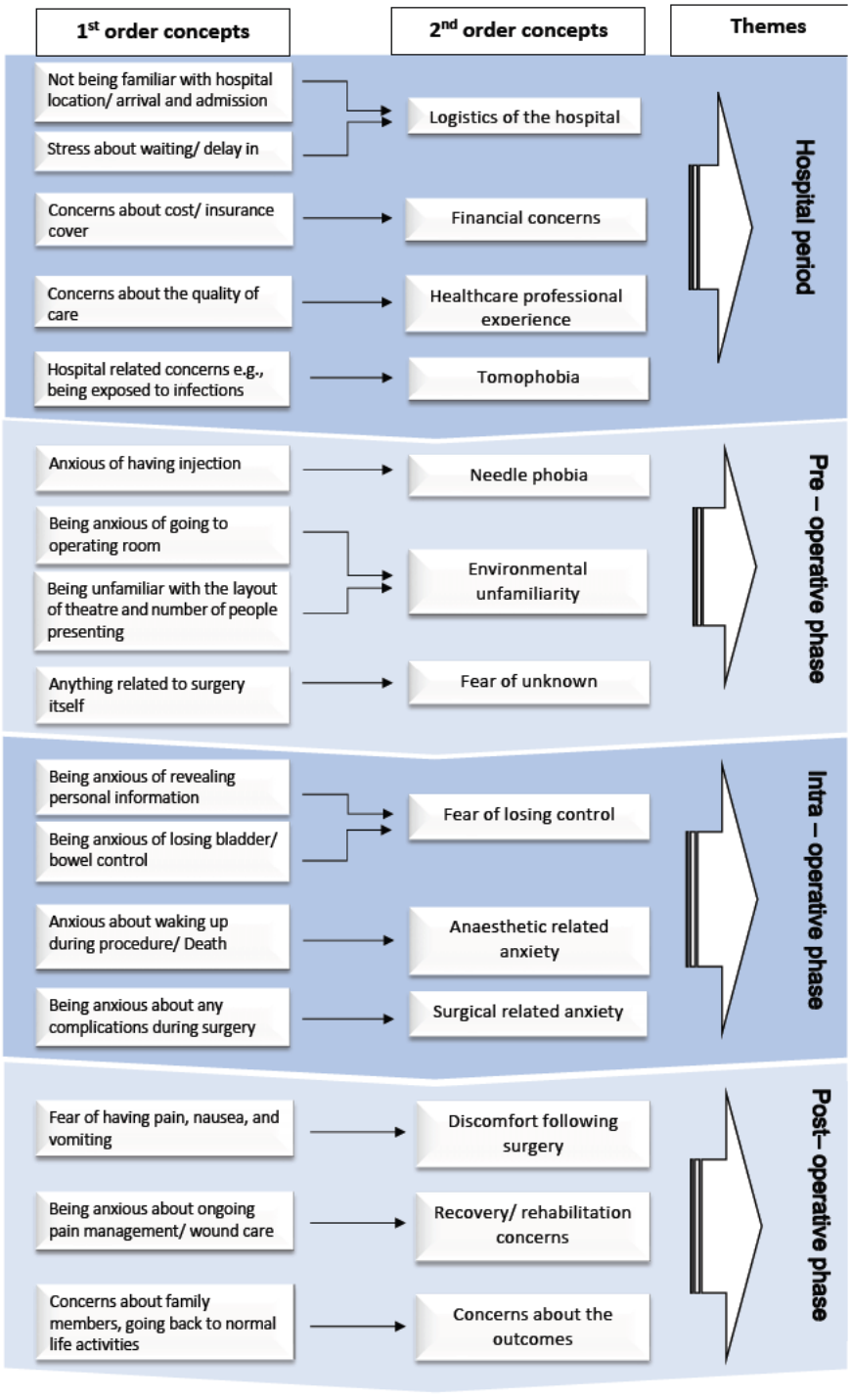


Figure 13 Thematic analysis coding from Policy Delphi study expert opinion on perioperative stress

Many of the concerns raised by the expert group were in line with previous research, including identifying the risk regarding harm or discomfort, scheduling issues, concerns related to others, limited understanding or information regarding surgery, and concerns related to the hospital environment and staff. However, several additional perioperative concerns were identified and not described by existing literature. These concerns related to current health status, e.g. COVID, related issues affecting the time of waiting lists and complications of the admission process, contracting an illness or infection while in the hospital, such as being exposed to Methicillin-Resistant Staphylococcus Aureus (MRSA), aesthetic aspects of surgery including surgical scars, and a lack of personal privacy.

6.3 The Co-design method results

Co-design challenges which facilitate the engagement of service users in quality improvement paradigms are commonly used in hospitals in three significant ways. First, to encourage patients to take a role in reviewing and developing services. Second, focus the designing of services around patient experiences. Third, the active adoption of techniques and tools derived from service design—e.g. prototyping and storyboards, as well as process maps to help inform decision making (Bird et al., 2021).

In healthcare, co-design is often used as a methodology to enhance the quality of experiences for a range of stakeholders including patients, carers, and healthcare personnel. The process involves patients' and staff's active involvement in examining the care pathway, and the emotional trajectory patients undergo (Garcia Martinez et al., 2022). This includes documenting their experiences and collaboratively seeking to comprehend and enhance these experiences. In the past, patients and their families were typically regarded as passive beneficiaries of healthcare services (Malmberg et al., 2019). Nevertheless, there has been a growing recognition in recent years regarding the significance of including more substantial consumer feedback in the evaluation and development of services. The fundamental tenets that form the foundation of our co-design efforts encompass concepts of equality, comprehensive comprehension of experiences, and enhancement of services (Vargas et al., 2022).

The co-design methodology not only served as a data collection method but also as an analytical framework through which participants actively contributed to identifying significant themes and patterns. The collaborative nature of this analytical process revealed insights that might not have emerged through more traditional researcher-centred approaches. The following description explains how the co-design process functioned as both method and analytical tool, shaping the findings presented in subsequent sections.

Co-design workshop typically encompass a range of diverse individuals interested in the project, conventionally convening in a single location to engage in discussions, collaborative learning, and decision-making processes. Although due to the impact of COVID more diverse strategies for engaging participants in a co-design process have been embraced (Davis et al., 2021). Co-design workshop in a health context can be used for different reasons, including initiating a project (start-up, project framing or planning workshop), gaining insight into patient or staff experiences, conducting thorough investigations into specific issues (journey mapping or ideas groups etc.), and generating practical solutions (utilising methods like prototyping).

The co-design workshop in this study aimed to explore the following topics based on the lived experience of the stakeholder representatives (See page 145 for a description of the inclusion criteria for participant selection):

- When, where, and what were the causes of your peak moments of stress?
- What would help alleviate these stressful moments?
- What information given to patients during their surgical journey was most beneficial?
- What other information would patients think would be helpful to improve their experiences?
- When is the best time to get this information?
- What format would people like the information provided in?
- What knowledge and experience do you have of immersive digital media?
- What other content ideas do you have that might help?

The questions and concerns above were explored through a patient journey mapping and prompting exercises in the codesign workshop

.

In the workshop, participants discussed their understanding of VR and AR technologies and considered how, when, and where these might be used to address perioperative anxiety. Specific activities were developed that allow the participants to understand the different stages of the journey. Identified Participants also explore what sort of content or information might be desired at different points in this journey.

Findings from the co-design workshop were triangulated with the findings from the Delphi study and the broader literature and technology review, to formulate a set of guiding principles and practice for the implementation of VR and AR interventions to mitigate perioperative anxiety.

6.4 Journey Mapping in Collaborative Design Workshops

Patient journey mapping functioned as a critical analytical tool that transformed individual experiences into visible patterns of anxiety triggers and intervention opportunities. Unlike traditional data analysis conducted solely by the researcher, this analytical approach allowed participants to directly visualize and interpret their perioperative experiences, creating a collaborative analytical process. The resulting journey maps represent both data visualization and analytical outcomes that inform the subsequent findings. In the co-design workshop, I employed a structured yet flexible approach to ensure effective and collaborative journey mapping. The was conducted over a duration of two and a half hours and accommodated groups of up to ten participants. This size was ideal to foster active engagement and ensure that every voice was heard, while still being manageable and conducive to group dynamics.

Design of the Journey Mapping Template

The journey mapping process began long before the actual workshop. We designed a template that was both intuitive and comprehensive, serving as a visual scaffold for participants' thoughts and insights. The template was structured around key stages of the user experience, with pre-defined sections such as 'Initial Contact,' 'Engagement,' 'Pain Points,' and 'Resolution.' We made sure to leave ample space for participants to add their own stages or touchpoints that were specific to their experiences.

Introduction of Journey Mapping to Participants

At the start of the workshop, I introduced the concept of journey mapping through a short presentation. This included examples of successful journey maps and a clear explanation of how this tool helps in visualizing the user experience from start to finish. It was emphasized the importance of identifying not just the what and the when, but also the how and the why behind each interaction.

Using the Template with Participants

Once participants were familiar with the concept, the templates were distributed along with markers, sticky notes, and coloured dots for them to use. To kickstart the mapping process, we used prompts that guided participants to think critically and empathetically. After the initial introduction and distribution of the journey mapping templates, I introduced another engaging tool — the photo collage. This was designed to visually stimulate the participants and aid in recalling and articulating their experiences more vividly. Participants were provided with a collection of photographs depicting various stages of user interaction and were encouraged to select images that resonated with their personal or observed experiences. These images were then incorporated into their journey maps at relevant stages.

Integrating Photo Collages with Journey Maps

Participants used the photo collages to enhance their journey maps by attaching images next to specific touchpoints or stages on their templates. This visual addition helped in several ways:

Enhancing Memory Recall: The photos served as cues that triggered memories of specific experiences, making the descriptions more detailed.

Expressing Emotional Responses: Images helped participants express feelings and attitudes

that were difficult to convey through words alone, enriching the emotional depth of the journey maps.

Facilitating Discussion: The photo collages prompted discussions among participants, as they compared images and shared why certain visuals were significant to their individual experiences.

Interactive Elements and Group Collaboration

Throughout the workshop, I encouraged participants to collaborate. They were invited to walk around, discuss their points with others, and even add insights to each other's templates. This cross-pollination of ideas often led to a deeper understanding and more nuanced journey maps.

Reflection and Consolidation

In the final hour of the workshop, we gathered to share insights and reflect on the journey maps created. Each participant or small group presented their map, highlighting key emotional peaks and troughs, unexpected insights, and potential areas for improvement. This session was crucial for synthesizing collective insights and setting the stage for the next steps in the design process.

During the reflection phase of the workshop, the photo collages played a crucial role. Participants presented their journey maps and explained the choice of images, providing insight into the emotional and experiential landscape of the user journey. This visual and narrative presentation allowed for a richer, more comprehensive group analysis and helped identify common patterns and unique outliers in user experiences.

By integrating photo collages, the journey mapping process became not only an analytical tool but also a compelling storytelling medium, making the insights gathered during the workshop both informative and memorable.

Through these methods, we not only captured detailed user experiences but also cultivated a strong sense of ownership and collaboration among all participants, enhancing the power of the insights for guiding subsequent design phases.

6.5 Making the Patient Journey Visible Uncovers New Opportunities

Journey maps were chosen for this research as they allow researchers to determine the paths various consumer segments tend to follow based on real-life experiences. In healthcare provision, journey maps enable healthcare organisations to monitor and analyse consumer sentiment (frustration, comfort) throughout interactions across multiple channels. Figure 14 shows Process of Patient Journey Mapping can be used within a healthcare context. Patient journey mapping techniques are a structured, often visual representation of a specific person's goals, activities, emotions, and interactions as they experience the service being investigated (Arias et al., 2020). They can be used to diagnose current insights and opportunities and envision the design of future experiences. Patient journey mapping can answer questions like:

- What are patients trying to achieve?
- How are they expecting to achieve this?
- Why and how do they make choices?
- What do patients feel while trying to reach the desired outcome?

Patient journey mapping within a hospital setting presents a valuable opportunity to transform how patients interact with the healthcare system, shifting the focus from a reactive approach to a proactive one. Helping to ensure patient engagement throughout the healthcare delivery stages can foster patient confidence and trust, promoting the likelihood of patient referrals to one's healthcare institution among acquaintances and family members.

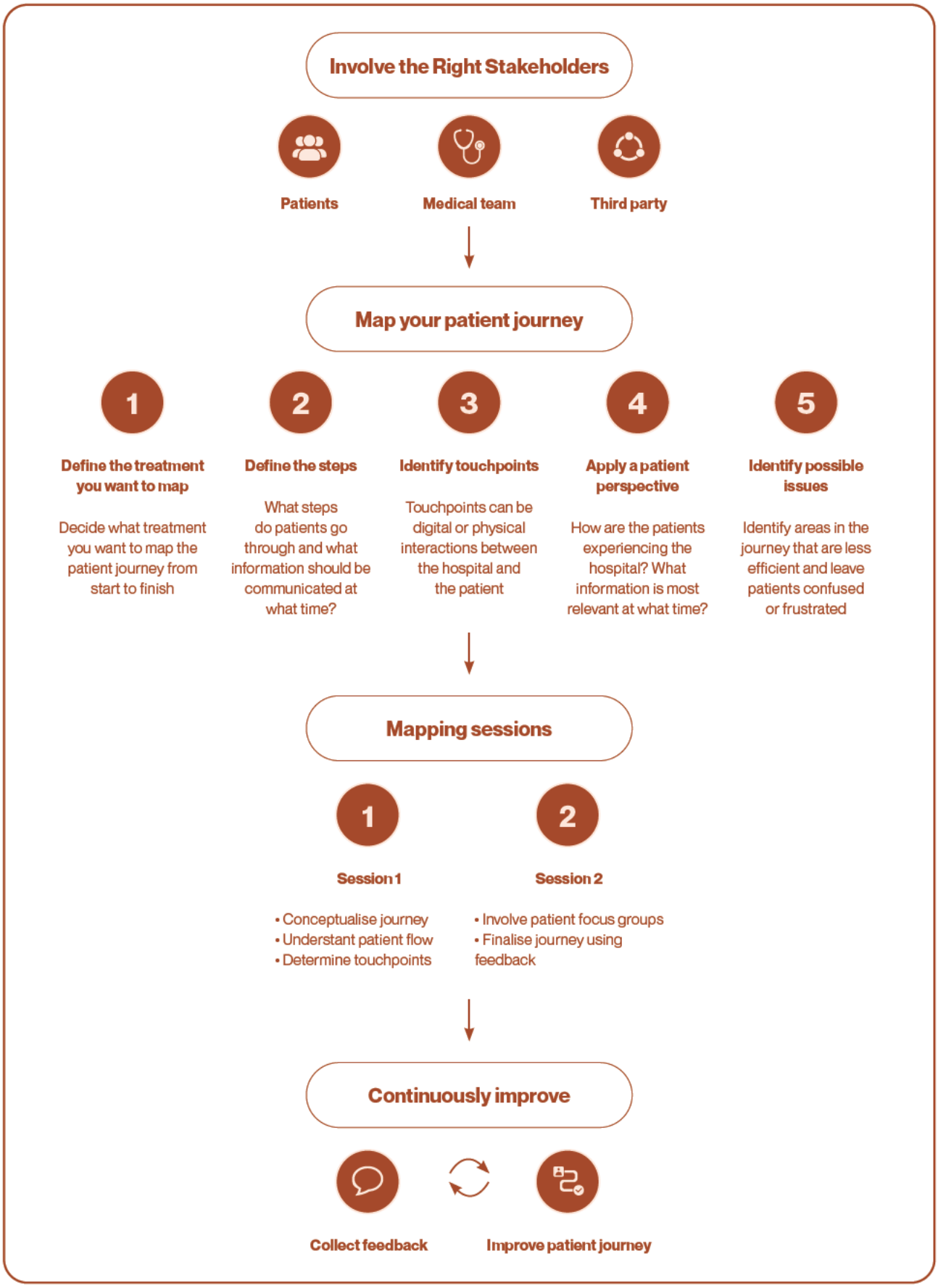


Figure 14 Process of Patient Journey Mapping (Arias et al., 2020)

How Patient Journey Mapping Enhances Healthcare

Expose service gaps

A patient experience map identifies areas of deficiency within the system, such as the appointment procedure, hospital care, and customer service to reveal underlying factors contributing to a negative patient experience.

Improve communication

Effective communication facilitates doctors' comprehension of patients' health conditions. Nevertheless, exchanging patient information and coordinating care might present difficulties and lead to patient frustration. The misalignment may arise due to various circumstances, such as issues about confidentiality or incompatibility between systems. Using a patient journey mapping template can help to facilitate the establishment of a transparent mode of communication between patients and healthcare professionals.

Understand patients' concerns

Many patients need more awareness regarding the correlation between their medical state and the manifestation of symptoms. The utilisation of a patient journey map has the potential to address the concerns experienced by patients.

Support patients during the post-treatment stage

Following the administration of a prescribed treatment, patients may need to adopt a modified lifestyle for a period of time to account for post-treatment recovery: this may encompass things such as medication adherence, engagement in physical therapy, and participation in counselling sessions, among others. Healthcare journey mapping can assist in the communication of the post-treatment phase by actively monitoring their post-treatment experiences, detecting potential challenges, and assisting in exploring viable solutions.

Streamline healthcare workflow

Healthcare customer journey maps can also enhance the usability and functionality of online patient portals, websites, and mobile applications, empowering patients with greater control, improving patient flow, and reducing operating costs.

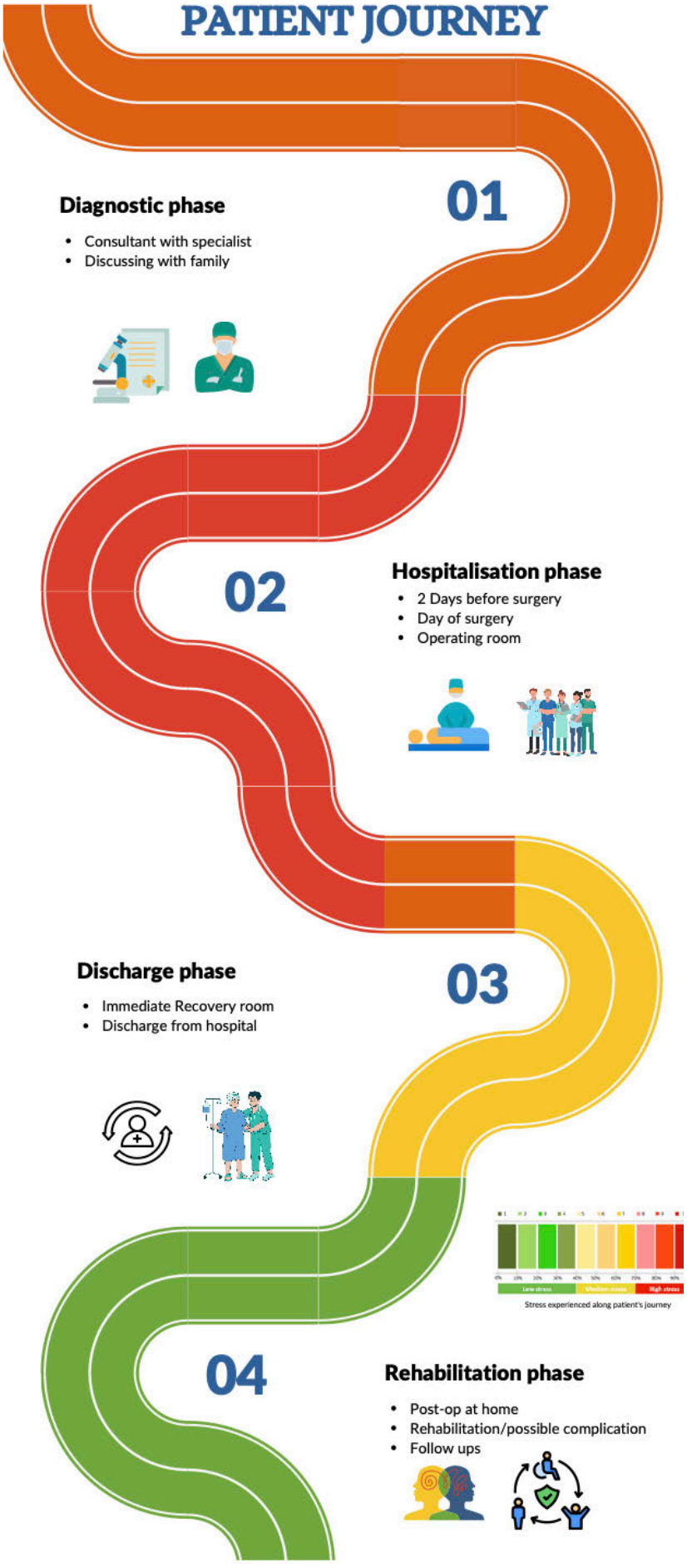


Figure 15 Overview of Perioperative journey map showing typical stress levels along the patient's journey lived experience research (created by researcher).

6.6 Themes from Co-Design sessions

Table 2 outlines themes derived from co-design sessions that focused on exploring the stress patients experience at various stages of the perioperative journey. These themes provide a nuanced understanding of the emotional challenges faced by individuals undergoing surgical procedures. These collaborative sessions provided a comprehensive exploration of the factors contributing to patient stress, shedding light on distinct moments within the perioperative process that evoke anxiety and unease. The identified themes offer valuable insights into the multifaceted nature of patient experiences, facilitating a targeted approach to address and alleviate stressors effectively.

The insights emerging from the data analysis directly address the study's central research question: 'How can immersive technologies be effectively integrated into perioperative care to reduce patient stress and anxiety while revolutionizing healthcare delivery and improving surgical outcomes?' The functional requirements and experiential insights identified through this analysis reveal the specific points where technological interventions can most effectively address patient anxiety throughout the perioperative journey. These findings also respond to the subsidiary research questions by identifying the key tensions and challenges encountered by patients (patient-centred care assessment), revealing methodological approaches for effective digital health interventions. The following sections detail these insights, organized according to functional and experiential dimensions that directly inform the development of the RED Rules framework introduced in section 6.10.

Table 2 themes derived from Co-Design sessions

Perioperative Journey	Themes of Patient Stress
Preoperative Anxiety:	Participants identified the preoperative phase as a significant source of stress for patients. Concerns related to the unknowns of the procedure, potential outcomes, and anticipation of surgery were highlighted.
Communication Gaps:	Stressors associated with inadequate or unclear communication emerged as a theme, emphasizing the importance of transparent information flow to address patient questions and alleviate uncertainties.
Wait Times & Uncertainty:	Long waiting periods and uncertainties about when the procedure will occur contributed to patient stress. Participants underscored the need for better scheduling and communication regarding timing.
Fear of the Unknown During Surgery:	Participants highlighted the fear and stress experienced by patients during the actual surgical procedure, emphasizing the importance of clear communication about the process and expected outcomes.
Postoperative Disorientation:	Patients expressed stress related to postoperative disorientation, waking up in a different environment, and grappling with the effects of anesthesia. Improved postoperative guidance and support were identified as essential.
Pain Management Concerns:	Stress associated with potential postoperative pain and concerns about pain management were identified, highlighting the need for proactive communication and effective pain control strategies.

Perioperative Journey	Themes of Patient Stress
Transition to Home Anxiety:	Participants noted that the transition from the hospital to home or another care setting can be stressful for patients. Clear post-discharge instructions and ongoing support were identified as crucial elements.
Information Overload:	While information is crucial, an overload of information was recognized as a stressor. Co-Design participants emphasized the importance of delivering information in a digestible manner and ensuring patients can access support when needed.
Perceived Lack of Control:	A recurring theme was the stress associated with a perceived lack of control over the perioperative journey. Strategies to empower patients and involve them in decision-making processes were identified to mitigate this stressor.
Emotional Support Needs:	Emotional support needs throughout the perioperative journey were highlighted, emphasizing the importance of addressing the psychological and emotional aspects of the patient experience.

Issues raised by patients around technology usage

In the pursuit of integrating immersive technologies within perioperative care, a co-design approach was employed to gather direct feedback from patients. This method not only helped in understanding the potential benefits of such technologies but also highlighted various issues and concerns from a patient's perspective. These discussions were instrumental in identifying key areas of concern that could impact the adoption and effectiveness of AR and VR technologies. Addressing these concerns is crucial for designing solutions that are not only technologically advanced but also patient-centred and accessible.

Table 3 Issues raised by patients around technology usage

Theme	Specific Issues Raised	Patient Concerns	Suggested Solutions
Technical Complexity	Difficulty in operating VR/AR devices	"The equipment seemed too complex to use comfortably."	Simplify interfaces and provide training
Physical Comfort	Discomfort wearing devices during procedures	"The headset was heavy and uncomfortable during long use."	Design lighter, more ergonomic devices

Theme	Specific Issues Raised	Patient Concerns	Suggested Solutions
Accessibility	Access issues for those with disabilities	"I couldn't use the device with my hearing aids."	Develop compatible and inclusive designs
Privacy & Data Security	Concerns about personal data usage	"I am worried about who has access to my data."	Implement strict data protection policies
Effectiveness	Uncertainty about the actual benefits	"Is this really going to help with my anxiety?"	Provide clear, evidence-based benefits
Cost	Worries about additional costs	"Will this technology make my treatment more expensive?"	Clarify cost implications for patients

Here's a detailed table to outline the benefits of immersive technologies as identified by patients, along with their ideas for potential applications:

Table 4 benefits of immersive technologies identified by patients

Stage of Perioperative Journey	Perceived Benefits	Patient Brainstormed Ideas	Proposed Implementation
Pre-Treatment	Reduces pre-surgery anxiety	"Could we use VR to simulate the surgery beforehand?"	Implement VR simulations of surgical procedures to familiarize patients.
During Treatment	Distraction from pain	"What if AR could show calming scenes during treatment?"	Use AR to overlay calming visuals/ music during procedures.
Post-Treatment Recovery	Faster recovery	"Can VR help in relaxation and pain management post-surgery?"	Deploy VR experiences designed for relaxation and guided meditation.
Long-Term Rehabilitation	Sustained engagement	"AR apps that guide daily rehab exercises at home would be helpful."	Develop AR-guided physical therapy programs for use at home.

Stage of Perioperative Journey	Perceived Benefits	Patient Brainstormed Ideas	Proposed Implementation
Education and Preparation	Enhanced understanding	"VR could be used to explain the risks and outcomes in a visual way."	Create interactive VR experiences that educate patients on their
Emotional Support	Emotional resilience	"Can we have virtual support groups in VR?"	Establish VR platforms for virtual patient support groups.

6.7 Comparison between Delphi study and Co-design findings

Additional themes of interest were discovered through the co-design process, providing insight into the multifaceted nature of patients' needs, and shedding light on the diverse spectrum of their experiential and perceptual dimensions. The following list highlights the similarities and differences between the insights revealed by the professional healthcare professionals in the Delphi study and the patient experiences revealed in the co-design workshop.

Commonalities

Both patients and healthcare professionals share the goal of adopting a patient-centred approach and enhancing communication tools in the perioperative process. Immersive technologies, such as Augmented Reality (AR) and Virtual Reality (VR), offer innovative ways to meet these needs by boosting patient empowerment and improving communication.

Empowerment through Technology: AR and VR can revolutionize patient empowerment by providing immersive, interactive experiences that demystify complex medical procedures and treatment plans. These technologies enable patients to visualize their procedures beforehand, which can alleviate anxiety and enhance their understanding of the treatment process. This not only informs patients but also empowers them to actively participate in their care decisions.

Enhancing Communication: Technologies like AR and VR can also play a significant role in improving communication between patients and healthcare providers. By using virtual reality simulations, healthcare professionals can more effectively communicate risks, processes, and benefits of procedures in a way that is easily understandable to patients. Furthermore, AR applications can be used during consultations to overlay information directly onto the patient's body, providing a clear and direct form of communication that can help in explaining what to expect during and after the surgery. Patients and healthcare professionals commonly acknowledge the need for accessible and clear information. There is a shared understanding that communication tools should be designed to provide information in a comprehensible manner to enhance patient understanding.

Collaborative Decision-Making: Leveraging these technologies encourages a more collaborative environment where patients feel more comfortable voicing their concerns and preferences. This is crucial for truly informed consent and for tailoring treatment plans that align with patient values and expectations.

Reducing Complications: With better informed and empowered patients, the likelihood of complications due to misunderstandings or lack of information decreases significantly. Technologies that provide detailed preoperative planning and simulation can help identify potential risks and prepare both the patient and the medical team more effectively.

Differences

Perceptions of Empowerment:

- Patients often emphasize empowerment in terms of being actively involved in decisions about their care, having their preferences considered, and feeling informed and in control.
- Healthcare professionals can view empowerment as a collaborative process where patients are educated and supported to actively engage in their care but recognising the need for shared decision-making.

Communication Preferences:

- Patients may prioritise personalised and empathetic communication, emphasizing the importance of being treated as individuals with unique needs and concerns.
- Healthcare professionals, while recognizing the importance of empathy, may also stress the need for clear and concise communication to convey medical information accurately.

Involvement in Decision-Making:

- Patients often want to be actively involved in decisions related to their perioperative care, including treatment options, recovery plans, and potential risks.
- Healthcare professionals may be more concerned with ensuring that patients are well-informed about their conditions and treatment options, guiding them through the decision-making process.

Knowledge Disparities:

- Patients may feel a lack of adequate information and understanding about the perioperative process, leading to anxiety and uncertainty.
- Healthcare professionals may assume a baseline level of medical knowledge, potentially underestimating the need for detailed explanations and educational resources.

Role in Designing Communication Tools:

- Patients may prefer direct involvement in co-designing communication tools to ensure relevance and user-friendliness
- Healthcare professionals may emphasize the importance of expert input to ensure accuracy and medical appropriateness.

Ultimately, this collaboration between healthcare professionals and patients, facilitated by advanced technological tools, has the potential to revolutionize the healthcare system. By doing so, healthcare professionals can gain a better understanding of the patient's needs and expectations, while patients can become more confident in their own health and feel more empowered to make decisions. Additionally, this collaboration can help improve the quality of care provided, as well as reduce medical errors and other complications that can arise during the perioperative process. For example, when healthcare professionals and patients work together using these technological tools, they can better identify potential risks and develop strategies to mitigate them, thus reducing the likelihood of complications and achieving better outcomes.

6.8 Insights from Data Analysis

The insights emerging from the data analysis directly address the study's central research question: 'How can immersive technologies be effectively integrated into perioperative care to reduce patient stress and anxiety while revolutionizing healthcare delivery and improving surgical outcomes?' The functional requirements and experiential insights identified through this analysis reveal the specific points where technological interventions can most effectively address patient anxiety throughout the perioperative journey. These findings also respond to the subsidiary research questions by identifying the key tensions and challenges encountered by patients (patient-centered care assessment), revealing methodological approaches for effective digital health intervention implementation (methodological approaches), and providing an evidence base for communicating findings to inspire sector-wide change (sector-wide communication and impact). The following sections detail these insights, organized according to functional and experiential dimensions that directly inform the development of the RED Rules framework introduced in section 6.11. This section discusses how method analysis categorizes insights into two main areas: functional requirements and experiential insights. By dissecting the data, we can pinpoint specific necessities and understand patient experiences more deeply. This dual approach ensures that healthcare solutions are both effective and aligned with patient expectations.

Functional requirements

Need for Information

Overall, patients expressed dissatisfaction with the level of complexity in written materials they receive from healthcare providers, specifically in respect to information regarding surgical procedures, anaesthesia, and informed consent. Service users indicated that there needed to be more verbal communication between patients and their physicians, particularly in an easily comprehensible language. The participants also discussed the importance of receiving comprehensive information, which extends beyond the medical issue and surgical intervention. This included exploring alternative treatment options and considering the potential consequences or limitations arising after the surgery. Additionally, the patients' professional responsibilities were considered in determining an appropriate duration of sick leave. In this context, many patients expressed dissatisfaction with the extent of their postoperative limits, which were found to be more severe than initially communicated by their physicians, if any explanation was provided at all. Patients commonly perceive that healthcare personnel often make assumptions about their knowledge, presuming that patients are aware of unfamiliar information. There was a collective desire expressed regarding the necessity of designating a family member as a "person of reference" responsible for receiving pertinent information from healthcare providers to prevent any potential miscommunications or omissions of crucial details.

From the patient's perspective, the need for information is important in establishing a sense of control and understanding.

> "I want to be equipped with comprehensive and accessible knowledge about my medical condition, the planned surgical procedure, and the potential outcomes".

Clear communication from healthcare professionals is essential in breaking down complex medical jargon into digestible information that enables patients to make informed decisions.

Healthcare providers should engage in open and honest conversations, using language that is easily understood by patients. Visual aids, such as diagrams or models, can further enhance comprehension. Providing written materials or access to reputable online resources also empowers patients to revisit information as needed. Recognizing the diversity of learning styles and preferences among patients, healthcare providers should adapt their communication methods to ensure effective information dissemination.

Additionally, offering opportunities for patients to ask questions and express concerns fosters a collaborative relationship between the healthcare team and the individual. Establishing this open line of communication helps alleviate anxiety, build trust, and create a more patient-centred experience.

Material Resources

The availability and quality of material resources significantly impact the patient's perception of the healthcare system's capability and reliability.

> "I want assurance that the medical facility is equipped with the latest technology, well-maintained surgical instruments, and a sufficient supply of necessary materials."

Transparent communication regarding the hospital's commitment to maintaining and updating these resources is crucial. Hospitals and surgical centres should regularly invest in technological advancements and adhere to strict protocols for equipment maintenance. Demonstrating a commitment to staying at the forefront of medical innovation instils confidence in patients, assuring them that their well-being is a top priority.

In addition to high-tech resources, attention to the cleanliness and organization of the surgical environment is paramount. An environment that is orderly, sterile, and well-equipped contributes to the overall safety and success of the surgical procedure. Patients appreciate visible efforts to maintain a hygienic and well-prepared surgical setting, further enhancing their trust in the healthcare facility.

Desire for Relatives or Companion

The presence of loved ones during the surgical journey is not merely a desire but a fundamental need for emotional support and reassurance. Having family members or a trusted companion by my side provides a sense of comfort and familiarity in an otherwise potentially overwhelming environment.

Recognizing the importance of this need, healthcare providers should actively encourage the involvement of relatives or companions in the patient's care journey. While respecting privacy and medical regulations, creating spaces for family members to be present during preoperative discussions, and allowing companionship in the recovery area can significantly enhance the patient experience.

Furthermore, healthcare professionals should acknowledge and address the potential anxiety and stress that family members may experience. Offering information and support to them, in addition to the patient, contributes to a holistic approach to care. It's essential to recognize the interconnectedness of the patient and their support network, understanding that the emotional well-being of both parties is intertwined.

Personalization

The concept of personalized care goes beyond acknowledging the patient as an individual; it involves tailoring every aspect of the healthcare experience to meet their unique needs and preferences. From the treatment plan to communication styles, personalization ensures that the patient feels seen and valued.

In a personalized care approach, healthcare providers take the time to understand not only the patient's medical history but also their cultural background, beliefs, and lifestyle. This information guides the development of a treatment plan that aligns with the patient's values and preferences. For instance, dietary considerations, cultural practices, and individual preferences should be integrated into the overall care strategy.

Moreover, personalization extends to the communication between healthcare providers and patients. Some patients may prefer detailed, technical explanations, while others may appreciate a more simplified overview. Offering options for communication styles and actively seeking feedback ensures that the patient feels heard and understood.

Healthcare Professional of Reference

Having a designated healthcare professional as a point of contact is critical for establishing a trusting and continuous relationship throughout the surgical journey. As a patient, knowing that there is a dedicated individual who will serve as their primary contact provides a sense of security and consistency.

The healthcare professional of reference plays a multifaceted role. They serve as a liaison between the patient and the medical team, providing updates, addressing concerns, and facilitating clear communication. This individual should be easily accessible, approachable, and empathetic, fostering a supportive relationship that extends beyond the surgical event.

To enhance the effectiveness of this role, healthcare providers should ensure that patients are introduced to their designated professional early in the process. This introduction allows the patient to establish a connection and understand the crucial role this individual plays in their care journey. Regular check-ins and proactive communication further reinforce the sense of continuity and personalized attention.

Reliance on Human Resources

The human resources involved in surgical care encompass a diverse group of skilled professionals, each contributing to the patient's well-being in a unique way. Recognizing the importance of this multidisciplinary team is paramount, and as a patient, I appreciate the collective efforts of surgeons, anaesthesiologists, nurses, and support staff.

Surgeons, as the key players in the surgical process, should be not only technically proficient but also empathetic and communicative. Their ability to convey information and address patient concerns contributes significantly to the overall patient experience. Anaesthesiologists play a critical role in ensuring the patient's comfort and safety during surgery, requiring a high level of expertise and attention to detail.

Nurses, as frontline caregivers, are instrumental in providing preoperative education, postoperative care, and emotional support. The interaction with nursing staff often shapes the patient's perception of the entire healthcare experience. Therefore, investing in nursing education, training, and adequate staffing levels is essential for maintaining high standards of patient care.

Support staff, including administrative personnel, play a behind-the-scenes yet crucial role in ensuring the efficiency of administrative processes. From scheduling appointments to managing medical records, their contribution influences the overall patient experience. Adequate staffing levels, ongoing training, and recognition of their importance contribute to a well-functioning healthcare system.

Coordination for a Smooth Experience

Coordination among healthcare professionals and departments is the backbone of a smooth and efficient surgical experience.

> "I would like to rely on the easy coordination and logistics in whole my journey for a seamless transition from preoperative preparations to postoperative care."

Effective communication channels should be established to ensure that all members of the healthcare team are on the same page regarding the patient's care plan. Regular interdisciplinary meetings and case conferences contribute to a shared understanding of the patient's unique needs and challenges.

Furthermore, clear protocols and standardized procedures aid in minimizing errors and streamlining processes. This includes ensuring that preoperative assessments are comprehensive, surgical checklists are diligently followed, and postoperative care plans are communicated clearly to both the patient and relevant healthcare providers.

Technology plays a pivotal role in enhancing coordination, with electronic health records facilitating seamless information sharing among different departments. Investing in user-friendly and interoperable health information systems contributes to more efficient communication and a reduction in administrative errors.

A holistic approach to coordination involves not only internal communication among healthcare professionals but also collaboration with external stakeholders. This includes primary care physicians, rehabilitation specialists, and home healthcare providers. Seamless transitions of care between these entities contribute to a continuum of support for the patient, minimising gaps and optimizing overall health outcomes and experiences.

Experiential Insights

Fears

The primary concerns of the participants in the study were focused on three specific instances: the waiting period, the surgical procedure (including anaesthesia and the surgery), and the process of being discharged from the hospital and returning home. The interval of time, sometimes referred to as the "waiting period," that occurs between the initial indication of surgery and the scheduled surgery date was seen to elicit feelings of worry, anxiety, and tension due to concerns regarding the potential deterioration of the underlying ailment, and the perceived or real need for immediate surgical intervention. This sensation's intensity was heightened when a specific date for the surgical procedure had not yet been allocated. During this waiting period, it was raised that better adherence and opportunities to attend scheduled follow-up appointments would provide better opportunities for closer monitoring of their status.

Regarding anaesthetic, patients commonly expressed two primary fears: the worry of regaining consciousness during surgery and the dread of not waking up post-operation with a sense of helplessness or engaging in embarrassing behaviours. Many patient participants expressed that their apprehension towards anaesthesia, particularly the concern of not regaining consciousness, surpassed their anxiety towards the surgical procedure itself. In relation to surgical procedure, it was agreed that the ambience of the operating room also often evokes anxiety and is characterised as "intimidating". Additionally, there are significant concerns about the potential occurrence of complications during surgery, including the possibility of mortality.

The primary concerns expressed during the immediate post-operative phase pertain to a limited comprehension of the expected post-surgical experiences, particularly regarding pain or discomfort. Additionally, following hospital discharge, individuals often express apprehension regarding their ability to adapt to a novel situation, typically accompanied by restrictions in their daily activities upon returning home. Several patients expressed dissatisfaction with the apparent magnitude of limits, either finding them more than anticipated or being informed of them by their health teams.

Emotional Impact

The co-design participants agreed that surgical interventions elicit various feelings, necessitating diverse consolation or alleviation. Drawing on my expertise in architecture and environmental psychology, I recognize that the hospital environment, beyond just the surgical procedures themselves, can often induce feelings of melancholy among patients. Certain patients often experience a desire for privacy through the expression of tears or seeking solitude for a while.

The postoperative phase, particularly upon returning home following hospital discharge, was seen to potentially elicit significant emotional responses. Some participants asserted that the perceived efficacy of the surgical procedure did not consistently align with their subjective sense of overall well-being. Moreover, the process of adjusting to the new circumstances within the household instils feelings of anxiety due to the pressing need to return to normalcy and mitigate any potential repercussions on the well-being of patients' family members, including children. This phenomenon is amplified when patients think that their impairments in doing daily activities are more substantial than initially anticipated. The participants desired additional guidance regarding appropriate actions and precautions throughout the convalescence period in their homes. They felt that there needed to be more information about what actions should be taken or avoided and any advice for facilitating the recovery process.

Pain

The co-design participants commonly regard pain as a typical occurrence during the postoperative phase, often considering it as an inherent part of the overall process. This was compounded by a perception that clinical teams exhibit inflexibility regarding analgesia on certain occasions. The provision of additional dosages of effective analgesics, when practicable, was regarded vital since it allowed a degree of flexibility in pain management. The participants asserted that they had encountered discomfort that they deemed as "unnecessary" as a result of physicians' hesitancy to administer more potent analgesics. Experiencing pain and having to endure until the subsequent planned dosage was a recurring circumstance that resulted in avoidable anguish.

Stress & Anxiety

There was a strong correlation between the stressed and anxious patients mentioned above and their fears. It was noted, however, that they were also discussed in situations that did not present an immediate threat, the most significant of which was the waiting period (because there was uncertainty around surgery dates) and hospital discharge (because of uncertainty regarding daily life and the duration of limitations). The fear of the unknown and the lack of control over the situation were other factors for the patients' stress levels. The lack of support from family and friends was also a factor, as some co-design patient participants felt alone and overwhelmed and that the medical staff and other health professionals were not always as understanding as they could have been, adding to the patient's stress. This lack of compassion and empathy made it difficult for patients to cope with the situation and further increased their anxiety. Furthermore, this lack of support created an environment of fear and isolation, which only served to exacerbate the emotional and psychological trauma that the patients were already struggling with. It was difficult for them to see any light at the end of the tunnel when they felt so alone and unsupported. For instance, one co-design patient participant reported feeling like they were not even seen or noticed by the medical staff despite being terrified and in need of emotional support. This was likened walking through a dark forest in the middle of the night without a flashlight, feeling overwhelmed by hopelessness and fear.

Implication in Decisions

Several of the co-design participants stated that they would have liked to have been better informed and involved in decisions taken by the clinical teams regarding some of their care issues, such as when it would be best to undergo surgery or which type of anaesthesia to be given. Participants also wanted to be better consulted on post-surgery treatments, such as physiotherapy or drug prescriptions. They felt they should have been more involved in the decision-making process, as this would give them a sense of control over their health. However, some co-design patient participants conversely expressed that they may feel overwhelmed by having too many choices or may not trust their judgment regarding their health. In these cases, medical professionals were requested to guide and support patients to help them make the best decisions for their health.

Privacy

The co-design patient participants acknowledged a lack of privacy in the hospital as a problem. It is recognized that although patients prefer to have individual rooms, it is rare to be able to do so. In certain circumstances, however, it was noted patients require greater privacy, such as when the clinical team informs them about surgery outcomes or specific diseases. Furthermore, despite progress in this area, the participants voiced a concern that data privacy is only sometimes guaranteed. As a result, they felt their personal information was not always secure, and that their privacy could be compromised. This absence of trust in security can lead to poor communication between patients and medical staff, hampering the diagnosis and treatment process. It may result in patients being reluctant to share important information about their medical history or lifestyle that could be relevant to the diagnosis, leading to a lack of effective treatment. This also can adversely affect research, as patients may be more reluctant to participate in studies requiring them to divulge personal details. Ultimately, it can lead to a decrease in trust between healthcare providers and the public.

Factors Influencing Patient Experience

Several factors can influence a patient's experience and satisfaction during the perioperative journey. Addressing the information needs of patients and involving them in shared decision-making can improve their satisfaction with care.

These factors can be summarized as follows:

Feeling Understood and Effective Communication:

- Patients value feeling understood by healthcare providers, including having their personal story and concerns acknowledged in a non-judgmental manner.
- Effective communication, active listening, clearly explaining conditions and treatment options, and addressing patient concerns positively impact satisfaction.

Convenience and Accessibility:

- Patients appreciate convenience factors such as the ability to schedule appointments online, communicate electronically, and manage their records.
- Accessibility, including ease of getting to appointments and overcoming language barriers, plays a role in the overall experience.

Quality of Care and Staff Attitudes:

- The quality of care received, including staff attitudes, nursing care, and physiotherapy, significantly shapes the patient's hospital experience.
- Patients are more satisfied when they feel their physician took their problem seriously and offered practical medical advice.

Patient Involvement and Shared Decision-Making:

- Involving patients in the decision-making process, considering their preferences, values, and expectations, leads to higher satisfaction.
- Patients who are allowed to express their ideas and concerns tend to be more satisfied and more likely to follow treatment recommendations.

Hospital Environment and Processes:

- The hospital environment, including factors like waiting times, ward transfers, and feeling "invisible" to staff, can negatively impact the patient experience.
- Streamlined processes, such as minimizing wait times and providing explanations for delays, contribute to a positive experience.

Privacy and Confidentiality:

- Respecting patient privacy and confidentiality, such as through the use of curtains or private rooms during examinations, enhances comfort and satisfaction.

Personalized Care and Meeting Preferences:

- Tailoring care to individual patient preferences and involving them in creating a comfortable environment can improve their overall experience.

While clinical outcomes remain the top priority, these factors related to interpersonal interactions, convenience, involvement in care, and the hospital environment play a crucial role in shaping the patient's overall experience and satisfaction throughout the perioperative journey.

6.9 Enhancing Perioperative Patient Journey: Research Insights, Forms, and Content Strategies

The following recommendations for implementing immersive digital technologies emerged directly from the integration of findings from both the Delphi study with healthcare professionals and the co-design workshops with patients. While specific technologies were not tested as functional prototypes within this study, these recommendations represent a synthesis of participant insights about technological preferences (Table 4), timing of interventions based on identified anxiety points in the patient journey (Figure 15), and content priorities expressed during the co-design process. Healthcare professionals in the Delphi study identified potential intervention points (as discussed in section 6.2), while patients in co-design workshops articulated specific content needs and preferences (section 6.3). The detailed descriptions of implementation strategies presented here translate these research findings into practical recommendations, connecting participant-identified needs with appropriate technological solutions. These recommendations serve as a foundation for future prototyping and testing rather than representing validated implementations. The integration of immersive digital technologies into the perioperative patient journey represents a significant advancement in healthcare, promising to enhance patient experiences and improve outcomes across various stages of the surgical process. This section delves into the timing and locations for implementing these technologies, the different forms they can take, and effective content delivery strategies.

Table 5 Timing and Locations for Implementation

Phase	Timing	Implementation Locations
Preoperative Phase	Several days to weeks before surgery and on the day of surgery.	Outpatient clinics, Patient's home, waiting rooms on the day of surgery
Intraoperative Phase	During surgery.	Operating rooms (OR)
Postoperative Phase	Immediately after surgery and during recovery.	Postoperative recovery rooms, home settings Postoperative recovery rooms, home settings

Table 6 Detailed Descriptions of Type of Immersive Digital Technologies, Content and Access Points for Patients

Phase	Detailed description
Preoperative Phase	**Outpatient Clinics: - VR Simulations:** Allow patients to take virtual tours of the surgical environment, understand the procedure, and learn about preoperative preparations. This can be done days or weeks before the surgery. - **AR/Smartphone Applications:** Provide educational content about the surgery, relaxation techniques, and interactive Q&A sessions to alleviate concerns. - **Holograms:** Use holographic displays to present detailed 3D models of the surgical procedure and equipment, helping patients understand what to expect. **Waiting Rooms on the Day of Surgery:** - **VR Experiences:** Provide calming and informative VR sessions to reduce anxiety as patients wait for their surgery. - **AR/Smartphone Applications:** Offer last-minute interactive educational content and relaxation exercises. - **Holograms:** Display holographic guides to offer last-minute procedural explanations and relaxation techniques to ease anxiety.
Intraoperative Phase	**Operating Rooms: - AR Applications:** Assist surgeons by overlaying critical patient data and procedural guides onto their field of view, which can improve precision and reduce stress levels for the surgical team. - **Holograms:** Provide real-time, 3D holographic displays of patient data and surgical guides to enhance precision and decision-making for the surgical team.
Postoperative Phase	**Postoperative Recovery Rooms: - VR Applications:** Provide immersive experiences that help in pain management and relaxation, contributing to a calmer recovery environment. - **Virtual Companions:** Offer emotional support and companionship, monitor vital signs, and provide postoperative care guidance. - **Holograms:** Use holographic displays to show guided exercises and relaxation techniques, facilitating a smoother recovery. **Home Settings: - VR Applications:** Continue postoperative care with guided exercises and pain management modules, ensuring ongoing support and reducing anxiety about recovery. - **Virtual Companions:** Maintain emotional support and provide reminders for medication and exercises. - **Holograms:** Provide interactive holographic guides for home exercises and postoperative care instructions to ensure proper recovery.
Virtual Companions	A novel addition to perioperative care involves virtual companions – AI-driven entities that provide emotional support and companionship to patients. These companions can be accessed through various devices, such as tablets or smartphones, offering comfort and guidance throughout the entire patient journey. Postoperatively, virtual companions can assist in monitoring vital signs and adherence to postoperative care instructions.

6.10 Sharing the knowledge

The synthesis and interpretation of the findings from this research have led to the development of a new transformative practice framework that could be adopted for advancing perioperative patient care. The pathway from research findings to framework development followed a systematic process of triangulation and integration across multiple data sources:

First, the Delphi study with healthcare professionals (section 6.2) revealed critical patterns in how anxiety manifests across different perioperative phases, identifying a need for interventions that address not only information provision but also emotional regulation and attentional redirection. Second, the co-design workshops (section 6.3-6.5) uncovered patients' specific preferences for intervention timing, content delivery methods, and technological interfaces, highlighting the importance of personalization and active engagement. Third, the journey mapping process (section 6.4-6.5) identified specific anxiety triggers and intervention opportunities across the perioperative timeline.

Through iterative analysis of these complementary datasets, three fundamental principles emerged as consistently effective across multiple contexts: interventions that promote relaxation, education, and distraction. These principles were repeatedly emphasized by both healthcare professionals and patients as essential components of effective anxiety management, appearing across multiple themes in the thematic analysis and representing the highest-priority needs identified in both participant groups.

The 'RED Rules' framework—Relaxation, Education, and Distraction—was thus developed as a direct response to the empirical evidence gathered in this study, offering a structured yet adaptable approach for healthcare providers to strategically enhance patient outcomes and experiences throughout the perioperative journey. This framework is particularly well-suited to implementation through immersive digital technologies, as these technologies demonstrated unique capabilities to address all three principles simultaneously in ways that conventional interventions cannot, as evidenced by patient feedback on technological preferences (Table 4).

6.11 Empirical Foundations of the RED Rules Framework

The RED Rules framework—Relaxation, Education, and Distraction—emerged organically through analysis of convergent patterns across multiple data sources collected in the research process, including background literature reviews and data collected on healthcare professional expertise and patient lived experiences.

Relaxation: Data-Driven Foundation

The Relaxation principle emerged from three consistent data patterns. First, physiological tension manifestations appeared as primary anxiety indicators the majority of patient narratives during co-design sessions. Statements such as "my whole body tightens up" and "I couldn't control my breathing" recurred across participant descriptions. Second, healthcare professionals in the Delphi study independently identified autonomic nervous system activation as the most observable anxiety marker, with 13 of 15 professionals ranking physiological calming techniques as "highly effective" interventions. Third, journey mapping revealed specific anxiety peaks (Figure 15) where patients reported feeling physically overwhelmed, particularly during waiting periods and transitions between care environments.

The triangulation of these data sources established relaxation not merely as a desirable outcome but as a fundamental mechanism through which other interventions could become effective. As one participant noted: "Nothing else would work until I could calm down enough to think straight" (Co-design Participant 7).

Education: Multi-Source Validation

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The Education component emerged as the most robust theme across all data sources. Nearly all patient participants, as well as every healthcare professional, identified information gaps as primary triggers of anxiety. More significantly, the data revealed a sophisticated pattern beyond mere information provision—participants consistently distinguished between generic information and contextually relevant, personally meaningful education.

Journey mapping data revealed that information needs evolved dramatically across the perioperative timeline, requiring different content and delivery formats at different stages. The Delphi study further reinforced this finding, with healthcare professionals expressing frustration at current "one-size-fits-all" information approaches that failed to address patient-specific concerns. As one anaesthetist noted: "We give them standardized information packets that answer questions they don't have, while leaving their actual concerns unaddressed" (Delphi Participant 3).

Distraction: Convergent Participant Insights

The Distraction principle reflected a sophisticated understanding of attention management that emerged consistently across participant groups. Co-design participants identified specific distraction preferences (Table 4) that varied according to anxiety intensity, A clear distinction also emerged in how participants described their coping strategies for anxiety. Most participants differentiated between using "light distraction" techniques for moderate anxiety and seeking "complete immersion" when experiencing more severe anxiety states.

Healthcare professionals independently validated this nuanced approach, with 11 of 15 Delphi participants describing graduated distraction techniques tailored to patient states. The journey mapping exercise revealed critical moments where distraction was identified as particularly valuable, notably during pre-surgical waiting periods and anaesthesia induction—findings that directly shaped the timing recommendations in Table 5 and 6.

Integration Into Cohesive Framework

While each principle emerged independently, their integration into a unified framework was driven by data patterns showing their interdependence. Journey mapping revealed that interventions incorporating multiple principles were consistently identified as most effective. Content analysis of co-design narratives demonstrated that relaxation facilitated information processing, education reduced uncertainty-driven anxiety requiring less distraction, and distraction created psychological space for relaxation techniques to take effect.

The RED Rules therefore represent not arbitrary categories but an empirically derived system of mutually reinforcing principles that collectively address the multidimensional nature of perioperative anxiety as documented through rigorous qualitative research methods.

6.12 fundamental principles: Relaxation, Education, and Distraction, the 'RED Rules'

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6.13 Design prototype for the use of Immersive technologies to mitigate perioperative stress and anxiety

The following information leaflet was designed as an exemplar for how the research findings could be communicated to clinical staff and healthcare managers, translating the conceptual RED Rules framework into an accessible format for practical consideration. The development of this communication tool followed standard information design principles, drawing on the journey mapping data (Figure 15) and recommendations synthesized in Tables 5 and 6. Design decisions regarding content organization, visual hierarchy, and presentation format were informed by

healthcare communication literature, particularly work by Houts et al. (2006) on effective health information design.

It is important to note that this leaflet represents a preliminary communication prototype rather than a validated clinical tool. The examples presented are derived from the research findings rather than from longitudinal clinical trials, ideally such materials would undergo iterative testing with healthcare professionals to assess usability, comprehensibility, and perceived value—a process planned for the next phase of research post-PhD. The leaflet 'prototype' simplifies complex relationships for clinical staff to understand the potential use of AR/VR interventions along the patient journey.

6.14 Addressing the Research Questions

6.14 Addressing the Research Questions

This research began with a central question how can immersive technologies be effectively integrated into perioperative care, to not only reduce patient stress and anxiety but also improve healthcare delivery and surgical outcomes. The findings presented in Chapter 6 address this central question and its supporting subsidiary questions.

Central Research Question

The study indicates that the effective integration of immersive technologies into perioperative care requires a systematic approach that aligns technological interventions with specific patient needs at different stages of the surgical journey. The RED Rules framework—Relaxation, Education, and Distraction—offers a structured yet flexible approach for this integration, identifying both when and how different technological modalities can address patient anxiety.

The findings indicate that immersive technologies are most effectively deployed when they:

1. Target identified anxiety triggers at specific points in the patient journey (as mapped in Figure 15)

2. Deliver content aligned with the psychological needs of patients at each stage (Tables 5-6)

3. Use appropriate technological formats based on the context and setting (see section 7.2 Patient Journey Breakdown and Technological Implementation)

4. Integrate seamlessly with existing clinical workflows rather than disrupting them

5. These insights directly answer the central research question by providing a blueprint for how immersive technologies can be integrated into perioperative care in ways that specifically target anxiety reduction while enhancing overall care delivery.

Subsidiary Research Questions

1. Patient-Centered Care Assessment: What are the key tensions, challenges, and problems encountered by patients during the perioperative experience?

The research identified several key tensions and challenges experienced by patients:
- Information gaps and communication breakdowns (section 6.8)
- Anxiety triggers specific to different perioperative phases (Table 2)
- Loss of agency and control throughout the surgical process (section 6.6)
- Fear of the unknown, particularly regarding anaesthesia (section 6.6)
- Transition challenges, especially when returning home (section 6.5 Support patients during the post-treatment stage)

These findings provide a comprehensive mapping of patient challenges, revealing that anxiety is not a uniform experience but varies significantly across the perioperative journey, requiring targeted interventions at specific moments.

2. Methodological Approaches: What methods can be employed to apply immersive digital health interventions effectively along the perioperative patient journey from the healthcare provider's perspective?

The study identified several key methodological approaches:

- Journey mapping as a tool for identifying intervention points (section 6.4)
- Co-design with patients to ensure interventions address actual needs (section 6.3)
- Integration of healthcare professional expertise through structured consultation (section 6.2)
- Alignment of technological interventions with existing clinical workflows (section 6.7)
- Application of the RED Rules framework as an organizing principle (section 6.11)
- These I approaches collectively provide healthcare providers with a process for implementing immersive technologies that respects both clinical requirements and patient experiences.

3. Sector-Wide Communication and Impact: How can findings from digital health research and practice on the perioperative patient experience be communicated effectively to inspire change across the healthcare sector?

The research identified several effective communication strategies:

- Translation of complex findings into actionable frameworks (RED Rules, section 6.11)
- Visual communication tools such as journey maps (Figure 15)
- Structured implementation guides aligned with clinical practice (Tables 5-6)
- Information design approaches for healthcare audiences (section 6.13)
- Engagement with multiple stakeholders through tailored communication (section 6.8)

These findings demonstrate that effective communication requires translation of research insights into formats that resonate with healthcare audiences while providing clear implementation guidance.

By systematically addressing each research question, this study offers a comprehensive understanding of how immersive technologies can transform perioperative care through patient-centered, methodologically sound, and effectively communicated interventions.



Figure 16 Surgical Anxiety A5 gatefold information leaflet (created by researcher)



Figure 17 Surgical Anxiety A5 gatefold information leaflet in use (created by researcher)

Chapter 7.

Reflections, summaries, and next steps...

This chapter provides a reflective overview of the entire research process, summarizing the key findings and discussing the broader implications. It offers critical reflections on the methodologies used, the challenges encountered, and the lessons learned. The chapter concludes by outlining potential next steps for future research, suggesting ways to build on the insights gained and proposing directions for further inquiry. This final chapter ensures that the research is contextualized within the ongoing academic dialogue and sets the stage for continued exploration in the field.

Chapter 7: Reflections, summaries, and next steps...

This chapter reflects how research into patient anxiety and the integration of immersive digital technologies into the perioperative patient journey has unfolded within the pages of this thesis.

As we have hopefully established, the amalgamation of digital technologies and healthcare not only promises to redefine the patient experience but also challenges us to reconsider the very essence of patient-centred care. In particular in relation to the implications of surgery, acknowledging the emotional and psychological facets that are central to a patient's journey.

In essence, this chapter serves as a call to action, inviting stakeholders—be they clinicians, researchers, policymakers, or technology developers—to collectively embark on a new era of healthcare.

This chapter presents the implications and discussions around the research questions, the significance of the research to both academia and healthcare practice, the contribution of new knowledge, and further research that could be conducted.

7.1 Integration of Research Findings with Theoretical Foundations

This chapter synthesizes the empirical findings of our research with the theoretical frameworks established in Chapters 2-4, demonstrating how our investigation addresses critical gaps in understanding perioperative anxiety management. Before exploring specific applications of immersive technologies, it is essential to situate our contributions within the broader scholarly discourse.

The gaps identified in managing perioperative stress and anxiety—ranging from inadequate preoperative education to insufficient psychological support and underutilization of advanced technologies—encompass both literature gaps and experiential deficiencies revealed through our patient journey mapping. These gaps manifest across three critical dimensions that directly correspond to our theoretical framework:

First, the knowledge gap in perioperative communication reveals the disconnect between theoretical recognition of patient education's importance and practical implementation of effective information delivery systems. Our research extends the work of Jaensson et al. (2019) and Cooper et al. (2023) by demonstrating how these communication failures create specific anxiety triggers at key moments in the patient journey, particularly during preoperative waiting periods and the transition to home.

Second, the psychological support inadequacies identified through our Delphi study confirm and extend the literature on personality factors and individualized interventions reviewed in Chapter 2.4. While Ji et al. (2022) and Kumar et al. (2019) established the theoretical basis for personalized anxiety management, our research reveals the practical barriers preventing implementation of these approaches in clinical settings, particularly the tension between standardized clinical workflows and individual patient needs.

Third, the technological implementation barriers we identified directly address the challenges in digital health innovation discussed in Chapter 4.3. Our findings extend the work of Béranger & Rizoulières (2021) and Shaw et al. (2018) by identifying specific contextual factors that prevent theoretical benefits of immersive technologies from being realized in current perioperative care settings.

Returning to our central research question—"How can immersive technologies be effectively integrated into perioperative care to not only reduce patient stress and anxiety but also revolutionize healthcare delivery and improve surgical outcomes?"—our study contributes new insights through the development of the RED Rules framework. This framework transcends isolated technological interventions to provide a comprehensive approach that integrates:

- Relaxation principles grounded in perioperative anxiety management literature but enhanced through design thinking methodologies
- Education components that bridge patient engagement theories with digital therapeutic design principles
- Distraction techniques that leverage immersive technologies within person-centered design frameworks

This integration model outlines how effective perioperative anxiety management requires more than technological sophistication; demanding a fundamental rethinking of the patient experience through the intersection of healthcare, design, and digital technologies—the three domains explored in our literature review.

Connection to Identified Gaps

The gaps identified in managing perioperative stress and anxiety—ranging from inadequate preoperative education to insufficient psychological support and the underutilization of advanced technologies—signal a pressing need for a comprehensive approach that addresses these areas. The Perioperative Patient Support Program (PPSP) proposed in this thesis is designed to address these gaps by focusing on the following:

Enhanced Patient Education and Communication

By providing detailed preoperative education and maintaining continuous communication, the PPSP aims to reduce uncertainty and anxiety, thus aligning with the goal of enhancing patient experiences and satisfaction.

Personalized Psychological Support

Recognizing the individual differences in how patients experience and manage anxiety, the PPSP incorporates psychological screenings and tailored interventions to offerpersonalized support that caters to specific patient needs.

Integration of Advanced Technologies

The PPSP utilizes next-generation digital information and communication technologies to create an interactive and engaging patient experience. This integration not only helps in reducing perioperative anxiety but also facilitates better communication and education, thereby enhancing patient outcomes.

Patient-Centred Decision-Making

At the heart of the PPSP is the commitment to patient-centred decision-making. This approach ensures that patients are actively involved in their care plans, making decisions that are informed by comprehensive education and support, thus addressing the gap in personalization of care and ensuring that patient preferences and values are respected during the perioperative period.

As noted, the past decade has seen significant growth in digital health, with the rise of social media platforms, smartphones and mobile applications, wearable devices, cloud-based data platforms, robotics and other Industry 4.0 technological advancements. As a result, the monitoring and promoting general well-being and health are increasingly extending beyond the traditional confines of hospitals and clinics into the digital domain. This expansion is facilitated by a variety of smartphone applications that provide new opportunities for digitally enabled tools to mitigate anxiety. While healthcare is still in the nascent stages of adopting such technologies, it is hoped that the insights from this research will aid healthcare providers in making informed decisions about integrating these strategies into their future care frameworks.

A suggested table comparing the perspectives of patients and healthcare professionals regarding digital health interventions in addressing stress and anxiety-related problems in the perioperative patient's journey based on this research is shown in Table 7:

Table 7 Perspectives of patients and healthcare professionals Regarding Digital health interventions

Potential	Patient perspective	Professional perspective
Accessibility & Information Dissemination:	Digital health offers clear information about the surgical process, recovery expectations, and coping strategies. This accessibility helps alleviate anxiety by providing a reliable source of information.	Valuing digital interventions that improve patient education and understanding. By ensuring information accessibility, professionals aim to empower patients to actively participate in their perioperative care.
Personalization of Interventions:	Personalized interventions can make patients feel more supported and understood, ultimately contributing to a more effective stress management strategy.	Personalization ensures that the support provided is relevant and resonant, leading to increased patient engagement and better outcomes.
Real-time Support & Communication:	Patients find value in real-time support through digital platforms, such as chatbots or virtual assistants.	Real-time support tools are seen as an opportunity to enhance communication between patients and healthcare teams.

Potential	Patient perspective	Professional perspective
Interactive Education and Simulation:	Patients benefit from interactive digital content that educates them about the surgical process, potential complications, and recovery. This enhances understanding and reduces uncertainty.	Interactive educational tools are recognized as effective means to improve health literacy, facilitate informed consent, and empower patients.
Remote Monitoring and Feedback:	Patients appreciate the convenience of remote monitoring through wearable devices or apps, allowing them to track their health progress. This continuous feedback loop provides a sense of control.	Remote monitoring is valued by healthcare professionals for its potential to detect early signs of complications, optimize postoperative care plans, and enhance patient outcomes.
Integration into Overall Care:	Patients prefer digital interventions seamlessly integrated into their overall care plan. This integration ensures a cohesive approach to stress management, complementing traditional healthcare services and providing a more holistic patient experience.	Integrating digital tools into the perioperative care pathway is seen as an opportunity to enhance care coordination, improve communication, and ensure a comprehensive approach to perioperative stress and anxiety management.

By aligning digital health interventions with these guiding principles and practices, both patients and healthcare professionals may experience improved perioperative outcomes. This alignment is supported by our co-design findings, where participants identified relaxation, education, and distraction interventions as addressing key anxiety triggers at specific points in the perioperative journey (Table 2, p.94). This approach is consistent with Kondylakis et al.'s (2022a) evidence that tailored digital interventions can reduce perioperative anxiety and Hallgren et al.'s (2021) findings that integrated approaches enhance patient satisfaction. However, longitudinal research would be necessary to fully validate the long-term impact of these interventions on overall well-being, as discussed in the limitations section.

While the initial reflections on the findings of my PhD research provide a concise overview of the transformative potential of digital health interventions for stress and anxiety-related issues in the perioperative patient's journey, a more comprehensive exploration including a clinical trial would be the next logical step.

This study also sought to investigate the impact of designing and implementing a novel digital health intervention that considers perioperative stress management, anxiety reduction, and pain relief techniques informed by ideas from behavioural science. The study aimed to create a set of guiding principles and practices that could be adopted to develop and deploy a range of strategies for a digital health intervention in the perioperative journey, along with suggestions for educational materials, information, and resources. The study also aimed to investigate the potential impact on perioperative stress by adopting an advanced digital health platform as part of the trend toward digital health support systems and services.

7.2 Perioperative Patient Journey based on Co-design analysis

The perioperative journey encompasses a series of critical stages that each present unique challenges and opportunities for improving patient care through the use of immersive technologies. This research details a comprehensive approach to integrating different types of immersive technologies to support, educate, and comfort patients from the preoperative phase through to postoperative rehabilitation. By tailoring technological interventions to the specific needs at each stage, we aim to enhance the overall surgical experience, reduce anxiety, and improve outcomes.

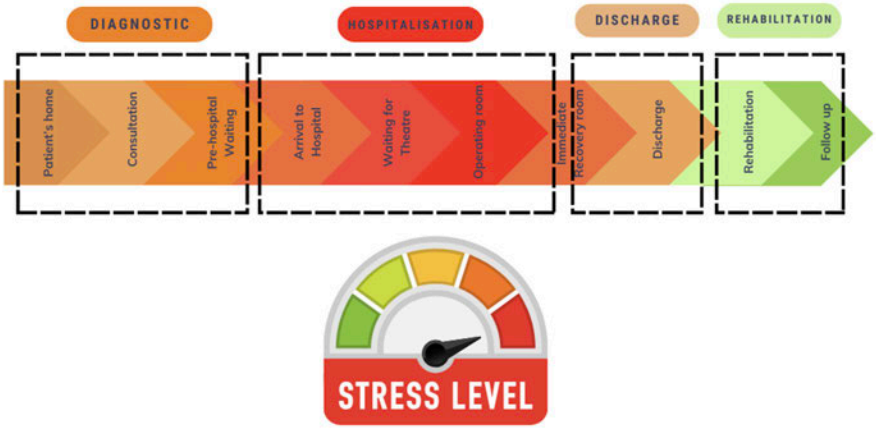

Figure 18 Perioperative Patient Journey map analysis for the research

Patient Journey Breakdown and Technological Implementation

Diagnostic Phase

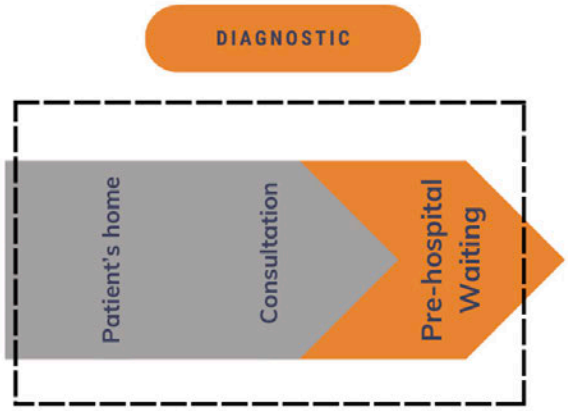

Figure 19 Perioperative Patient Journey map analysis for Diagnostic Phase

- **When:** Days or weeks before surgery
- **Where:** Patient's home or a designated preoperative education centre
- **Content Type:** Educational VR experiences to familiarize patients with the surgical procedure, immersive relaxation techniques, and virtual companions providing information and support.

Hospitalisation Phase

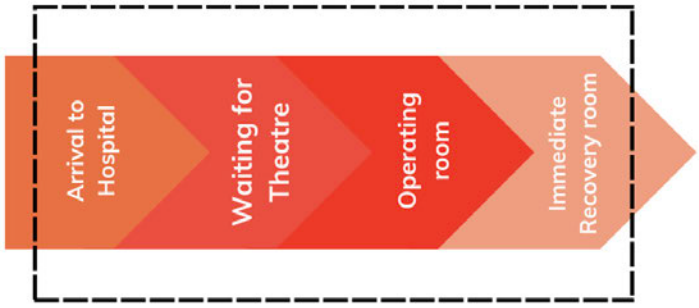

Figure 20 Perioperative Patient Journey map analysis for Hospitalisation phase

Waiting area

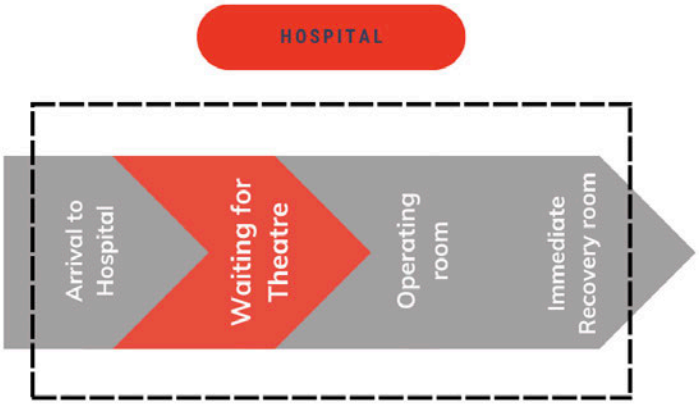

Figure 21 Perioperative Patient Journey map analysis for Hospitalisation phase - Waiting area

- **When:** On the day of surgery, while waiting for admission
- **Where:** Hospital waiting areas or preoperative holding areas
- **Content Type:** Distraction-focused VR experiences are being used to reduce anxiety and stress, while educational content reinforces preoperative instructions in reception and waiting areas. Additionally, relaxation and distraction interventions are employed to promote a calm mindset. The use of holographic virtual companions to comfort patients before imminent surgeries is also on the horizon.

Intraoperative Phase

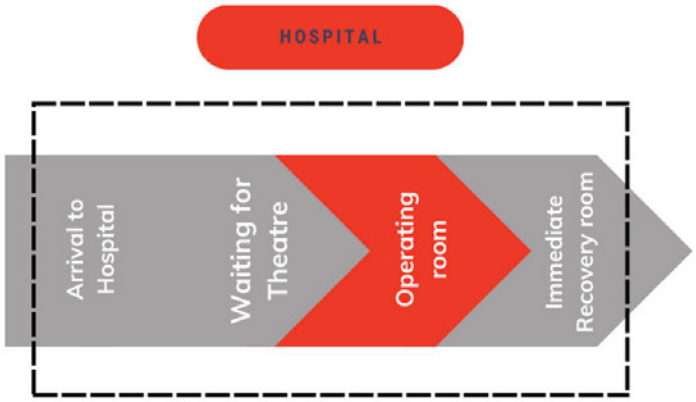

Figure 22 Perioperative Patient Journey map analysis for Hospitalisation phase - Intraoperative Phase

- **When:** During the surgical procedure
- **Where:** Integration into the operating room environment
- **Content Type:** AR overlays for surgeons providing real-time information, distraction-oriented VR experiences for patients under local anaesthesia, and virtual companions to provide reassurance and information.

Discharge Phase

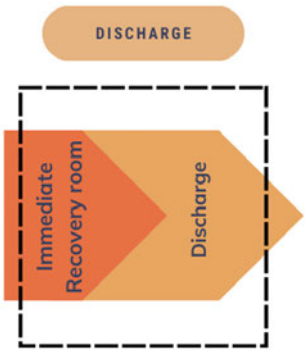

Figure 23 Perioperative Patient Journey map analysis for Discharge

- **When:** Post-surgery, during the recovery period
- **Where:** Recovery rooms, patient wards
- **Content Type:** Relaxation-focused VR experiences to aid in pain management, educational content on postoperative care, and virtual companions offering post-surgical support.

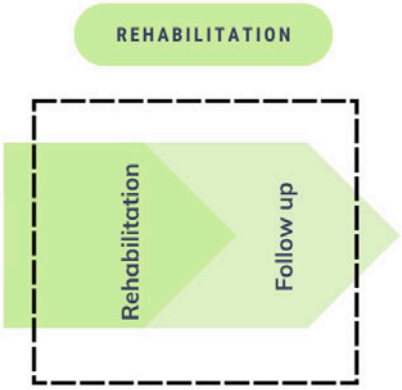

Figure 24 Perioperative Patient Journey map analysis for Rehabilitation and Follow-up

- **When:** Post-discharge and throughout the recovery process
- **Where:** Rehabilitation centers, outpatient clinics, or at home
- **Content Type:** Customized VR exercises for physical and mental rehabilitation, educational content for ongoing recovery, and virtual companions for continuous support.

Personalization and Patient-Centred Care:

The significant potential for personalization in digital health interventions cannot be overstated. The ability to tailor interventions to the unique needs and preferences of perioperative patients fosters a sense of empowerment and engagement. This research revealed that an individualized approach, incorporating patient demographics, medical history, and psychosocial factors, contributes to the effectiveness of these interventions.

One key aspect is the incorporation of adaptive content within digital health platforms. These systems can dynamically adjust the information and support provided based on the patient's progress, feedback, and evolving needs. For instance, as a patient advances through the perioperative stages, the intervention can adapt to address specific concerns related to preoperative preparation, the surgery itself, and postoperative recovery. This personalized journey enhances the overall patient experience and contributes to stress reduction.

Moreover, interactive modules within digital health interventions enable patients to actively participate in their care. Incorporating features such as decision aids, interactive educational materials, and self-assessment tools empowers patients to make informed choices and actively manage their stress. This participatory approach aligns with the principles of shared decision-making, promoting a collaborative relationship between healthcare providers and patients.

Communication and Connectivity

Effective communication is pivotal to the success of any healthcare intervention, and digital technologies play a crucial role in enhancing communication and connectivity during the perioperative period. Real-time communication channels, secure messaging platforms, and telehealth solutions facilitate seamless interaction between healthcare providers, patients, and their support networks.

The research underscores the importance of maintaining an open line of communication throughout the perioperative journey. From initial consultations to postoperative follow-ups, a continuous flow of information contributes to a sense of reassurance and trust. Patients, knowing that they can easily reach out to their healthcare team, experience reduced anxiety as they feel supported and connected throughout their surgical experience.

Furthermore, digital platforms serve as conduits for building a robust support network around

the patient. Family members, friends, and caregivers can be seamlessly integrated into the communication loop, providing additional layers of emotional support. This interconnectedness not only addresses the practical aspects of care but also contributes to the patient's overall sense of well-being.

Immersive technology and Distraction Techniques

An intriguing aspect of my research revolves around the utilization of immersive technologies as effective distraction techniques during the perioperative period. These technologies have demonstrated the ability to create calming and engaging environments, diverting patients' attention from stress-inducing aspects of the surgical process. By providing an alternative focus for patients, these technologies contribute to a more relaxed mindset before surgery. Similarly, postoperatively, these technologies can serve as a therapeutic tool, aiding in pain management and overall recovery.

The findings of this research suggest that the immersive and interactive nature of these technologies can not only distract patients from their immediate surroundings but also induce a positive psychological impact. Integrating these technologies into the perioperative journey aligns with the broader trend of utilizing innovative solutions to enhance patient experience and well-being.

Distraction caused by immersive technology often involves a combination of psychological and physiological factors. Here are some key mechanisms that can positively contribute to distraction in the broader care setting:

a) **Attention Capture:** Immersive technologies, such as virtual reality (VR) or augmented reality (AR), are designed to capture and hold users' attention. The realistic and engaging nature of these experiences can shift focus away from the physical environment.

b) **Multisensory Stimulation:** Immersive technologies often provide a multisensory experience, engaging users through visual, auditory, and sometimes haptic stimuli.

c) **Reward Systems:** Many immersive technologies incorporate reward systems to encourage user engagement. The anticipation of rewards or the desire to achieve specific goals within a virtual setting can lead individuals to prioritize the immersive experience over their real-world tasks.

d) **Temporal Displacement:** Immersive technologies can create a sense of temporal displacement, where users lose track of time while engaged in virtual experiences.

e) **Social Interaction:** Social aspects within immersive technologies, such as virtual social platforms or multiplayer games, can contribute to distraction.

f) **Escapism:** Immersive technologies often provide an escape from reality, allowing users to immerse themselves in alternate worlds or scenarios.

While our findings suggest potential applications of immersive technologies for cognitive and psychological interventions, it is important to acknowledge the limitations of our current research methodology in testing these specific impacts. The assertions regarding cognitive-behavioral techniques, mindfulness applications, and positive psychological impacts represent theoretical extensions based on our findings rather than directly tested outcomes. Our co-design process revealed patient interest in such approaches (Table 4), but their efficacy would require dedicated clinical validation through controlled studies. The integration of cognitive-behavioral techniques through digital platforms represents a promising direction for future research rather than a conclusively demonstrated outcome of the current study. This limitation highlights the need for subsequent targeted investigations specifically designed to test the psychological mechanisms and impacts of these interventions, as outlined in our recommendations for future research (section 7.6)

Behavioural Change and Mastering the Mind

Beyond the external facets of patient care, our research considers the internal realm of behavioural change and mastering the mind to overcome stress during the perioperative period. The incorporation of digital technologies offers a unique opportunity to influence patient behaviour positively.

Digital interventions, such as mobile applications and wearable devices, can be designed to encourage behaviour change. For instance, apps can provide personalized reminders for preoperative preparations, facilitate mindfulness exercises to manage stress, and offer postoperative recovery plans tailored to individual needs. By incorporating behavioural psychology principles with immersive technological healthcare experiences, these interventions aim to create sustainable habits that promote better mental and emotional well-being.

Moreover, the research suggests the potential of incorporating cognitive-behavioural techniques through digital platforms. These interventions focus on mastering the mind, equipping patients with cognitive strategies to reframe negative thoughts, manage anxiety, and build resilience. Digital tools can deliver guided mindfulness sessions, relaxation exercises, and cognitive restructuring modules, providing patients with practical tools to navigate the psychological challenges of the perioperative journey.

The findings suggest that a holistic approach, combining external support mechanisms with internal strategies for mastering the mind, has the potential to create a synergistic effect in promoting mental well-being. By addressing both the external stressors of surgery and the internal cognitive processes, healthcare providers can contribute to a more comprehensive and lasting impact on patients' wellbeing. It is important to note that these conceptual connections between external support mechanisms and internal cognitive strategies require further empirical validation. While our research suggests potential synergies between these approaches, the limited sample size and exploratory methodology do not allow for definitive claims about efficacy or impact on mental wellbeing. The framework proposed represents an integration of insights from our research and existing literature, providing direction for future investigation rather than conclusive evidence.

Data-Driven Insights for Continuous Improvement

A noteworthy aspect of the research is the emphasis on leveraging data-driven insights for continuous improvement in perioperative care. The implementation of digital technologies generates a wealth of data regarding patient interactions, preferences, and outcomes. Analysing this data offers a unique opportunity for healthcare providers to refine and optimize the perioperative journey iteratively.

Through the application of advanced analytics and machine learning algorithms, healthcare organizations can extract meaningful patterns and trends from the vast datasets generated by digital platforms. These insights can not only inform real-time decision-making but also contribute to the development of evidence-based practices in perioperative care.

Continuous improvement, guided by data-driven insights, involves refining communication strategies, updating information resources, and tailoring interventions based on patient feedback. This iterative approach fosters a culture of adaptability and responsiveness, ensuring that the implementation of digital technologies remains aligned with the evolving needs and expectations of patients.

7.3 Critical Considerations in Technological Interventions

While immersive technologies offer promising opportunities for addressing perioperative anxiety, it is essential to critically examine potential challenges and limitations of their implementation. The integration of any technology into healthcare settings requires careful consideration of unintended

consequences, contextual factors, and diverse patient needs. This section explores several critical considerations that emerged from our research findings and connects them to broader discussions in the literature, providing a more nuanced understanding of the complexities involved in deploying digital interventions in perioperative care.

The enthusiasm for technological solutions must be tempered with recognition that these interventions are not universally beneficial for all patients in all contexts. As our co-design participants highlighted (Table 3), technological interventions can sometimes create new problems even as they attempt to solve existing ones. This balanced perspective is essential for developing truly patient-centered approaches that acknowledge both the potential benefits and risks of immersive technologies in perioperative settings.

7.4 The Possibility to introduce virtual companion

Drawing upon the findings of this research, the integration of an individual or a simulated character into the perioperative journey could yield stress-alleviating outcomes. Research indicates that social support from others contributes positively to stress reduction and overall well-being. In situations where constant access to human support may be lacking, the utilization of virtual personas or companions emerges as a viable alternative.

The exploration of virtual companions presented here represents an emerging area where empirical evidence remains limited. This research ventures into new territory, proposing conceptual applications rather than validated interventions. The virtual companion concept exemplifies the potential future direction of immersive technologies in perioperative care, while acknowledging that these technologies are still evolving and maturing.

The term “companion” in this context refers to a virtual character that accompanies an individual throughout an experience. Companions possess the ability to assist users, (in this case patients) by influencing their behaviour and emotions within specific contexts.

This is particularly relevant during the patient perioperative journey where the patient can encounter a number of different care providers at different times and does not necessarily have the guarantee of consistent care companion through the process.

A virtual companion, computer-based or software-driven AI entity designed to provide support, assistance, and companionship to users in various contexts can leverage technologies like natural language processing, machine learning, and sometimes even emotional intelligence to interact with users in a human-like manner. The primary goal of a virtual companion is to enhance user experience, offer guidance, and sometimes simulate a social or supportive presence (Bertoncello et al., 2018; Cheung et al., 2019; Wolff et al., 2021).

In the context of healthcare, virtual companions can play a significant role in supporting patients throughout their medical journey. They may provide information, answer queries, offer emotional support, and assist with tasks related to medical procedures, recovery, and overall well-being. Virtual companions in healthcare settings are often designed to be empathetic and adaptable, tailoring their interactions to the individual needs and preferences of the user.

The capabilities of virtual companions can vary widely. Some are simple chatbots that respond to text-based input, while others incorporate advanced features like voice recognition, facial expression analysis, and even virtual reality to create immersive and interactive experiences. The aim is to create a more personalized and user-friendly interaction, whether it’s for educational purposes, emotional support, or practical guidance in a specific domain.

In the realm of virtual companions, holographic technology represents an innovative and immersive dimension. A hologram is a three-dimensional (3D) projection of light that creates a lifelike and interactive representation of an object or, in this case, a virtual companion. Holographic virtual companions leverage holographic displays to bring a more realistic and engaging presence to the user experience. (add sample image)



Figure 25 example of holographic assistant in airport security context (Easen, 2022).

In healthcare, holographic virtual companions have the potential to transform the way patients interact with digital entities. Imagine a scenario where a holographic virtual companion appears beside a patient, offering information, guidance, and emotional support in a visually compelling manner. This technology can create a more intuitive and lifelike interaction, enhancing the overall effectiveness of the virtual companion in conveying complex medical information or providing emotional assistance.

Moreover, holographic virtual companions have the potential to facilitate remote consultations in a more immersive way. Healthcare professionals could use holographic representations to virtually appear in a patient's home, allowing for a more natural and personalized interaction, even when physical presence is not possible. This technology can bridge the gap between physical and virtual spaces, providing a sense of connection and support.

However, it's important to note that while holographic technology holds great promise, its widespread adoption in healthcare is still in the early stages. Technical challenges, cost considerations, and the need for specialized equipment are factors that currently limit the accessibility of holographic virtual companions. As technology continues to advance and become more accessible, holographic virtual companions could become a transformative element in healthcare, offering new dimensions of engagement and support for patients in their medical journeys.

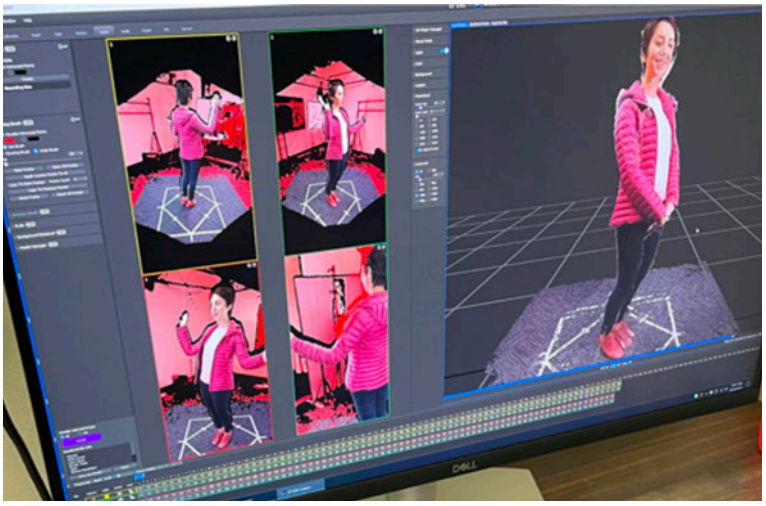

Figure 26 Project researchers trying out next generation immersive technology and 3D holographic screen technology (2024)

The medical validity of these concepts requires further investigation through rigorous clinical studies before implementation. The suggestions here remain conceptual contributions to an evolving discourse rather than evidence-based clinical recommendations. Future research should focus on establishing efficacy, acceptance, and impact on patient outcomes through controlled trials and long-term evaluation studies.

7.5 Critical Reflection on the Research Process

This section offers a critical reflection on the research process, examining methodological strengths and limitations, contextual constraints, and considerations regarding validity, generalizability, and reproducibility of findings.

Methodological Reflections

The combination of Policy Delphi and Co-Design methodologies offered complementary strengths while presenting distinct challenges. The Policy Delphi method effectively gathered expert perspectives and created a foundation for understanding professional viewpoints on perioperative anxiety. However, the process revealed limitations in capturing nuanced clinical experiences, as healthcare professionals sometimes struggled to articulate the practical insights developed through practice. The structured nature of the Delphi process, while valuable for systematically categorizing perspectives, occasionally constrained the emergence of unexpected insights.

The Co-Design workshops proved particularly effective in generating rich, experience-based data directly from patients. The creative, collaborative atmosphere fostered open sharing of sensitive experiences, revealing dimensions of perioperative anxiety that might not have emerged through more traditional interview methods. However, the workshops presented challenges in balancing creative exploration with focused data collection. Some participants required more support in translating their experiences into design concepts, while others sometimes proposed technologically unrealistic solutions, necessitating careful facilitation to maintain both creative freedom and practical feasibility.

Journey mapping emerged as the most successful methodological element, creating a shared visual language that bridged the experiential understanding of patients with the clinical knowledge of healthcare professionals. This visualization approach also facilitated analysis by making temporal patterns of anxiety visible in ways that verbal descriptions alone could not achieve.

Validity and Generalizability Considerations

Several factors influence the validity and generalizability of this research. The sample size (n=30 across the Delphi study and Co-design activities) provided sufficient data for rich qualitative insights but limits statistical generalizability. The private healthcare context in South Australia represents a specific healthcare environment with distinct characteristics—including generally shorter waiting times and different resource constraints than public healthcare systems. This contextual specificity suggests caution in generalizing findings to public healthcare settings or systems with significantly different organizational structures.

The research demonstrated strong internal validity through triangulation across multiple data sources (healthcare professional perspectives, patient experiences, and journey mapping visualizations). The convergence of themes across these sources suggests robust findings within the study context. However, external validity requires consideration of cultural and systemic differences. Healthcare systems in countries with different funding models, patient-provider power dynamics, or cultural attitudes toward technology would likely reveal different patterns of anxiety and technological acceptance.

The RED Rules framework, while derived from empirical data in this specific context, presents principles general enough to potentially transfer to other healthcare settings. However, the specific implementations would necessarily vary based on resource availability, cultural factors, and healthcare system structures. For example, in countries with higher technological adoption rates in healthcare, implementation barriers might differ significantly, while in countries with stronger hierarchical medical cultures, the participatory aspects of technological integration might face different challenges.

Research Constraints and Challenges

Several factors constrained the research process. Access to healthcare environments presented challenges, particularly during the COVID-19 pandemic, which limited opportunities for in-situ observation and necessitated adaptations to data collection methods. The interdisciplinary nature of the research created tensions between the methodological expectations of healthcare research (often emphasizing quantitative evidence) and design research (valuing participatory processes and creative outcomes). Navigating these different epistemological traditions required careful balancing to maintain both scientific rigor and design innovation.

Time constraints limited the ability to implement and test the proposed interventions within real clinical environments, which would have required additional ethical approvals and extended timeframes beyond the PhD scope. This necessarily positioned the research outcomes as conceptual frameworks and recommendations rather than validated interventions—an appropriate scope for doctoral research but a limitation in terms of immediate clinical applicability.

My dual positionality as both researcher and perioperative nurse presented both advantages and challenges. While my clinical experience provided valuable insider knowledge and facilitated recruitment and rapport with healthcare professionals, it also created potential for bias in data interpretation. I addressed this through regular reflexive practice, explicitly examining how my professional experiences might influence my analysis and seeking alternative interpretations through supervisor consultation and participant validation.

Reproducibility and Future Applications

The reproducibility of this research is supported by the detailed documentation of methodological approaches in Chapter 5 and the transparent presentation of analytical processes in Chapter 6. However, several context-specific factors would influence reproduction in different settings. The success of the Co-Design workshops depended significantly on facilitation skills and the creation of psychologically safe environments for participants—qualities difficult to standardize across research contexts. Additionally, the specific technological landscape described in this research represents a snapshot of rapidly evolving fields, meaning that similar research conducted even a few years later would encounter different technological possibilities and constraints.

Future applications of this research methodology would benefit from several adaptations. A longitudinal approach that follows patients throughout their actual perioperative journey (rather than retrospective reflection) could provide more granular insights into anxiety triggers and intervention opportunities. Multi-site comparisons across different healthcare contexts (public/private, different countries) would strengthen generalizability. Additionally, prototype testing in clinical environments would move beyond conceptual frameworks to measured impacts on patient outcomes.

This critical reflection demonstrates both the value and limitations of the chosen research approach, contextualizing the findings within appropriate boundaries while identifying pathways for future research to address existing constraints.

7.6 Summary and next steps

Building on the insights and frameworks developed through this research, several specific next steps would advance both the theoretical understanding and practical implementation of immersive technologies for perioperative anxiety management. The immediate priority would be testing the RED Rules framework and communication materials (such as the gatefold information leaflet presented in section 6.13) with clinical staff at private hospitals in South Australia where initial research contacts have been established. This testing would assess the usability, comprehensibility, and perceived clinical value of these resources, leading to iterative refinements based on practitioner feedback. Following this initial validation, I would seek funding through the Medical Research Future Fund's Digital Health Initiative or similar programs to support a pilot implementation in selected perioperative settings. This pilot would involve training clinical staff in using the RED Rules framework, deploying selected immersive technologies at key intervention points identified in this research, and measuring impacts on patient-reported anxiety levels and satisfaction metrics.

The testing and implementation phases were beyond the scope of this PhD due to the additional ethical approvals required for interventional studies in clinical environments and the extended timeframes needed for meaningful assessment of outcomes. However, preliminary discussions with clinical partners at Pulse Anaesthetic Group and other private hospital networks have indicated interest in participating in such follow-up research. Additionally, the consultation with a neurosurgeon during this research revealed potential applications beyond the perioperative context, particularly for reducing anxiety during MRI scanning procedures where patient movement due to anxiety results in significant costs associated with failed scans and sedation team involvement. This represents a valuable opportunity to test the transferability of the RED Rules framework to adjacent clinical contexts.

Beyond these specific next steps focused on validating and implementing the findings from this research, broader developments in digital health technologies will continue to shape opportunities for anxiety management in healthcare settings. The following areas represent critical directions for advancing this field:

Clinical Trials and Efficacy Studies

The first step towards deployment in advancing immersive technologies in perioperative care is the initiation of rigorous clinical trials and efficacy studies. While the initial explorations have shown promise in terms of reducing anxiety and enhancing patient satisfaction, it is imperative to delve deeper into their clinical benefits. These studies should not only focus on psychological outcomes but also assess tangible clinical improvements, such as reduced complications and faster recovery times. By establishing a robust evidence base, healthcare providers can confidently integrate immersive technologies into surgical procedures, backed by empirical data supporting their efficacy.

Customization and Personalization

As the field progresses, the emphasis should shift towards customization and personalization of immersive content. Recognizing that patients have unique needs and preferences, tailoring virtual reality (VR) and augmented reality (AR) experiences to individual requirements can optimize the impact of these technologies. Customization could involve creating specialized modules catering to different surgical procedures, patient demographics, or even cultural considerations. A more personalized approach ensures that immersive technologies align with the specific needs of each patient, fostering a patient-centric model that enhances overall satisfaction and outcomes.

Integration with Electronic Health Records (EHR)

Seamless integration with Electronic Health Records (EHR) is a critical aspect of ensuring the practical utility of immersive technologies in perioperative care. The interoperability of immersive systems with existing EHR systems can streamline communication among healthcare providers, facilitating real-time data sharing. This integration ensures that surgical teams have immediate access to relevant patient information during procedures and postoperative care. As healthcare continues to evolve towards a more interconnected model, the integration of immersive technologies with EHR becomes imperative for optimizing patient care and outcomes.

Cost-Benefit Analysis

To promote widespread adoption, a comprehensive cost-benefit analysis is also essential. This analysis should extend beyond the initial investment costs and consider long-term maintenance expenses. Moreover, it should evaluate potential savings resulting from reduced hospital stays, decreased complications, and improved recovery rates. Understanding the economic implications of incorporating immersive technologies into perioperative care provides stakeholders with a clearer picture of the overall value proposition. This, in turn, enables informed decision-making, assisting healthcare institutions in effectively allocating resources for the integration of these transformative technologies. As these technologies continue to develop, they are expected to become more affordable and culturally accepted.

Patient Education and Training

Successful adoption of immersive technologies in perioperative care hinges on comprehensive education and training programs. These programs should target both healthcare providers and patients, familiarizing them with the functionalities and benefits of VR, AR, and virtual companions. Healthcare professionals need to be trained on the effective use of these technologies to enhance patient care, while patients should receive guidance on navigating and deriving maximum benefit from immersive experiences. By demystifying these technologies and ensuring proficiency among users, healthcare providers can overcome potential resistance and foster a culture of acceptance and enthusiasm for immersive solutions.

The journey toward leveraging immersive digital technologies in perioperative care is not merely a technological endeavor but a holistic transformation of healthcare delivery. By combining technological innovation with a patient-centric mindset, healthcare providers can usher in a new era of enhanced surgical experiences and improved outcomes. The next steps involve further research, refinement of technologies, and a concerted effort to integrate these tools seamlessly into the fabric of modern healthcare, marking a paradigm shift in the way we approach and experience perioperative care.

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Appendices

Participant Information Sheet-Co Design

Participant Information Sheet- Delphi

Interview questions for policy Delphi

Human Ethics Application

University of South Australia

Participant Information Sheet-Co Design

Ethics Protocol No.	203279
Title	*Reducing anxiety in perioperative experiences through the design of AR/ VR interventions*
PhD Candidate	Nikou Javadi
Principal Supervisor	Prof. Ian Gwilt Ian.gwilt@unisa.edu.au +61 8 8302 7014
Co- Supervisors(s)	Dr Kristin Carson-Chahhoud Dr Zoe Kopsaftis Dr Ross Smith

Introduction – What does my participation involve?

You are invited to take part in this research project, which is called 'Reducing anxiety in perioperative experiences through the design of AR/ VR interventions.' You have been invited because you are a patient representative with the admission to hospital for the elective surgery in the last 12 months in South Australia.

This Participant Information & Consent Form tells you about the research project. It explains the processes involved with taking part. Knowing what is involved will help you decide if you want to take part in the research.

Please read this information carefully. Ask questions about anything that you don't understand or want to know more about. Before deciding whether or not to take part, you might want to talk about it with a relative, friend or local health worker.

Participation in this research is voluntary. If you don't wish to take part, you don't have to.

If you decide you want to take part in the research project, you will be asked to sign the consent section. By signing it you are telling us that you:
• Understand what you have read
• Consent to take part in the research project
• Consent to be involved in the research described
• Consent to the use of your personal and health information as described.

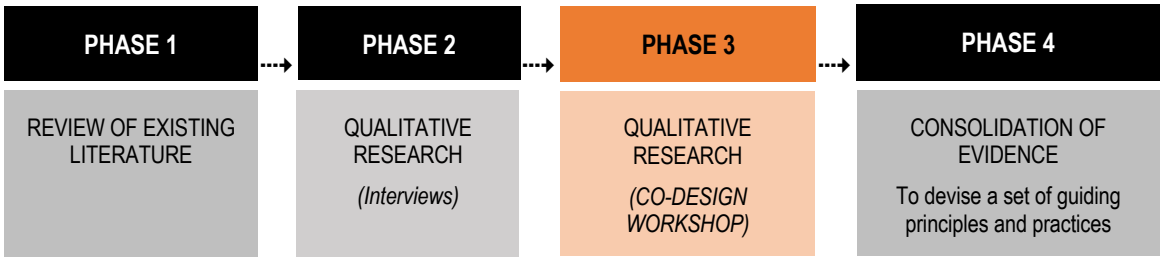
You will be given a copy of this Participant Information and signed Consent Form to keep.

What is the purpose of this research?

Available literature reveals that the perioperative patient anxiety can be a prevalent issue that can have extensive impact on the patients. Perioperative anxiety is directly proportional to increased infection risk, length of hospital stay, the amount of postoperative pain, and

analgesic use. One in 10 Australians experience 'tomophobia', the phobia of needles and blood. Or in this case, the fear of undergoing surgery. An estimated 340, 000 Australians experience 'Tomophobia' as a surgical patient each year.

The purpose of this phase of the study (phase 3) is to is to obtain input from patient representatives to ensure the priorities and needs of perioperative patients are being met.



The aim of this research project is using a co-design process to investigate if augmented and virtual reality technologies might be used to help address anxiety in perioperative patient experiences. To ensure we obtain an adequate amount of qualitative data 15-20 participants will be recruited.

What does participation in this research involve?

If you agree to participate in this study, you will be asked to sign the attached Consent Form and bring it with you to the interview.

You will be invited to take part in co-design workshop that will each last up to 2.5 hours. No preparation or follow up activities will be required. During these workshop we collaboratively explore a range of questions relating perioperative anxiety and potential interventions specially using AR/VR to address this issue.

Photographs may be taken during the workshop session; however, participants face, and all significant identifying features will be removed from these photographs prior to storage and/or publications. Photographs and other workshop data will not be made available to anyone outside of research team unless required by law, or if the data is being used for further research for which further ethical approval will be obtained.

Individual contributions will be kept confidential by the researcher and participants will not be identified in the reporting of the research.

Participation is voluntary; you will not be paid for participating in this research project. However, should you require reimbursement of travel expenses (taxi, car parking) this can be arranged.

What are the possible benefits of taking part?

We cannot guarantee or promise that participants will receive any benefits from this research; however, possible benefits may include implementing a new digital intervention to perioperative environments to reduce the patient's anxiety prior to attending their medical procedure.

What are the possible risks and disadvantages of taking part?

It is not anticipated that there are any risks to participation in this study beyond those encountered in everyday life. However, recalling participants' experiences with their medical procedures might trigger their anxiety. Telephone and online support service information such as Beyond Blue lifeline will be provided at the beginning of each session and in the case of an immediate emergency situation 000 would be contacted.

All care will be taken to maintain privacy and confidentiality; however, the researchers cannot guarantee anonymity and confidentiality for group discussions. All group participants will be asked to maintain the confidentiality of group discussions and identity of participants.

Do I have to take part in this research project?

Participation in any research project is voluntary. If you do not wish to take part, you do not have to. If you decide to take part and later change your mind, you are free to withdraw from the project at any stage. If you do decide to take part, you will be given this Participant Information and a Consent Form to sign, and you will be given a copy to keep. Your decision whether to take part or not to take part, or to take part and then withdraw, will not affect your routine care, your relationship with professional staff or your relationship with the University of South Australia.

If you decide to withdraw from the project, please notify a member of the research team before you withdraw. you may request to have the data you have previously contributed will be removed from the study where possible.

What will happen to information about me?

By signing the consent form you consent to the research team collecting and using information and opinions given for the research project.

Any information obtained in connection with this research project that can identify you will remain confidential. All data collected, including questionnaires and co-design workshop data will be de-identified.

Your information will only be used for the purpose of this research project and it will only be disclosed with your permission, except as required by law.

Any information obtained during the research project are subject to inspection (for the purpose of verifying the procedures and the data) by the relevant research personnel, the institution, the human research ethics committee, or as required by law. By signing the Consent Form, you authorise release of, or access to, this confidential information to the relevant research personnel and regulatory authorities as noted above.

The results of this research project may be published and/or presented in a variety of forums (i.e. PhD thesis, journals, conferences, media). In any publication and/or presentation, information will be provided in such a way that you cannot be identified.

In accordance with relevant Australian and/or South Australian privacy and other relevant laws, you have the right to request access to the information about you that is collected and stored by the research team. You also have the right to request that any information with which you disagree be corrected. Please inform the research team member named at the end of this document if you would like to access your information.

Any information obtained for the purpose of this research project that can identify you will be treated as confidential and securely stored. It will be disclosed only with your permission, or as required by law.

All photographs and personal data will be retained in a confidential, password protected file for 5 years in accordance with state and national guidelines.

What happens when the research projects end?

A summary of project results will be available to you from September 2021. You can access this summary by contacting Prof Ian Gwilt or PhD candidate Nikou Javadi.

The data you have contributed to this research project may be used in further research projects if approved by the Human research Ethics Committee.

Who is organising and funding the research?

This research project is being conducted by PhD candidate Nikou Javadi from the design research for health and wellbeing group within UniSA Creative Unit. The candidate has been awarded a scholarship for investigating interdisciplinary design and healthcare collaborations to improve outcomes, and the Vice Chancellor and President's Scholarship.

You will not benefit financially from your involvement in this research project even if, for example, knowledge acquired from your information proves to be of commercial value to UniSA. No member of the research team will receive a personal financial benefit from your involvement in this research project.

Who has reviewed the research project?

This research project has been approved by the Human Research Ethics Committee (HREC) of the University of South Australia as required by the Australian government research requirements, specified in the National Statement on Ethical Conduct in Human Research (2007 - updated 2018). This statement has been developed to protect the interests of people who agree to participate in human research studies. If you have any ethical concerns about the project or questions about your rights as a participant, or should you or any third parties wish to lodge a complaint about either the study or the way it is being conducted, please contact the Executive Officer of this Committee (tel: +61 8 8302 3118; email: humanethics@unisa.edu.au)

COVID-19 Requirements

The COVID-19 screening process that has been adopted across UniSA will be used in allowing researchers and participants to access the research venue. If they answer yes to any of the following questions, they will be excluded from the research activity and recommended to make an appointment at a medical clinic.

- Are you feeling unwell with fever or respiratory symptoms (i.e. cough, shortness of breath, sore throat)?
- Have you been in contact with a suspected or confirmed COVID-19 case? Social distancing measures, as directed by the government, e.g., all people involved to keep 1.5 to 2 metres distance from each other at all times, or 4 square metres per person indoors.

University of South Australia

Participant Information Sheet- Delphi

Ethics Protocol No.	203279
Title	*Reducing anxiety in perioperative experiences through the design of AR/ VR interventions*
PhD Candidate	Nikou Javadi
Principal Supervisor	Prof. Ian Gwilt Ian.gwilt@unisa.edu.au +61 8 8302 7014
Co- Supervisors(s)	Dr Kristin Carson-Chahhoud Dr Zoe Kopsaftis Dr Ross Smith

Introduction – What does my participation involve?

You are invited to take part in this research project, which is called 'Reducing anxiety in perioperative experiences through the design of AR/ VR interventions'. You have been invited because you are a health professional with experience in dealing and treating people with perioperative anxiety in South Australia.

This Participant Information & Consent Form tells you about the research project. It explains the processes involved with taking part. Knowing what is involved will help you decide if you want to take part in the research.

Please read this information carefully. Ask questions about anything that you don't understand or want to know more about. Before deciding whether or not to take part, you might want to talk about it with a relative, friend or local health worker.

Participation in this research is voluntary. If you don't wish to take part, you don't have to.

If you decide you want to take part in the research project, you will be asked to sign the consent section. By signing it you are telling us that you:
• Understand what you have read
• Consent to take part in the research project
• Consent to be involved in the research described

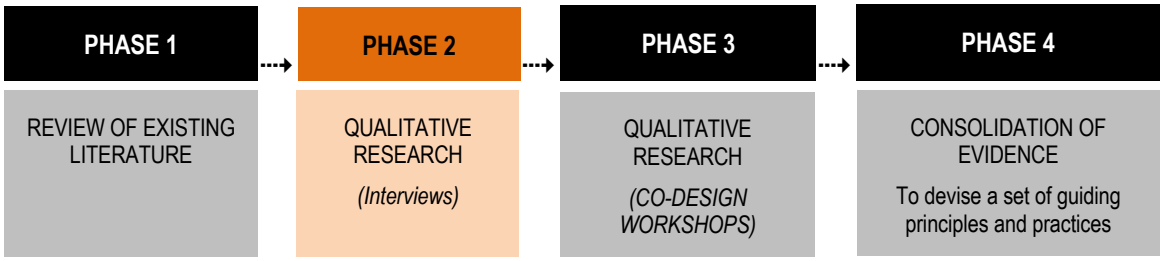
You will be given a copy of this Participant Information and signed Consent Form to keep.

What is the purpose of this research?

Available literature reveals that the perioperative patient anxiety can be a prevalent issue that can have extensive impact on the patients. Perioperative anxiety is directly proportional to increased infection risk, length of hospital stay, the amount of postoperative pain, and analgesic use. One in 10 Australians experience 'tomophobia', the phobia of needles and

blood. Or in this case, the fear of undergoing surgery. An estimated 340, 000 Australians experience 'Tomophobia' as a surgical patient each year.

The purpose of this phase of the study (phase 2) is to investigate if augmented and virtual reality technologies might be used to help address anxiety in perioperative patient experiences.



Qualitative data will be obtained through one-on-one interviews from Anaesthetists. To ensure we obtain an adequate amount of qualitative data 15 participants will be recruited.

What does participation in this research involve?

If you agree to participate in this study, you will be asked to sign the attached Consent Form and bring it with you to the interview.

We will arrange an interview at a time and location that suits you. The interview will run for approximately 45 minutes to 1 hour.

During the interview, we will ask you a series of moderated questions to seek your insight regarding perioperative patient's anxiety and potential interventions to address this issue through the semi structured interview questions. These questions relate to your perceptions, opinions, beliefs, and attitudes on perioperative anxiety. There are no right or wrong answers.

The interview will be conducted by PhD candidate. The session will be recorded using an audio device, which will help us to later transcribe the audio into written text. Once the interview is finished and all collected data from interviews analysed, a generated questionnaire as a second round of Policy Delphi will be sent to you by email.

Participation is voluntary; you will not be paid for participating in this research project. However, should you require reimbursement of travel expenses (taxi, car parking) this can be arranged.

What are the possible benefits of taking part?

We cannot guarantee or promise that participants will receive any benefits from this research; however, possible benefits may include implementing a new digital intervention to perioperative environments to reduce the patient's anxiety prior to attending their medical procedure.

What are the possible risks and disadvantages of taking part?

It is not anticipated that there are any risks to participation in this study beyond those encountered in everyday life. Whilst all care will be taken to maintain privacy and confidentiality.

Do I have to take part in this research project?

Participation in any research project is voluntary. If you do not wish to take part, you do not have to. If you decide to take part and later change your mind, you are free to withdraw from the project at any stage. If you do decide to take part, you will be given this Participant Information and a Consent Form to sign, and you will be given a copy to keep. Your decision whether to take part or not to take part, or to take part and then withdraw, will not affect your routine care, your relationship with professional staff or your relationship with the University of South Australia.

If you decide to withdraw from the project, please notify a member of the research team before you withdraw. you may request to have the data you have previously contributed will be removed from the study where possible.

What will happen to information about me?

By signing the consent form you consent to the research team collecting and using information and opinions given for the research project.

Any information obtained in connection with this research project that can identify you will remain confidential. All data collected, including questionnaires and transcriptions will be de-identified. Any identifiable information recorded during the interview session will be removed in the transcription.

Your information will only be used for the purpose of this research project and it will only be disclosed with your permission, except as required by law.

Any information obtained during the research project are subject to inspection (for the purpose of verifying the procedures and the data) by the relevant research personnel, the institution, the human research ethics committee, or as required by law. By signing the Consent Form, you authorise release of, or access to, this confidential information to the relevant research personnel and regulatory authorities as noted above.

The results of this research project may be published and/or presented in a variety of forums (i.e. PhD thesis, journals, conferences, media). In any publication and/or presentation, information will be provided in such a way that you cannot be identified.

In accordance with relevant Australian and/or South Australian privacy and other relevant laws, you have the right to request access to the information about you that is collected and stored by the research team. You also have the right to request that any information with which you disagree be corrected. Please inform the research team member named at the end of this document if you would like to access your information.

Any information obtained for the purpose of this research project that can identify you will be treated as confidential and securely stored. It will be disclosed only with your permission, or as required by law.

All audio recordings and study documentation will be retained in a confidential, password protected file for 5 years in accordance with state and national guidelines.

What happens when the research projects end?

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- Are you feeling unwell with fever or respiratory symptoms (i.e. cough, shortness of breath, sore throat)?
- Have you been in contact with a suspected or confirmed COVID-19 case? Social distancing measures, as directed by the government, e.g., all people involved to keep 1.5 to 2 metres distance from each other at all times, or 4 square metres per person indoors.

Interview questions for policy Delphi

1. Can you please list 5 main anxiety causes of perioperative patients based on your experience?
2. What kind of information do you think should be provided to the patient prior to their medical procedure?
3. What's your opinion about the role of digital health in reducing patient's anxiety?
4. In particular to what extent do you think using AR/VR might be a good intervention to reduce perioperative patient anxiety?
5. In your opinion, what would be the pros and cons of using AR/VR to reduce perioperative patient's anxiety?
6. In what stage of perioperative phase do you think implementation of AR/VR would be helpful?
7. What types of content in AR/VR do you think would be good to use to reduce patient's anxiety?
8. What other kinds of strategies do you think might help with reducing patients' anxiety?

University of South Australia

Human Ethics Application

Application ID :	203279
Application Title :	Reducing anxiety in perioperative experiences through the design of AR/ VR interventions
Date of Submission :	N/A
Primary Investigator :	Ms Nikou Javadi; Chief Investigator
Other Personnel :	Prof Ian Gwilt; Supervisor
	AsPr Kristin Chahhoud; Supervisor
	Dr Zoe Kopsaftis; Supervisor
	AsPr Ross Smith; Supervisor

Create New Ethics Application

Create New Ethics Application

The following provides brief information on how to complete an online ethics application. For more detailed information, please refer to the User Guides available at the UniSA website. Please note that there is also a User Guide for the Principal Supervisor to assist supervisors with the review of student applications. The User Guides also detail the process to follow should you be required to respond to reviewer's comments.

The System allows researchers to complete and submit human ethics applications electronically. Applicants navigate their way through the application by answering a number of questions. Sections, pages and / or questions appear based on the answers to previous questions therefore it is advisable that you complete questions sequentially in order to avoid skipping questions unintentionally. At times, word limits may prevent you from providing all the information you need to include. If this is the case, please include the necessary information as either a separate document and add it as an attachment (function available on the left hand menu available from the Attachments Section), or as a page comment. Please refer to the User Guides if you are unsure how to use these functions.

Please ensure you enter requested information in the sections available on the screen's left hand menu (Investigators, Attachments etc). Submitted applications that do not contain the required information will be returned to you and therefore the review process will be delayed. Refer to the User Guides if you are unsure how to use these functions.

ANSWERING QUESTIONS
It is important to take time to answer each question carefully and fully before progressing to the next question. By doing so, you will minimise the request for more details from the reviewers and/or prevent potential system errors.

Please note that the system will time out after 40 minutes of inactivity and any unsaved answers will be lost.
Each section of the online form can be saved by clicking the 'save' icon on the toolbar at the top right corner of the page. Each page is saved automatically when you click the green arrow to move on to the next section.

The research activity must not commence until ethics approval is finalised.*

☑ I agree

Investigator

Investigator

1 Is primary applicant a student? Please select 'Yes' if you are a student; if you are a staff member answer 'No'*

◉ Yes
○ No

2 **Please ensure that you mark the Primary Contact (usually the Chief Investigator) for this protocol as "Primary".**
(Please click on the name and select 'Yes' to 'Primary?' field).

Use the Name/ID search function to search for and add other investigators. Select their position/role from the dropdown box.

To save your changes, click the OK button at the right bottom corner of the form. *

1	Given Name	Nikou
	Surname	Javadi
	Full Name	Ms Nikou Javadi
	System code of Position held	Chief Investigator
	User Person Code	110230056
	Primary?	Yes
	AOU system code	UniSA Creative
	Organisation	
	Organisation Name	

2.1 Please provide your contact phone number if you agree to it being used by Ethics Administrators to follow up any points requiring clarification.

[redacted]

Principal Supervisor

Supervisor

Only the details of your principal supervisor (i.e. the person responsible for reviewing your application) can be included here.

If you are having trouble finding your supervisor's details, please try searching by surname only. Use the Name/ID search function to search for and add supervisors. To save your changes, click the OK button at the right bottom corner of the form. *

1	Given Name	Ian
	Surname	Gwilt
	Full Name	Prof Ian Gwilt
	System code of Position held	Supervisor
	User Person Code	139245
	Primary?	No
	AOU system code	UniSA Creative
	Organisation	
	Organisation Name	
	Supervisor person code	
2	Given Name	Kristin
	Surname	Chahhoud
	Full Name	AsPr Kristin Chahhoud
	System code of Position held	Supervisor
	User Person Code	139304
	Primary?	No
	AOU system code	UniSA Allied Health and Human Performance
	Organisation	
	Organisation Name	
	Supervisor person code	
3	Given Name	Zoe
	Surname	Kopsaftis
	Full Name	Dr Zoe Kopsaftis
	System code of Position held	Supervisor
	User Person Code	132391
	Primary?	No
	AOU system code	UniSA Allied Health and Human Performance
	Organisation	
	Organisation Name	
	Supervisor person code	
4	Given Name	Ross
	Surname	Smith
	Full Name	AsPr Ross Smith
	System code of Position held	Supervisor
	User Person Code	110117
	Primary?	No
	AOU system code	UniSA STEM
	Organisation	
	Organisation Name	
	Supervisor person code	

Prior Assessment

Project Core Details

Primary AOU*

UniSA Creative

Ethics category code*

Human Ethics

Application Title*

Reducing anxiety in perioperative experiences through the design of AR/ VR interventions

Non-UniSA HREC

UniSA HREC seeks to avoid the unnecessary duplication of ethical review. If your ethics application has already been approved by another Australian Human Research Ethics Committee, you should attach a copy of the full application submitted to the other HREC and the approval letter. The remainder of this application form will then be automatically shortened. UniSA HREC will review these documents, and if satisfied, will ratify the decision of the other committee.

1.1 Has another Australian, NHMRC-registered Human Research Ethics Committee (other than UniSA) reviewed this research project before and does this clearance/approval accurately describe the project as it is to be conducted? *

- ○ Yes
- ◉ No

UniSA HREC

2.1 Is this application a resubmission of an application that was considered by UniSA HREC and the decision was 'Not Approved: Resubmit', 'Not Approved' or "Approved subject to" and the status has expired (ie amendments were not made within the 6 month timeframe). Please note if your application is "Approved subject to" and 6 months **has not** lapsed then you should use the original application submitted to make the required changes. *

- ○ Yes: Not approved: resubmit
- ○ Yes: Not Approved
- ○ Yes: Approved subject to and the status has expired
- ◉ No

Project Scope

Project Scope

11.1 Is the activity archival research? A large proportion of activity involving the analysis of documents, publicly available information, or previously collected data may be outside the scope of the University's human research ethics arrangements. *

- ○ Yes
- ◉ No

11.2 Is the work being conducted only for UniSA administrative / service delivery purposes? *

- ○ Yes
- ◉ No

12.1 Should the work be characterised as quality assurance or an audit, rather than human research within the scope of the University's human research ethics arrangements? *

- ○ Yes
- ◉ No

12.2 Is the work a practical exercise or test conducted for teaching purposes in a University administered facility? (Guidelines for Evaluation Activities Involving UniSA Students and Staff). *

- ○ Yes
- ◉ No

13.1 Is the work a routine experiment or procedure conducted for teaching purposes in a University administered facility? *

- ○ Yes
- ◉ No

13.2 Is the work / data collection conducted by a student only for teaching / learning purposes? *

- ○ Yes
- ◉ No

13.2.2 Will the collected information be subjected to formal analysis? *

- ◉ Yes
- ○ No

13.2.4 Will the information obtained be recorded in such a manner that participants can be identified, directly or through identifiers linked to the participants, and is identification likely to be considered problematic or a cause for concern by the participants? *

- ○ Yes
- ◉ No

13.2.5 Will the information obtained be recorded in such a manner that any disclosure of the participants' responses outside the research team could reasonably place the participants at risk of criminal or civil liability or be damaging to the participants' status, financial standing, employability or reputation? *

- ○ Yes
- ◉ No

13.2.6 Will the research deal with sensitive aspects of the participants' own behaviour, such as sexual preference, illegal conduct, use of alcohol, drug use, or includes information about health status? *

- ○ Yes
- ◉ No

Initial Check

The purpose of this 'Initial Check' is to direct your ethics protocol to the appropriate level of review.

If you were **not** notified that your protocol was assessed as Exempt (Criteria 1) or Exempt (Criteria 2), please select **Continue** and click on the next page arrow.

However, if the previous screen stated that your protocol was assessed as being either Exempt (Criteria 1) or Exempt (Criteria 2), please select **Finish** and click on the next page arrow.

*

- ◉ Continue
- ○ Finish

Project Details

Ethics Training

3.1 Have you had human ethics training in the last 24 months? (Please do not include training you have attended regarding how to use the online ethics system)*

- ○ Yes
- ◉ No

Project Type

4.1 Main type of research (e.g. staff, PhD). *

PhD

4.1.2 **Please note that, if you are a student applicant, your application will be forwarded to your principal supervisor once submitted for their approval. If they are satisfied with your application it will be forwarded to the relevant review group. If your supervisor requires changes to be made then your application will be returned to you to make the required changes.**

4.2 Are there any other types of research involved (not identified in 4.1) . Please select all that apply*

- ☑ None
- ☐ Honours
- ☐ Other
- ☐ Course Approval
- ☐ PhD
- ☐ Masters by Coursework
- ☐ Masters by Research
- ☐ Professional Doctorate
- ☐ Undergraduate
- ☐ Graduate Diploma/Graduate Certificate
- ☐ Staff

4.3 Please list which school(s) the UniSA researcher(s) is/are from?*

UniSA Creative/ School of Art, Architecture and Design

Project Details

5.1 Plain English title*

Reducing anxiety in perioperative experiences through the design of AR/ VR interventions

5.2 What are the aims of your research?*

Aims:
- To contribute research on the use of AR/VR interventions for perioperative anxiety reduction
- To investigate how AR/VR design interventions may be used to help address anxiety in perioperative patient experiences
Objectives
- To undertake primary research with health care professionals to document care-providers perspectives on perioperative anxiety (Delphi study)
- To undertake patient-centered research to understand the lived experience of perioperative anxiety (focus group ¿ co-design methodology)
- To design and test an AR/VR prototype (co-design workshops)
- To report on how an AR/VR intervention might be used to manage patient perioperative anxiety
- To devise a set of guiding principles and practices for the use of AR/VR interventions in relation to perioperative anxiety

5.3 List your research questions or hypotheses. Your protocol should clearly identify the questions which you want your research to answer. *

1. How can AR/VR design interventions reduce anxiety in the perioperative patient experience?
2. What are the knowledge gap and expectations of perioperative patients regarding reducing their anxiety?
3. What knowledge and skills should perioperative patients have in respect to designing AR/VR interventions to reduce their anxiety?
4. What are the effects of AR/VR interventions in reducing perioperative patient anxiety?

5.4 Explain the need for, and value of, your research. Place the aims in the context of existing research or practice AND what your study does to add to existing literature. (You must include a list of not more than 10 key references as an attachment to support your answer to this question. These are to be attached to the Attachments section of this application).*

Perioperative anxiety has emerged as a challenge for care provider. Perioperative nursing care is aimed at facilitating an ample environment for before, during and after the operating procedure (Mulugeta et al. 2018). The gap in the availability of literature relating to the use of AR/VR interventions for the reduction of preoperative anxiety is a factor that leads to the need of a study such as this one.
This study generates information on how patients perceive their needs when involved in surgical procedures. This study¿s findings will avail new insight and information regarding the nature of information that patients may want during the preoperative period and how such information can be delivered through the use of AR/VR technologies. Results from studies on perioperative patients indicate that surgical environments can provoke stress, loss of control, anxiety, and fearfulness (Fortier, et al., 2009; Bodner, 2005; Maliglig, 1994; Stewart, Algren, & Arnold, 1994). Based on a preliminary literature review conducted by candidate using relevant databases with the combination of the keywords that have been mentioned herein, there is no research on the use of AR/VR interventions for perioperative anxiety reduction (Jenkins et al. 2014). This study, therefore, will avail perioperative information to facilitate the formalization of educational experiences and materials anchored on the familiarization of preoperative patients through the use of AR/VR interventions in clinical contexts and the entire preoperative process.

5.5 Please describe your research design and methodology (e.g. where will the data collection occur, what will participants be asked to do during the course of data collection, how long will the interview/focus groups/filling out the questionnaire take, etc).*

This research will use the interview process with healthcare professionals to establish a baseline understanding of the level of comprehension and interest in using Augmented and Virtual reality to address perioperative anxiety in patients. It will then use two co-design workshops to develop concepts: 1. Translating the baselines information into visualization ideas, and the second workshop to refine and deliver the ideas. The interview will use purposive sampling methodology at two locations, Pulse anaesthetic group, UniSA Health clinic. Participants will be asked to respond to a series of demographic questions before being asked to qualitatively reflect on their understanding of perioperative patients¿ anxiety and potential interventions to adders this issue through a series of semi-structured questions. The interviews will be one and one face-to-face with COVID-19 safety measures in place. The demographic information will be collected via physical questionnaire forms while the data from the semi-structured interview questions will be added in real-time to storyboard using specifically designed question cards. It is anticipated the interviews will take between 45 minutes to an hour depending on the complexity and detail of responses to semi-structured questions. The co-design sessions will each be about 2.5 hours in length and take place in [Unisa city west campus]. These sessions will have new participants who are interested in the process and meet the criteria (will be mentioned in the next sections), or they may be participants from the interview process indicated above. Participants will be asked to take part in a series of facilitated exercises based on the Design Thinking facilitation methods developed by UniSA Match Studio. Final in-situ testing of concept(s) developed will use the semi-structured questionnaire to gather the feedback from the participants and will ask them to respond to the concept via question cards that will be pinned to the storyboard.

Resources

Project Funding

6.1 Have you applied for funding for this project from any external source?*

- ○ Yes and application for the funds has been successful
- ○ Yes but the outcome of the application is not yet known
- ◉ No

6.5 Will the project be supported in ways other than direct funding (eg in-kind support/equipment by an external party)? *

- ○ Yes
- ◉ No

Ownership of Data

8.1 Detail who will own the data and the results of your research (student researchers normally own their own research and data unless there is a written agreement between the student and the University / third party; staff research and data is normally owned by UniSA). Please select all that apply.*

- ☐ UniSA
- ☑ Student researcher
- ☐ Other

8.2 Does the owner of the information or any other party have any right to impose limitations or conditions on the publication of the results of this project?*

- ○ Yes
- ◉ No

8.3 Please note that it is the researcher's responsibility to ensure that, where required, an appropriate agreement is in place. If you are unsure whether this is needed, please consult the Intellectual Property website. Do you require an agreement regarding ownership or do you currently have an agreement in place?

Please note that a signed agreement will usually be required where:
- A research team includes both students and staff; or
- Where researchers from different institutions are collaborating on a project.*

- ○ An agreement is required
- ○ A signed agreement is in place
- ◉ An agreement is not required

Data: storage, access, disposal

9.1 The information which will be stored at the completion of this project is of the following type(s). Please select all that apply.*

- ☐ Individually identifiable
- ☐ Re-identifiable
- ☑ Non-identifiable

9.2 Where will the data be stored? University policy requires researchers to store a copy of the data onsite at UniSA, usually in the relevant School Office (please specify the campus and office/room location e.g. Mawson Lakes Campus, RM GP2-19). Please refer to the University's Ownership and Retention of Data Policy.*

Digital data will be stored on university servers in a password protected form with a password known only by researcher and supervisor. Physical research data will be stored in a locked filling in K2-25.

9.3 For how long will the information be stored after the completion of the project? Why has this period been chosen? *

Data will be stored for a period of 5 years as this is general research that does not involve any SA government departments.

9.4 In what formats will the information be stored during the research project? (eg. paper copy, computer file on floppy disk or CD, audio tape, USB memory stick, videotape, film) *

Digital data will be stored on university servers in a password protected form with a password known only by researcher and supervisors. Prototypes and Paper copies of data will be stored in a locked filling in K2-25.

9.5 How will information, in all forms, be disposed of after the retention time has lapsed? (Please refer to the Ownership and Retention of Data Policy. The Head of School (or equivalent) must be aware of this process).*

paper information will be disposed by using confidential bins. digital copies will be deleted from the university server.

9.6 Will any other individual(s), organisation(s) or researcher(s) (other than those listed on the Investigators & Supervisors section) have authority to use or have access to the information?*

- ○ Yes
- ◉ No

9.7 Specify the measures to be taken to ensure the security of information from misuse, loss, or unauthorised access while stored during the research project. (eg. Will identifiers be removed and at what stage? Will the information be physically stored in a locked cabinet?)*

the data will be stored on a UniSA secure server with restricted access. Files will be password protected known only to researcher and supervisors. All other Prototypes and Paper copies of data will be stored in a locked filling in K2-25.

9.8 If the principal researcher leaves UniSA prior to the finalisation of data collection and/or before the storage retention time has lapsed, the researcher(s) will comply with the Universities Ownership and Retention of Data Policy in relation to the storage of data / information collected for, used in, or generated by this project.*

- ◉ I agree
- ○ I do not agree

Insurance Cover

10.1 **Insurance Cover for your research**

Improvements have been made in the recording and assessment of the insurance cover for research projects. Your responses to selected ethics application questions will be assessed to determine whether your research activity is covered by the University's standard insurance cover or whether individual insurance assessment is required. Where individual insurance assessment is required the ethics team will email you to obtain any additional information not available from your ethics application.

10.1.2 **Standard insurance conditions**

Standard insurance conditions continue to apply to your research. These are based on (1) obtaining full ethics approval prior to commencement of any research activities, (2) on the presentation of appropriate agreements in place with collaborators, and (3) on maintaining personal and professional integrity in all your research activities.

Further Information

Please refer to the Insurance website for further information about insurance cover.

If you have any questions about insurance for your project please contact humanethics@unisa.edu.au.

Research type and participants

Research type

14.1 This project involves: Research using...(Please select all that apply.)*

- [x] Qualitative methods
- [ ] Quantitative methods, population level data or databanks, e.g. survey, epidemiological research
- [ ] None of the above

14.2 What research methodologies will you use? (Please select all that apply.) *

- [ ] Anonymous questionnaires
- [ ] Internet questionnaires
- [ ] Evaluation research
- [ ] Observation of participant's usual activities
- [ ] Observation of an activity set up for the purposes of the study
- [ ] Access to medical records
- [ ] Access to records containing intimate, individually identifiable information, not publicly available
- [ ] Experiment or testing of a procedure, drug or equipment
- [ ] Use of biological hazards, GMOs or pathogenic organisms
- [ ] Use of carcinogenic and/or toxic chemicals, including heavy metals
- [ ] Use of Radiation (Ionising and/or Non-ionising, but not Ultrasound)
- [ ] Other
- [ ] Questionnaires requesting intimate personal, identifying, or sensitive information
- [ ] Other questionnaires
- [x] Face to face interviews which do not request personal or sensitive information
- [ ] Face to face interviews which request personal or sensitive information
- [ ] Telephone survey which does not request personal or sensitive information
- [ ] Telephone survey which requests personal or sensitive information
- [x] Focus groups
- [x] Action Research

14.2.2 Is it intended that the interview/focus group transcript will be shown or made available to participants?*

- ( ) Yes
- (•) No

14.2.2.2 Why are participants not provided with the transcript of the interview/focus group?*

The participants would not benefit from receiving the transcripts. They are also not disadvantaged in any way by not receiving the transcripts. The participants will instead be provided with a summary of the sessions.

14.3 Will you be audio-taping, video-taping, or taking photographs of participants during the course of the study? Please select all that apply.*

- [x] Audio-taping
- [ ] Videotaping
- [x] Photographs
- [ ] No

14.3.1 Why is it necessary to collect data in this form?*

photographs are an important part of documenting a co-design process. the visualization of the process is an important part of communicating the research methodology and methods used to peers in the co-design field. photographs will focus on storyboards, written ideas, and objects being created and discussed, but images of participants may be captured while capturing these photographs. I require audio recordings for accuracy. It provides a more thorough and comprehensive collection of data than note-taking alone, ensuring that
no important comments or observations are lost. Recordings will be important in confirming the results recorded from performance measures studies.

Participant information

15.1 How many participant groups are involved in this research project? *

2.00

15.2 Please provide the details as an **attachment** for each participant group. **(To upload your attachment, please click on the Attachments section of the application on the left hand side of the screen)**

15.3 What is the expected total number of participants in this project at all sites?*

30.00

15.3.1 Please provide details of how many participant groups will be involved, the number of participants in each group, the age range of the participant groups, the relevant characteristics of each group and what each participant group will be required to do? e.g. pilot study group, main study group, interview group, focus study group, experimental group, control group etc. If required, please add a document to the Attachments page in response to this question.*

The interview (Delphi method participant), n=10
Focus group participants (Co-design), n=20
Delphi method participants will be healthcare professionals
Co-design workshop participants will be recent day surgery patients with first or limited experiences
The actions of each participant group are described in section 5.5.

15.3.2 Please justify the chosen sample size.*

the co-design methodology will be used to generate theoretical propositions rather than statistical assumptions. Because of this, representative sampling is not necessary. the sample size for the interview process is based on the assumptions about the nature of the study and the role of healthcare providers. the purpose of a baseline questionnaire in a co-design process is to establish an initial set of data that can be used as a generative tool in the ideation of the process. it is not intended to be statically significant.

Selection of participants

16.1 What process(es) will be used to identify potential participants?*

The potential participants in the interview process (Delphi study) are healthcare professionals (Anaesthetists) and flyers for participation will be sent out. In the co-design workshops, Participants who meet the selection criteria will self-report, stating that they have recently been admitted to hospital for an elective day surgery case no experience or minimal experience of having surgery. participants will be engaged through a purposive sampling method.

16.2 Will potential participants be 'screened' or given a test/questionnaire to assess their suitability as a participant for the study?*

- ○ Yes
- ◉ No

16.3 Describe how initial contact will be made with potential participants.*

For the Delphi method, identified experts will be contacted through their professional email obtained from their organizational website with invitation and information sheet prior their interest to participate in research. The creative unit research academic service office has offered to email staff and students who are registered on their database, inviting them to participate in the research co-design workshops. Posters advertising the research will be also placed on the city west Kaurna building.

16.4 Is an advertisement, e-mail, website, letter or telephone call proposed as the form of initial contact with potential participants?*

- ◉ Yes
- ○ No

16.4.1 Please detail how this will be used and/or whether any approval is needed to use this contact method. **Please attach any relevant documents to the Attachments section of this application.***

Approval from the creative unit academic research office will be sought.
Approval will be sought for the placement of posters on campus following the UniSA policy.

16.5 List the selection and, if appropriate to your study, the exclusion criteria for participants.*

Purposive sampling will be undertaken to select appropriate sets of participants for each stage of the research.
Inclusion criteria
¿ No experience or minimal experience of having surgery
¿ Admitted to hospital for an elective day case surgery in the last 6 months
¿ Ages =>18 years

Exclusion criteria
These criteria are not always clinical in nature, aiming principally to accommodate participants in a safe and ethical manner. Criteria may include:
¿ circumstances that interfere with the participant¿s ability to give informed consent (diminished understanding or comprehension, or a language other than English spoken and an interpreter unavailable),
¿ emergency procedures for which no preoperative visit had been scheduled
¿ Pregnancy
¿ History of psychological disorders
¿ history of seizures or epilepsy
¿ Paediatric patients

16.6 If it became known that a person or participant group was recruited to, participated in, or was excluded from the research, would that knowledge expose the person to any disadvantage or risk?*

- ○ Yes
- ◉ No
- ○ Not Applicable

Project start, end, location details

17.1 Will the research be undertaken in Australia?*

- (●) Yes
- ( ) No

17.1.1 In which town(s)/city(ies)/State(s) of Australia will the research be undertaken in? *

Adelaide, South Australia

17.1.2 In how many Australian organisations will the research be conducted? (Please list all organisations where participants will be specifically recruited from e.g. if recruiting UniSA staff or students, you have at least 1 organisation)*

1.00

Please note: you must obtain written approval from the organisations where the research will be undertaken and either attach the letter to the application or forward this to the Ethics and Compliance Officer before final approval can be granted for the project. Please refer to UniSA/organisation approval for additional information on the type of approval needed.

17.1.2.1 Please enter the details for the Australian site(s) where participants will be recruited from, the location of the organisation, the anticipated start date for the site and the anticipated end date for the site.*

Pulse anaesthetic group:
1/281-285 Wakefield St, Adelaide SA 5000

UniSA Creative unit (City West Campus):
27-29 North Terrace, Adelaide SA 5000

Start date: 1 December 2020
End date: 30 May 2021

17.2 Will the research be undertaken overseas?*

- ( ) Yes
- (●) No

17.3 Are there any time-critical aspects of the research project of which the review committee should be aware?*

- ( ) Yes
- (●) No

Irregular consent process

Limited disclosure/waive consent

18.1 Does the research involve limited disclosure to participants? Refer to Chapter 2.3 of the National Statement. *

- ( ) Yes
- (●) No

18.2 Are you asking the HREC / review body to waive the requirement of consent? Refer to Chapter 2.3 of the National Statement.*

- ( ) Yes
- (●) No

Covert Observations

19.1 Does the research involve covert observation? Refer to Chapter 2.3 of the National Statement.*

- ( ) Yes
- (●) No

Deception

20.1 Does the research involve deception? Refer to Chapter 2.3 of the National Statement.*

- ( ) Yes
- (●) No

Project Type

Project Type

21.1 Does the research involve any of the following? Please select all that apply.*

- [ ] Drugs; narcotics; poisons; ingestion/injection of placebo, or an invasive procedure administered
- [ ] Clinical trials
- [ ] Cellular therapy
- [ ] Collection and/or use of human samples (eg tissue; blood or other body fluid collection/extraction)
- [ ] Genetic testing and/or genetic research
- [ ] Human gametes or use or creation of human embryos
- [ ] A practice or intervention which is an alternative to a standard practice or intervention
- [ ] Investigating workplace practices which could possibly impact on workplace relationships
- [ ] Conducting the research overseas and recruiting participants
- [x] None of the above

Participants

Recruitment

38.1 Who will you be recruiting as participants for this study? Please select all that apply.*

- [x] General public (over 18 years of age)
- [ ] Members of a collectivity
- [ ] People who may be involved in illegal activity
- [ ] UniSA staff
- [ ] UniSA students
- [ ] Not recruiting participants
- [ ] Other
- [ ] People whose first language is not English
- [ ] People who are illiterate
- [ ] Pregnant women/human foetus
- [ ] Children
- [ ] People who are in a dependent or unequal relationship
- [ ] People who are highly dependent on medical care
- [ ] People with a cognitive impairment
- [ ] Aboriginal and/or Torres Strait Islander peoples

38.2 Does the research involve issues likely to be considered significant to Indigenous peoples?*

- ( ) Yes
- (•) No
- ( ) Not Applicable

Risk to Participants

Risk to Participants

51.1 Please select all that apply. This research project:*

- [ ] Has the potential to expose participants to potential civil, criminal or other proceedings
- [ ] Makes it possible for third parties to identify participants
- [ ] Offers an inducement which could be considered coercive
- [ ] Involves participation of people who legally cannot provide voluntary & informed consent
- [x] None of the above
- [ ] Involves a risk of physical injury
- [ ] Involves human exposure to ionising and/or non-ionising radiation (including X-ray)
- [ ] Involves exposure to disease or infection
- [ ] Involves pain or significant discomfort
- [ ] Involves psychological or emotional stress
- [ ] Involves sensitive personal information
- [ ] May expose participants to potential loss of professional reputation,market standing; employability
- [ ] May result in significant negative impact upon personal relations

Right to Privacy

66.1 Does the Commonwealth Privacy Act apply to the research (eg access to identified personal data held by third parties subject to privacy regimes)? Refer to the Privacy law.*

- ( ) Yes
- (•) No

Collection Method

Collection Method

67.1 Data collected for this research project will be collected directly from participants (e.g. they are completing a question about themselves, their thoughts, their opinions etc).*

- (•) Yes
- ( ) No

67.1.1 **Information which will be collected for this research project directly from the participant**

67.1.2 Describe the information that will be collected directly from participants. Be specific where appropriate.*

Participants will be asked to reflect on their understanding of issues and factors that contributed to perioperative anxiety and their opinion and knowledge about using digital health technologies to address this problem.

67.1.3 The information collected by the research team about participants will be in the following form(s). Please select all that apply.*

- [ ] Individually identifiable
- [ ] Re-identifiable
- [x] Non-identifiable

67.2 Data collected for this research project will be collected from another person about the participant (e.g. asking participants' doctors about their patients medical history).*

- ( ) Yes
- (•) No

67.3 Will data collected for this research project involve the use or disclosure of information by an agency, authority or organization (other than UniSA)? (e.g. accessing participants' medical records)*

- ( ) Yes
- (•) No

67.4 Data collected for this research project will involve using information which you or your organisation collected previously for a purpose other than this research project?*

- ( ) Yes
- (•) No

67.5 Describe and justify how you will analyse the data collected from or about the participants.*

The data collected from the interview method will be used to identify the knowledge gap and key patterns in regard to perioperative anxiety. theses data from Delphi methods will be analyzed using an inductive thematic analysis process. Data from co-design workshops will be analyzed as part of the workshops themselves so participants will play a role in gathering and analyzing the data that is generated. this is in line with international best practices in co-design and the process will be based on the British design council's double-Dimond design process.

67.6 Select all that applies to this project from the following:
Information collected for, used in, or generated by, this project.. *

- [ ] Will not be used for any other purpose
- [x] Will/may be used for another purpose by the researcher for which ethical approval will be sought
- [ ] Will establish a database/collection or register for future use (ethical approval will be sought)
- [ ] Will/may be made available to a 3rd party for subsequent use (ethical approval will be sought)
- [ ] Other

67.6.1 How might the data be used for the additional purpose? (Please note that the participant information sheet should specify that the data collected may be used for another purpose).*

The information gathered during the co-design workshops will be used to prototype and test the product.

Participants Relationships

68.1 Is there an existing relationship or one likely to arise during the research, between the potential participants and any member of the research team or an organisation involved in the research?*

- ( ) Yes
- (•) No

68.2 Does the researcher / investigator have another role in relation to the participant?*

- ( ) Yes
- (•) No

68.3 Will the research impact upon, or change, an existing relationship between participants and researcher / investigator or organisations?*

- ○ Yes
- ◉ No

Consent

69.1 Will consent for participation in this research be sought from all participants? Refer to Chapter 2.2 of the National Statement.*

- ◉ Yes
- ○ No

69.1.2 Will there be participants who **have** capacity to give consent for themselves?*

- ◉ Yes
- ○ No

69.1.2.1 What mechanisms / assessments / tools are to be used, if any, to determine each of these participant's capacity to decide whether or not to participate?*

participants will be asked to confirm that they are over the age of 18, No experience or minimal experience of having surgery and Admitted to the hospital for an elective day case surgery in the last 6 months

69.1.3 Will there be participants who **do not have** capacity to give consent for themselves?*

- ○ Yes
- ◉ No

Consent Process

70.1 Describe the consent process, ie how participants or those deciding for them will be informed about, and choose whether or not to participate in, the project.*

participants will be given a copy of the participant information sheet prior to participation. The consent form will be emailed individually to each applicant. Applicants will be asked to confirm via email that they agree to meet with the principal researcher, individually and confidentially, face to face, to discuss the project in more detail, the consent process will be discussed in detail, confirming that they understand it and participate in the research. A hard copy of the consent form will be provided to each participant, which they will be asked to sign. (see the attachment)

70.2 If a participant or person on behalf of a participant chooses not to participate, are there specific consequences of which they should be made aware, prior to making this decision?*

- ○ Yes
- ◉ No

70.3 If a participant or person on behalf of a participant chooses to withdraw from the research, are there specific consequences of which they should be made aware, prior to giving consent?*

- ○ Yes
- ◉ No

70.4 Can individual participants be identifiable by other members of their group? (e.g. co-workers, focus group members etc.)*

- ◉ Yes
- ○ No

70.4.1 Could this identification expose them to risks?*

- ○ Yes
- ◉ No

70.4.2 Will participants receive any incentive/payment (e.g. movie tickets, food voucher) or reimbursement (eg travel expenses) to participant in the study?*

- ○ Yes
- ◉ No

70.7 Will consent be specific or extended or unspecified? Refer to statements 2.2.14-2.2.18 of the National Statement.*

- ○ Specific
- ◉ Extended
- ○ Unspecific

70.7.1 Provide reasons why this form of consent has been chosen. *

Extended consent is sought due to the ongoing nature of research that is being undertaken. Prototypes and products produced in the course of the Co-Design workshops may inform further research activities. Further Ethics approval will be sought for these activities.

Risks and Benefits

Risks and Benefits

Please note that when answering the following questions, only risks beyond those encountered in everyday life are relevant. Refer to Chapter 2.1 of the National Statement.

71.1 Are there any risks to participants as a result of participation in this research project (eg physical, psychological, spiritual, emotional, legal, social, financial well-being, employability or professional relationships)?*

- ○ Yes
- ◉ No

71.2 What expected benefits will this research have for the wider community?*

This research project takes place within the context of the design and health disciplines for which an investigation of the application of AR/VR as intervention for perioperative anxiety reduction in clinical settings will be carried out. This research will lead to an improved understanding of anxiety reduction in perioperative contexts through designing AR/VR interventions. The study will propose some key principles for the maximisation the process of clinical and personal change of perioperative patients will have a positive impact on surgical experiences and outcomes.

71.3 What expected benefits (if any) will this research have for participants?*

participant will experience a Design Thinking led Co-Design process. Design Thinking and other skills associated with Co-Design practice are increasingly being recognised as important skills for both professional and non- professional participants.Recent research has shown that there are significant intangible benefits for participants involving in Co-Design process, particularly from the opportunity to be given to non-professionals to take the ownership of their own care.

71.4 Are there any other risks involved in this research? eg. to the research team, the organisation, others (eg physical, psychological, spiritual, emotional, legal, social, financial well-being, employability or professional relationships)*

- ○ Yes
- ◉ No

Risks and Benefits cont.

72.1 Is it anticipated that the research will lead to commercial benefit for the investigator(s) and or the research sponsor(s)?*

- ○ Yes
- ◉ No

72.2 Is there a risk that the dissemination of results could cause harm of any kind to individual participants - whether their physical, psychological, spiritual, emotional, legal, social or financial well-being, or to their employability or professional relationships - or to their communities?*

- ○ Yes
- ◉ No

72.3 Describe how the members of the research team will monitor the conduct of the research. (e.g. Will regular meetings be held between researchers? Will student researchers be in regular contact with their supervisors? etc)*

Meetings will be held between the chief investigator and supervisors before and after each phase of data collection.

72.4 **It is mandatory for researchers to report suspected cases of child abuse/neglect, domestic violence, bullying, illegal activities, use of illicit substances, abuse of elderly persons, professional negligence etc.**

72.4.1 Is it likely that this will be disclosed during the course of the project?*

- ○ Yes
- ◉ No

Researcher Training

73.1 List the relevant qualifications, experiences and /or skills of the research team which equip them to conduct this research.*

To conduct this interdisciplinary research I have a panel of qualified supervisors from different academic disciplines; Prof. Ian Gwilt, (Professor of Design, UniSA Creative, principal supervisor), Dr. Kris Carson-Chahhoud (Associate Research Professor, UniSA Allied Health & Human Performance, co-supervisor), Dr. Zoe Kopsaftis (Research Assistant, UniSA Allied Health and Human Performance, co-supervisor) and Dr. Ross Smith (Associate Professor in Computer Science UniSA STEM, co-supervisor). The project team also include Dr. Aaron Davis (Research Assistant, UniSA Creative Unit, facilitator of Design Thinking workshops and co-design process), end-user research collaboration consisting of Dr. Paul Lambert, Executive Director Digital Design, Central Adelaide Local Health Network (End-user).
Prof. Ian Gwilt has significant experience in the use of co-design methodologies in answering complex questions. Formally a member of lab 4 Living at Sheffield Hallam University, UK, and the Design Research Society, Ian has worked with a range of participant groups to develop iterative solutions to a range of social and technological challenges using the co-design methodology. Dr. Aaron Davis is a research assistant at the University of South Australia. As part of his work, Aaron facilitates Design Thinking workshops and co-design process with a range of university, government, industry, and community groups. Working closely with my supervisory panel; this research tries to respond to the need for design thinking, using creative practice-based research methods and provide a set of essential guiding principles and practices to shape this research project, to achieve real-world outcomes with exposure to industry experiences and contexts.

73.2 Do the researchers involved in this research project require any additional training in order to undertake this research?*

- ○ Yes
- ◉ No

Reporting of Results

74.1 Is it intended that results of the research that relate to a specific participant be reported to that participant?*

- ○ Yes
- ○ No
- ◉ Not Applicable

74.2 Is the research likely to produce information of personal significance to individual participants?*

- ○ Yes
- ◉ No

74.3 Will individual participant's results be recorded with their personal records?*

- ○ Yes
- ◉ No
- ○ Not Applicable

74.4 Is it intended that all or some of the results that relate to a specific participant be reported to anyone other than that participant?*

- ○ Yes
- ◉ No

74.5 Will research participants have the opportunity to receive a copy of your final report or summary of the findings if they wish?*

- ◉ Yes
- ○ No

74.5.1 How will you provide a copy of the final report or summary of the findings?*

Delphi method and Co-design participants will have the opportunity to be notified about the research findings, if they would be interested.

Reporting of Results cont.

75.1 Is the research likely to reveal a significant risk to the health or well being of persons other than the participant (eg family members, colleagues)?*

- ○ Yes
- ◉ No

75.2 Is there a risk that the dissemination of results could cause harm of any kind to individual participants - whether their physical, psychological, spiritual, emotional, social or financial well-being, or to their employability or professional relationships - or to their communities?*

- ○ Yes
- ◉ No

75.3 How is it intended to disseminate the results of the research? Please select all that apply.*

- ☑ Thesis/dissertation
- ☑ Journal article/s
- ☐ Research paper
- ☑ Conference presentation
- ☐ Commissioned report
- ☐ Other

75.4 Will the confidentiality of participants and their data be protected in the dissemination of research results?*

- ◉ Yes
- ○ No
- ○ Not Applicable

75.4.1 Explain how confidentiality of participants and their data will be protected in the dissemination of research results.*

individual participant responses will not be identifiable in the data and result. Pseudonyms will be used where relevant (for example, when quoting from an interview).

Attachments

Attachments

Note: You can upload additional documents by clicking on the "Add New Document" link. Types of documents which should be attached include Reference List/Bibliography, Participant Information Sheet, Consent Form, Copy of Research Tools, Internet Questionnaire, Interview Questions, Focus Group Questions, Details of Observational Aspects, Details of Action Research Process, Organisational Approval, international government research approvals where required, safety & distress protocols, communication plans with Indigenous communities involved in research etc. Please see here for additional Application Considerations.

The Human Research Ethics Committee pays particular attention to Participant Information Sheets and consider them to be public documents.

HREC requires researchers to conform to the Participant Information Sheet Guidelines. Please refer to Chapter 2.2 of the National Statement.

A consent form template is available at Model Consent Form. Please ensure all irrelevant information is deleted as there are numerous notes to the researcher included in the model consent form to assist researchers to draft their form.

*

This question is not answered.

Declaration

Declaration

The Primary Contact for this project is responsible for the application that is submitted and must be the one to agree to the following statement.

"On behalf of the research team for this project, I confirm that all members of the research have read the current NHMRC *National Statement on Ethical Conduct in Human Research*. The research team accepts responsibility for the ethical and appropriate conduct of the procedures detailed in this application, confirm that the research team will conduct this project in accordance with the principles described in the *National Statement*, and confirm that the research team will comply with any other condition laid down by the University of South Australia's Human Research Ethics Committee."*

☐ I Agree

This question is not answered.

Please click on the *Action* tab on the left hand side of the screen and click *Submit*.

Instructions

Instructions

Please click on the *Action* tab on the left hand side of the screen and click *Submit*.



University of
South Australia

A thesis submitted for the degree of Doctor of Philosophy