Quantifying the size of wellbeing and financial consequences in elective surgery in Australian hospitals: A patient's perspective

Yoey Gwan Venise Hon (BSc, MPH)

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under the supervision of Prof Andrew Hayen, Dr Daniel Demant and Prof Joanne Travaglia

University of Technology Sydney

Faculty of Health

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CERTIFICATE OF ORIGINAL AUTHORSHIP

I, Yoey Gwan Venise Hon, declare that this thesis is submitted in fulfilment of the requirements for the award of Doctor of Philosophy in Public Health in the School of Public Health, Faculty of Health at the University of Technology Sydney. This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis. This document has not been submitted for qualifications at any other academic institution. This research is supported by the Australian Government Research Training Program.

Signature: Production Note:
Signature removed prior to publication.

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THESIS ABSTRACT

This thesis provides an overview of elective survey consequences in terms of complications and avoidable readmissions. Surgical complications in elective surgery are known to increase morbidity and mortality, extend length of stay and elevate healthcare costs through readmissions. Despite the broad impact complications could bring to health and societal systems, several challenges have been identified in various classification systems across jurisdictions, further investigation is demanded in data quality and specified surveillance reporting.

This thesis aims to examine duration and potential parameters of outcomes such as out-of-pocket costs, well-being and change in quality of life from patients' perspectives. Systematic review and mix-method study addressed financial and wellbeing outcomes from patient and clinician's perspectives. The quantitative approach will consist of Centre of Victorian Data Linkage data analysis on National Healthcare Agreement PI-23 on unplanned readmissions within 28 days and patient survey, while the qualitative section will involve clinician questionnaire to collate more information on postoperative care.

Major findings concluded aged over 80, requiring an interpreter or mental health assistance are prominent factors leading to unplanned readmissions within 28 days after surgery. Language used at home and type of hospital admission are leading factors associated with readmission up to 90 days. ANOVA reflected readmission led to an extended 16.45 days of average hospital stay and longer ICU hours. In terms of cost, ANOVA demonstrated 12.5 times higher mean hospitalisation costs in readmission due to the increased allied health, nursing, medical, pharmacy, prosthetics, and theatre operating room costs. Apart from the accrued capital cost, the time cost of wound management also significantly impacts patients' financial and wellbeing status. According to survey responses, each dressing session lasts approximately 30 minutes, while complications lead to extra sessions taking up to at least two months.

This study implied that measurements in preventable readmissions could extend to socioeconomic characteristics, stakeholders' involvement, and postoperative care instead of merely relying on perioperative prevention and standardised hospitalisation parameters. Future investigation is necessary to initiate practical interventions to determine the interrelation of factors influencing length of stay, discharge destination, and outcomes across patient groups. The essence is to demonstrate the magnitude and patterns of impact and avoid disparities in knowledge for better decision-making, effective strategies and streamlined care.

COVID-19 IMPACT STATEMENT

The COVID-19 pandemic significantly impacted survey recruitment in Chapter six and moderately impacted retrieval of hospital data in Chapter five of this thesis. The challenge was mainly because part of the timeframe of interest overlaps with the elective surgery suspension from April 2020 to February 2022.

Chapter five retrospectively analysed hospital elective surgery admission data from June 2018 to October 2022. Due to the initial pandemic restrictions and changes, multiple discussions and proposed solutions were attempted with the Centre for Victorian Data Linkage to obtain relevant technical specifications and ensure the inclusion of eligible episodes. The data was however delayed for six months due to reallocation of hospital resources during pandemic; hence, the planned data analysis timeframe had also been shortened. Although the validity and accuracy of the data were assured, the actual number of relevant admissions and related complications or avoidable readmissions had been reduced compared to the non-pandemic period.

Chapter six initially captured patients' elective surgery and complications experiences from 2018 to 2023 after the ethics approval in August 2022. Due to the paucity of responses and attempts to improve response uptake, an ethics amendment in July 2023 approved the carrying out of a concurrent clinician survey to collect additional information from stakeholders on elective surgery experiences. However, the responses of both patient and clinician surveys were lower than expected due to challenges in recalling and recruiting stakeholders during and shortly after the pandemic. Further justification on the study design due to COVID-19 is also discussed under **CHAPTER 6 DISCUSSION: Justification of study design.**

In conclusion, the COVID-19 pandemic has impacted the acquisition, timeframe, availability of eligible episodes for analysis; with challenges in the recruitment of relevant stakeholders, including patients and clinicians to provide feedback in elective surgery, complications, and avoidable experience experiences.

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PUBLISHED MANUSCRIPT INCLUDED IN THIS THESIS

Hon, Y. G. V., Demant, D., & Travaglia, J. (2023). A systematic review of cost and well-being in hip and knee replacements surgical site infections. *International wound journal*, *20*(6), 2286–2302. https://doi.org/10.1111/iwj.14032

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The impact of unplanned readmissions on elective procedures in Victoria from 1 June 2018 to 31 October 2022.

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LIST OF ACRONYMS AND ABBREVIATIONS

SSI	Surgical Site Infection
SAI	Surgical Associated Infection
HAI	Hospital-acquired Infection
WHO	World Health Organization
HDI	Human Development Index
THR	Total Hip Replacement
THA	Total Hip Arthroplasty
HH	Hip Hemiarthroplasty
ESIS	Elective Surgery Information System
VAED	Victorian Admitted Episode Dataset
CVDL	Centre for Victorian Data Linkage
ACHI	Australian Classification of Health Interventions
ICD-10-AM	International Classification of Diseases 10th revision Australian Modification
QoL	Quality of Life
HAC	Hospital-acquired Complications
CHAD	Classification of Hospital Acquired Diagnoses
QALY	Quality-Adjusted Life-Year
DALY	Disability-Adjusted Life Year
AIHW	Australian Institute of Health and Welfare
ICU	Intensive Care Unit

CHAPTER 1: INTRODUCTION

1.1 Background

Elective surgery is a planned procedure scheduled in advance by a medical specialist. The timing of the surgery is based on the level of urgency determined by the specialist (Bureau of Health Information, 2014). About 2.3 million admissions in Australia annually are elective surgery, with 66% occurring in private hospitals. Elective surgery admissions rose by an average of at least 1.7% per year from 2013 to 2018, with a rise of 1.9% in public compared to 0.9% in private hospitals (Australian Institute of Health and Welfare, 2018). In 2023-24, Victoria was reported with the second largest annual increase of 10% in elective surgery admission compare with 2022-23.(Australian Institute of Health and Welfare, 2024c)

Elective surgery is one of the most frequently reported reasons of hospital acquired complications with elective procedures in Australia such as hip replacements having an unplanned or unexpected public hospital readmission rate of 21 per 1,000 procedures within 28 days (Australian Institute of Health and Welfare, 2018). Current literature captures elective surgery complications and readmissions under multiple definitions due to discrepancies in time, site of occurrence, and type of surgery. Surgical site infections are defined as infections occurring up to 30 days after surgery (or up to one year after surgery in patients receiving implants) and affecting either the incision or deep tissue at the surgery site (Owens & Stoessel, 2008). The WHO definition of surgical site infections occurs within 30 days after the operative procedure (with day 1 as the procedure date) for superficial infections, or up to 90 days for deep, organ or space infections (World Health Organisation, 2018b). In Australia, 1.4 per 100 public hospitalisations lead to healthcare-associated complications. Among 20.5 million days of patient care in public hospitals, 1,493 cases developed staphylococcus aureus bacteraemia infections (Australian Institute of Health and Welfare, 2018).

Despite the broad definitions which capture various complications and infections occurring in elective surgery, surgical site infections are one of the main reasons for elective surgery readmission among the documented surgical complications (Guest et al., 2023). As the most common type of hospital acquired complications, the 30-days crude surgical site infection rates for hip prosthesis and knee prosthesis in Victoria selected hospitals was 0.9 and 0.7 per 100 procedures (Doherty Institute, 2017). Surgical complications that require returning to theatre (Australian Commission on Safety and Quality in Health Care, 2018) are associated with increased morbidity and mortality, increased length of stay and higher healthcare costs.

With an estimated $24.3bn of overall health spending coming directly from consumers (Australian Bureau of Statistics, 2018-2019), patients in Australia experience an average of $1,578 per person or 2.5% of the average annual income out-of-pocket costs. The financial strain may prevent those with long-term or chronic conditions and lower income from seeking health care (Peng & Zhu, 2021), leading to a snowballing impact of burden form unresolved conditions and creating a vicious cycle of health system and societal strains. Despite the out-of-pocket expenses in Australia being about twice as high per person as in the United Kingdom and New Zealand (Parliament of Australia, 2020), little is known about the impact and magnitude of elective surgery on financial burden at an individual level.

1.2 Statement of the problem

Every patient who undergoes surgery is at risk of acquiring an infection. The global rate of developing one or more complications after elective surgery within 30 days is 16.8%, with a mortality rate of 2.8% (The International Surgical Outcomes Study Group, 2016). According to a publication of the Australian Commission on Safety and Quality in Health Care, surgical site infection is one of the most common complications associated with surgery (Morris et al., 2015), occurring in approximately 3% of surgical procedures (Si et al., 2014; Worth et al., 2015). Recent discussions focused on approaches to surveillance for acute care settings in Australia (Australian Commission on Safety and Quality in Health Care, 2017). Among postoperative adverse outcomes, 45% of surgical site infections were detected after discharge from the hospital (Sawyer & Evans, 2018). The burden of complication in terms of mortality, morbidity, healthcare costs, and productivity loss is significant.

Like other hospital infections, elective surgery complications will likely lead to readmissions. Current research summarised the prevalence of complications worldwide, providing context on the size of cohorts encountering complications of diverse definitions and classifications. Due to discrepancies across jurisdictions on postoperative timeframe, sites and reasons for infections, a broad spectrum of complications, such as hospital-acquired infections, healthcare-associated infections, surgical site infections, and surgical-associated infections, were found in the literature. The extensive rates reported for various complications provided a comprehensive background in complication classifications. The primary emphasis of this study is to ensure the validity and accuracy of subsequent analysis by focusing on one of the most prevalent complications that result in preventable readmissions.

A study from English acute care hospitals (Eriksen et al.) identified that the incidence of surgical site infections for total hip replacement and hip hemiarthroplasty (HH) are 1.38 and 2.3 infections per 1,000 postoperative inpatient days. Due to compromised immune system and existing comorbidities, the risk of infection associated with revision surgery was 2.7%, significantly higher than after primary surgery with 1.1%. The average cumulative SSI incidence rates are 1.3% for THR and 4.1% for HH (Wilson et al., 2008). A Singaporean study has examined the overall total knee arthroplasty infection rate was 1.1%. All superficial infections occurred within the first month post-surgery and were self-limiting with oral antibiotics. Patients with periprosthetic joint infection required repeated procedures following TKA, including debridement, implant removal or revision arthroplasty (Teo et al., 2018).

Healy et al. (2016) found that hospital costs and third-party reimbursement costs were 119% and 106% higher, respectively, for patients with complications. However, as most research, Healy et al. (2016) focused on the objective to demonstrate hospital reimbursement and profit margins instead of the actual patient out of pocket costs. Iskandar et al. (2019) highlighted the challenge to quantify the overall economic burden of SSI due to the absence of a validated method to avoid bias and promote generalisation of the study methods to other hospitals or patients. Macefield et al. (2017) included the methods of measuring surgical infection cost relying on a patient self-reporting system, further testing of the validity, reliability and accuracy of the measure is underway.

1.3 Significance of the study

In 2018, a total of 749,000 patients were admitted to public hospitals from the elective surgery waiting lists, with private health insurance-funded patients making up 7% of admissions in that year (Australian Institute of Health and Welfare, 2018). Regardless of type of defined complications, research in Australia targeting costs and wellbeing of complications that occur directly for elective surgery during and after hospital discharge is limited.

Plowman (2000) indicates that HAIs impose a substantial economic burden on both the hospital sector and post-discharge on patients and their carers. Perencevich et al. (2003) also found that a surgical infection diagnosed after discharge was associated with excess costs from higher standard costs in antibiotics and patients' rehospitalisation. Furthermore, in addition to the direct medical costs, patients with surgical infection after discharge had a significant decline

in the mental health component of the SF-12. Graves et al. (2006) argues that (Perencevich et al., 2003) overstated the out-of-pocket expenses due to methodological weaknesses in fewer control variables and increased dependence on accurate documentation in automated record screening. As studies involving more control variables are believed to reduce bias from omitted variables, hence reducing the cost attributed to surgical infections, Graves et al. (2006) therefore criticised the sensitivity of the surveillance method in (Perencevich et al., 2003) stating that, because there might be a chance that cases of post-discharge surgical infections flagged may be the most severe cases with more readmissions, they generated the highest costs. However, from our review in former studies, none of the out-of-pocket costs demonstrates a substantial economic burden from a societal perspective. It is, therefore, unclear if the cost of surgical infections occurring after hospital discharge is substantial.

The above evidence demonstrates the need for a unified way to measure actual complication costs for patients**.** Another example of a patient perspective is the prediction and costs for surgical infections associated with patients with endometrial cancer at an individual level (Bakkum-Gamez et al., 2013). Again, research in this area focuses on direct hospital costs instead of out-of-pocket costs, suggesting that from 2003 to 2012, total hospital knee and hip arthroplasty costs have increased by at least 29% and 26%, respectively (Steiner C., 2012). It is likely that the expenses incurred by patients would also have increased but is often neglected in studies (Peel et al., 2015). Other limitations in the current body of evidence include that the suitability of current measures for assessing complications in other specialities like orthopaedics is unknown, and that it is not known how complication burden results would reflect in a broader and culturally and linguistically diverse populations as currently there is no such assessment in Australia. As a culturally and linguistically diverse country, 23% of Australians spoke a language other than English at home, facing more significant obstacles in receiving quality healthcare due to barriers in health literacy, language barriers and service delivery (Australian Institute of Health and Welfare, 2024).

These limitations highlight the significance of this study to generalise methods to other surgical categories, quantify the financial and wellbeing burden of complications in patients from different socioeconomic backgrounds and demographics, making the data representable for larger populations by developing a standardize cost-of-illness study as a reference. Hence, further interventional studies are required to demonstrate health equity by investigating the impact of complications towards various socioeconomic determinants such as age group,

gender, and cultural backgrounds, improving individual treatment experience and reducing the burden of complications in the total population.

The focus of the proposed study is the costs and consequences in quality of life from complications in elective surgery in Australia paid by patients. Out of pocket costs include all costs from the patients' perspective, which is not subsidised by any third party, including Medicare. Potential outcomes are to estimate out of pocket costs borne by patients and health utility score changes, demonstrate distributions in age, gender, and type of elective surgery. It will also include a further description of how these factors affect out of pocket costs and wellbeing. Undertaking research will also provide other answers, such as the population of complications in elective surgery in hospitals, the timeline for treatment and readmission, and other factors contributing to extra costs and wellbeing burden.

1.4 Outline of thesis

This thesis first provided a literature overview on the surveillance of complications and readmissions from health and societal perspectives. By summarising the existing gaps, the methodology outlined a systematic review, hospital database analysis, and surveys of clinicians and patients to identify current research trends and highlight key focus areas for this study. Findings demonstrated the epidemiology of defined complications and risk factors contributing to readmissions with feedback from stakeholders. The discussion evaluated hospital indicators, sociodemographic, and costs between groups with and without complication, while the conclusion delivered a broad implication of impacts and challenges in postoperative care.

CHAPTER 2: LITERATURE REVIEW

2.1 Overview of complications globally

Recent research from Germany by Hardtstock et al. (2020) reported with an average of 4.4 times the number of hospitalisations and 7.7 times the number of hospital days, the SAI group had a higher one-year post-orthopaedic mortality rate at 22.4%, compared to 5.3% in the non-SAI group. Their total medical costs were significantly higher with €42,834 compared to €13,781 for the non-SAI group. A US study (Levy et al. (2020)concluded that literature evaluating postoperative infection's economic cost following orthopaedic trauma remains sparse. Apart from demonstrating hospitalisation cost to the health system, which might not capture the complete picture of direct medical costs, it also claimed that there is likely a gross understatement of the actual societal cost of infection after elective orthopaedic surgery. A retrospective matched outcomes study (Kaye et al., 2009) in the US focused on older patients found around four times greater mortality with SSI versus without, with an odds ratio of 3.51. Patients aged 65 years or above are associated with 2.9 times longer postoperative hospitalisation, with a mean attributable duration of post-surgery hospitalisation of 15.7 days, leading to 1.9 times more hospital expenses.

2.2 Overview of complications in Australia and New Zealand

Australia has surgical site infection surveillance programs in several states, including New South Wales, Western Australia, and VICNISS in Victoria. A national report stated that standardised and strategic approaches for SSI surveillance are lacking in most states and territories. A valid and timely infection comparison among hospitals within and across jurisdictions is required to advocate surveillance through improved presurgical risk assessment and post-discharge data quality (Cruickshank et al., 2009). New Zealand's Surgical Site Infection Improvement Programme (SSII Programme) reported a 1.3% incidence of SSI in publicly funded hip and knee procedures from March 2013 to June 2014. According to Morris et al. (2015), Northland District Health Board reported an average cost of $78,000 for an infected hip replacement. The cost for one single infected hip replacement in 2013, which involved four readmissions over five months, was NZ$112,000. Another matched case-control study demonstrated a mean excess SSI cost at NZ$40,121 and an excess length of stay of 42 days in the case group. In a hospital study in Perth following discharge, the total cost of treating surgical wound dehiscence patients in community nursing services was estimated to be AU$56,000, excluding travel costs and organisational overheads for nurse visits, with the management of infection contributing 67% of the overall cost (Sandy-Hodgetts et al., 2016).

2.3 Effects of surveillance on complication incidence and prevalence

The estimation of the prevalence and incidence of complication involves various methods. Hollenbeak et al. (2011) captured surgical site infections through observed counts and costs derived from the ICD-9 definition[1]. With 8.8% of patients undergoing general and vascular surgery experiencing SSIs, the attributable cost of SSI is overestimated at 33% when derived from ICD-9. A single electronic measure of SSI might not correlate well with traditional measures, leading to severe implications in estimating risk factors and burden (Hollenbeak et al. (2011). Therefore, combining relevant hospital databases with electronic measures such as ICD codes is recommended to capture retrospective SSI reliably.

A European study by Meijs et al. (2019) evaluated the epidemiology of revision in total hip and knee arthroplasties. In measuring the epidemiological burden of hip and knee prosthesis, incidence surveillance is regarded as a more accurate and stable method than a point prevalence survey. As prevalence fluctuates randomly depending on the measurement day, it is only recommended when sufficiently large point prevalence data samples are available or when incidence surveillance of SSIs is not performed (Meijs et al. (2019).

Abu-Sheasha et al. (2020) assessed three different surveillance methods followed a cohort of surgical patients: inpatient, follow-up in an outpatient clinic, and over the phone. The post-discharge SSI follow-up methodology found that phone surveillance was more cost-effective than outpatient clinic surveillance. Inpatient surveillance was less effective but still able to detect severe SSI at a low cost. While out-patient-clinic surveillance had the highest cost, it might as well overestimate the incidence. Compared to inpatient surveillance, the outpatient clinic method costs US$15.6 per extra detected SSI, whereas the phone method costs only US$4.6.

The above studies shed light on future research methods in capturing complication counts accurately to be highly reliable.

[1] International Classification of Diseases, Ninth Revision (ICD-9) coding for SSIs, unspecified

2.4 Effects of complication on the financial burden

We conducted a systematic review (Chapter 4) to determine the financial burden of SSI in the current body of literature. This literature review aimed to examine the financial and wellbeing burden in postoperative patients by identifying gaps in literature evidence. A total of 2034 potentially relevant articles were identified from five databases (Medline, CINAHL, EMBASE, Scopus and Web of Science), of which 31 articles met the inclusion criteria and were included in the review. Among these, 23 studies were conducted on incidence and prevalence analysis, 22 on hospital system costing, 2 on societal perspective costing, and 6 on patients' wellbeing.

Apart from the review, other research also acknowledges the complex clinical and economic hardships SSI brought to both healthcare and social systems. A study in the US by Levy et al. (2020) concludes that literature evaluating the economic cost of postoperative infection following orthopaedic trauma is inadequate. Due to a fracture-related SSI, the total annual cost of hospitalisation has a direct economic consequence of over half a billion dollars in the United States annually. In terms of hospital care cost, Graves et al. (2008)reflects healthcare-acquired SSI increased the length of hospital stay by 2.51 days, increasing the $134.40 variable cost per case. The incidence rate for infections that occur after discharge was 8.46% over eight months. Most of the costs incurred by the hospital sector arose from lost bed-days, and only a tiny proportion arose from variable costs such as increased cash expenditures on consumables.

Most estimates, however, do not capture the complete picture of total treatment costs, which is supposed to include the actual societal and out of pocket costs of SSI patients, especially post-discharge. Another systematic review of Australian studies from 1995-2010 by Coleman et al. (2010) shows that SSI rates varied across different procedures, with orthopaedic procedures ranging from 4.7% to 8.0%. Estimations on attribute hospitalisation cost to SSI was around AU$54 million annually, with a more significant proportion of SSIs occurring after discharge from hospital. Interventions aimed at reducing SSI would provide cost savings and improve the efficiency of the health system. It also affirmed the loss of productivity as one of the SSI indirect costs to patients. However, further studies are required to provide more information on the linkage of SSI consequences and indirect costing evaluation.

2.5 Effects of complication on wellbeing burden

Apart from financial consequences, the impact of complication may extend to the quality-of-life changes and associated burden on wellbeing. Surgical patients could experience lower

postoperative quality of life compared to the general population due to complications, anxiety, depression, and pain (Hymowitz, 2024). The burden, for instance, of a grade IV complication could lead to a reduction of 0.086 QALYs for at least a year post-operation (Downey, 2023).

In the SF-36 scale, wellbeing refers to eight domains of the health. These domains are physical functioning, physical role limitations, bodily pain, general health perceptions, vitality, social functioning, emotional role limitations and mental health (Lins & Carvalho, 2016) . Factors such as loss of employment days and extra follow-up sessions can lead to financial stress and affect the lives of patients and their potential carers, especially during the post-discharge period (Hah et al., 2021; Rossvoll et al., 1993).

The second objective of our systematic review was to determine SSI wellbeing burden from various QoL determinants such as mortality rate, DALY and QALY for morbidity. Six studies (Andersson et al., 2010; Cassini et al., 2016; Hardtstock et al., 2020; Le Meur et al., 2016; Matza et al., 2019; Zacher et al., 2019) involving 752,725 adults experiencing SSI were included to demonstrate differences in QoL through health utility score measurement and interviews. A direct association of SSI and reduction of QoL was found among patients undergoing hip and knee replacements.

In addition to the systematic review, few articles solely concentrated on the QoL analysis in orthopaedic surgeries, as the main objectives were often cost, or incidence focused. Tracing back to 2002, Whitehouse et al. (2002) found a significant reduction in SF-36 scores in physical functioning and role-physical domains, minor reductions in bodily pain, general health and social functioning domains in matched case groups for orthopaedic surgeries. A systematic review in 2015 (Gheorghe et al., 2015) examined SSI utility scores for general surgeries, including orthopaedics, confirmed SSI is a clinically significant complication associated with mild to moderate disutility, ranging from 0.1 to 0.3. Other studies related to the quality of life of SSI from other surgeries such as anorectal, biliary, colorectal, hernia and skin surgeries shared the same view that SSI reduces health utility scores to various extents. Woodfield et al. (2019) stated deep SSI was associated with lower EQ-5D-3L derived QALYs, increased health and societal cost presented insights on QoL measurements which is potentially replicable in orthopaedic surgeries study.

2.6 Summary and gaps in the existing literature

Extensive research has been done globally in HAI surveillance and prevention; with the support of incidence and prevalence calculation, current evidence contributes a reliable source of references for infection rates in elective surgeries. Australian and New Zealand studies (Morris et al., 2015; Cruickshank et al., 2009; Sandy-Hodgetts et al., 2016) concentrated mainly on complications incidence and infection management costs borne by the health system. As most cost-of-illness studies are hospital expenses related, they were still through the hospital viewpoint instead of patients' perspective. Nevertheless, there was minimal research on patients actual out of pocket costs. Prospective studies are suggested to include assessment of indirect costs of complications, possibly leading to insights for treatments with greater societal benefits. Factors like the extra length of stay and loss of employment days were investigated in economic evaluations, with limited studies extending these determinants to patients' wellbeing research on mortality and morbidity analysis. Qualitative interviews and quantitative health utility scores were used to measure changes in morbidity and demonstrate patient-level burden to different extents. Due to the limited studies available, further research is required to reflect methods to determine QoL fluctuations in SSI patients.

Although most studies indicated that SSI negatively impacts patients' financial and wellbeing status, further evidence from a patient's standpoint is also required to enhance treatment equity and quality. Therefore, this study aims to provide insights by connecting patient demographics and socioeconomic determinants to complications consequences.

CHAPTER 3: METHODOLOGY

3.1 Aim and objectives of the study

The main aim of this study is to examine the size of the burden of elective surgeries on the well-being and financial outcomes of patients. Based on the aim, this thesis has four objectives:

1. Through a systematic review, to examine the effects of postoperative SSI on financial and societal burden among orthopaedic adult patients since 2010;

2. To retrospectively determine the prevalence and incidence, including postoperative complications in elective surgery from 2018 to 2022;

3. To examine the financial stress born by avoidable readmissions

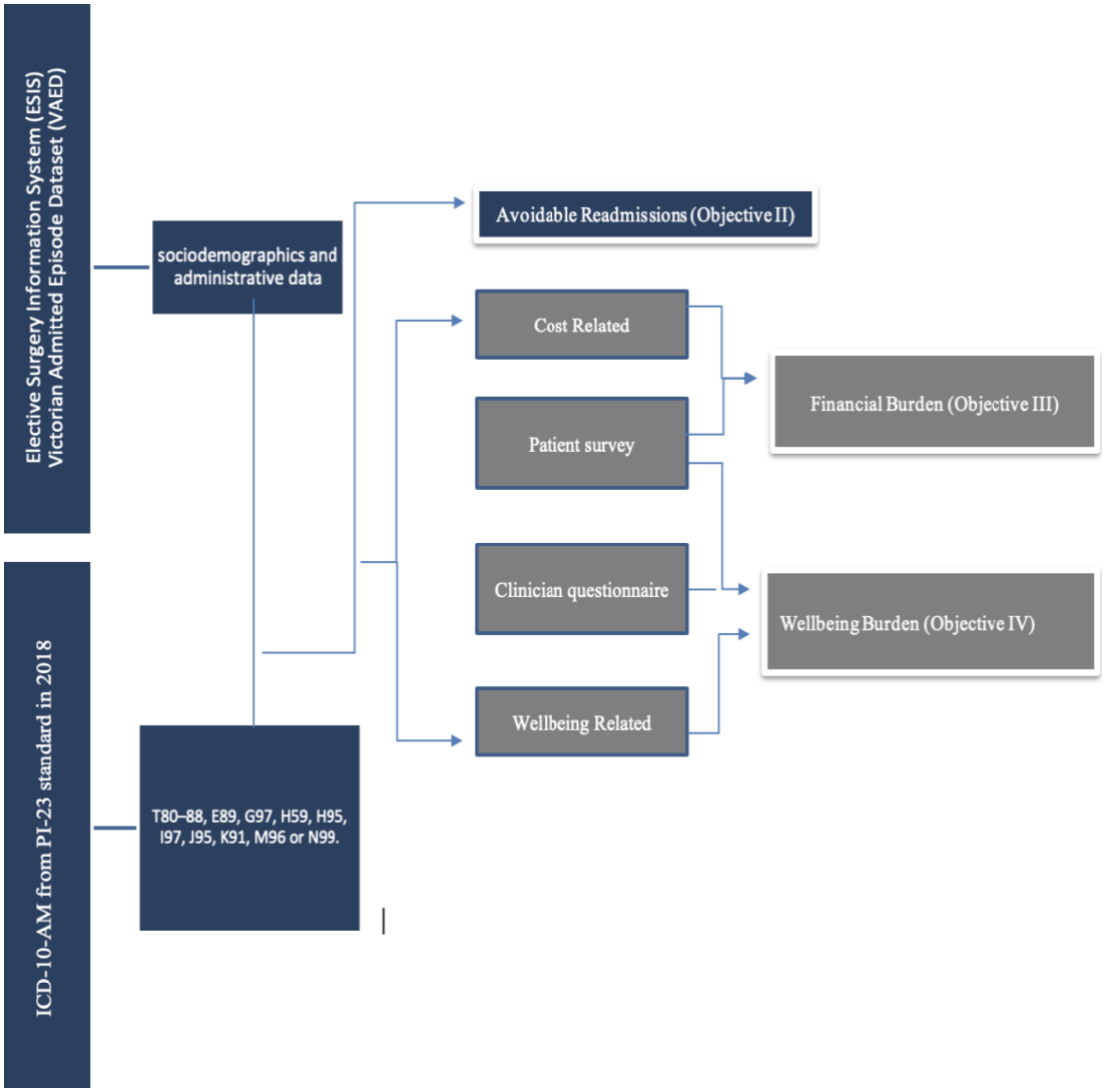
4. To measure the wellbeing burden on patients and determine the association between demographics and socioeconomic status towards recovery experience.

3.2 Overview of study design

This study used a mixed-methods research approach to comprehensively examine the burden of postoperative complications from health system and patient perspectives. It employed a systematic review, an analysis of hospital-collected data, and a cross-sectional survey component. The first objective is to provide an overall summary of currently available evidence in postoperative SSI burden; hence a systematic review has been conducted. The systematic review demonstrates trends and focuses of research themes in SSI from 2010 to 2021, providing evidence on the association of SSI to burdens health systems and patients and infections after orthopaedic surgeries are associated with significant economic difficulty, risk of mortality and morbidity. The second objective will be addressed with the assistance of the hospital databases to provide background information on the prevalence and incidence of complications, hence, avoidable readmissions, as a reference point for objectives three and four. A mixed methods research design will address the remaining objectives. The quantitative approach will consist of hospital data analysis and semi-structured patient survey, while the questionnaires on clinicians and patients will both examine the qualitative feedback on treatment experience. A detailed explanation of the relationship between objectives and study design is presented among sections (A) hospital dataset and (B) open-ended surveys.

3.3 Relationship between objectives and study design

3.3.1 Flow diagram of data linkage across databases



Note: Objective I is a systematic review

3.3.2 Objective II: To retrospectively determine the prevalence and incidence, including postoperative complications in elective surgery from 2018 to 2022.

The epidemiological studies of SSI will be obtained from the linkage of VAED, ESIS and ICD-10-AM by the CVDL database. The linkage is to capture both day surgery patients, and those who required extra admitted follow up sessions. Patient records will be available in the ESIS due to elective surgery enrolments. Patients developing SSI or required further follow up sessions might be admitted to the hospital under a record of VAED. Patients who developed complications such as SSI, which leads to avoidable readmissions, are currently captured under the ICD-10-AM coding system in reference to the National Healthcare Agreement PI-23 on

unplanned readmissions to the same public hospitals within 28 days of selected surgical admissions (Metadata Online Registry, 2018). The ICD-10-AM codes under PI-23 capture principal procedure and diagnosis of index admission and readmission respectively. Patients sociodemographic and administrative data will be captured in ESIS, and VAED, linked by CVDL with ICD-10-AM codes to identify patients developing complications from day surgery and admitted episodes.

3.3.3 Objective III: To determine financial stress borne by avoidable readmissions.

The Victoria Cost Data Collection only includes cost information from the hospital perspective at an episode level. In terms of costs at a patient level, this research concentrated on extra hospitalisation and individual costs due to complications and avoidable readmissions. Factors contributing to financial burden can include extra length of stay and missed workdays cost due to extra follow up sessions. Readmission costs will be estimated from the type of surgery, locality such as residence LGA, postcode versus hospital campus code or location of surgery in the CVDL dataset. Other determinants such as Medicare eligibility and insurance declaration will also be considered. The cost-related section of the patient survey will examine the mode of transport of patients, loss of workdays or further indirect costs borne by patients. The overall socioeconomic burden of avoidable readmission will reflect in their financial and wellbeing pressures under objectives III and IV.

3.3.4 Objective IV: To measure the quality of life and wellbeing burden on patients and determine the association between demographics and socioeconomic status towards recovery experience.

As the CVDL dataset is primarily quantitative data, we will require further investigation to examine the wellbeing burden. A mixed-methods study will be performed to investigate changes in quality of life after the experience of complications and avoidable readmissions. The quantitative section will invite all participants to provide sociodemographic data and admission details to measure association between elective surgery status and risk factors from patient-reported outcomes. Apart from collecting qualitative feedback from semi-structured patient survey, the qualitative questionnaire with clinicians on treatment experience will providing a comprehensive reflection of the patient journey with a focus on clinical, social and financial assistance, aiming to associate elective surgery consequences with the quantitative hospital data. Some additional open-ended questions will be solution-based, concentrating on

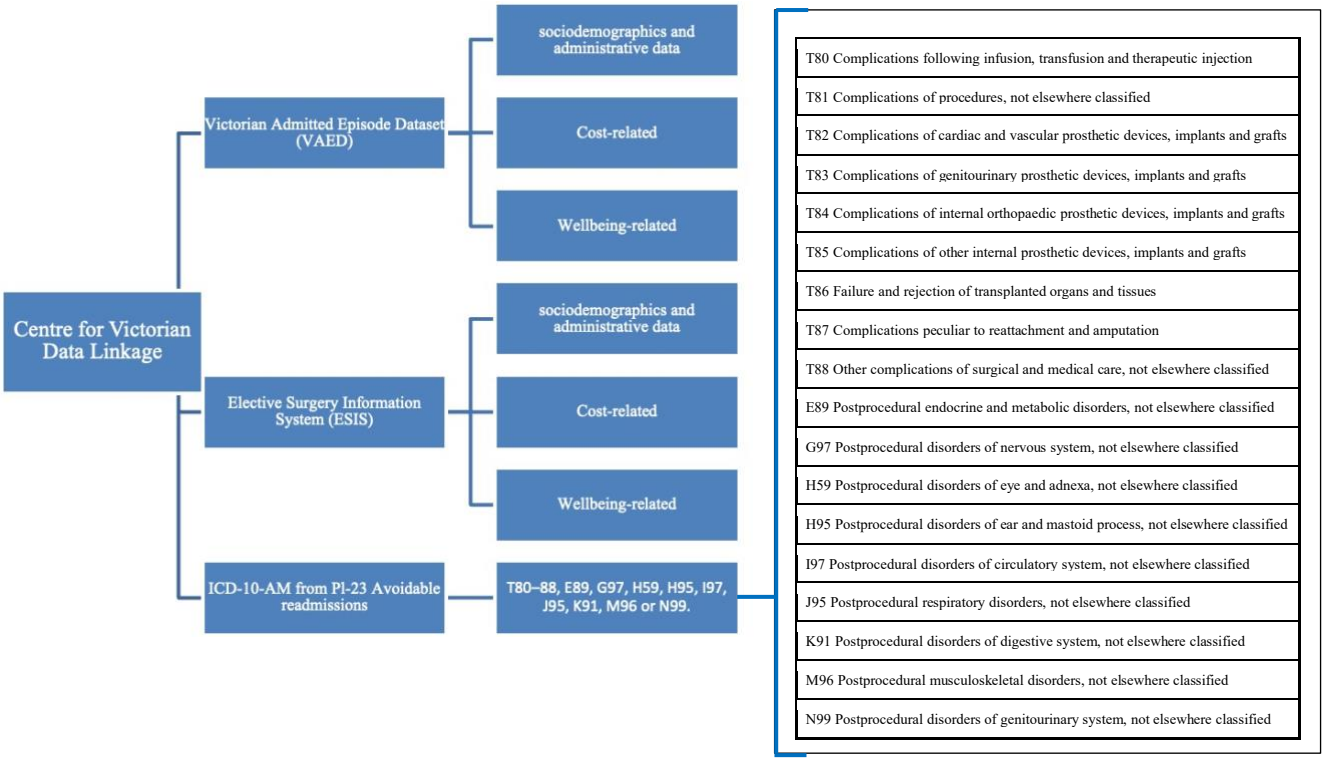
general feedback, revealing potential support and guidance that could have been offered to improve their experience. Responses will be compared between patients with and without complications, further expanding towards socioeconomic determinants and demographics such as indigenous status, preferred language, and type of hospital admission.

Section A – Hospital Database

3.4 Data Sources

The quantitative section of the mixed methods study will include three primary data sources: Victorian Admitted Episode Dataset (VAED), Elective Surgery Information System (ESIS) and ICD-10-AM codes of admission in VAED, ESIS and readmissions under PI-23, linked by the Centre for Victorian Data Linkage (CVDL).

Table 1: Data Sources and Linkage



The VAED dataset is based on admitted hospital patient data, includes admitted procedures (ACHI codes, up to x40) per patient admission. The current number of orthopaedic surgery patients' admission in Victoria is 23,172. The ESIS dataset concludes hospital waiting lists and details of the episodic event. Not all hospitals report to ESIS, so socioeconomic variables like

SEIFA scores are not readily obtainable in this dataset. Only demographics data such as sex and age (grouped) will be available. The ICD-10-AM codes will be referring to the Pl-23 National Health Agreement on Avoidable Hospital Readmissions in 2018. It demonstrates the type of postprocedural complications experienced by elective surgery patients. The CVDL will represent a linkage to track patients between hospitals and health services at a patient level. It also includes patient counts and a cost-recovery model for potential costing investigation. For instance, revision estimations for ESIS for hip and knee replacements were 10.8% and 8.1% in 2020. CVDL then connects the number of revisions and the reasons for extra follow-ups from VAED and ESIS, revealing the incidence of readmissions due to complications in patients admitted for elective surgeries. All relevant data for CVDL linkage in this study are listed in Appendix.

3.5 Study Population

A retrospective cohort study will be performed with eligible patients with clinically confirmed complications from index elective surgery. Patients with complications under PI-23 criteria will be compared with patients without through data acquired from CDVL linked database. Variables involved in comparison include age group, gender, type of procedure, type of insurance, hospitalisation cost, comorbidities, date of admission and date of surgery. Participants will be excluded if they have previously undergone another elective surgery within the last year or any overlapping complications treatments before elective surgery to avoid bias.

3.6 Sampling technique and sample size estimation

The study will be a retrospective cohort study for patients admitted for elective surgery in 2018-2022. The total sample size will be according to the data provided by the CVDL database. In terms of survey recruitments (Section 3.10), the sample size estimation will be in accordance with previous literature. The number of elective surgery patients treated in Victoria and National are estimated to be 147,792 and 622,988 respectively in 2021-2022(Australian Institute of Health and Welfare, 2023a). From previous literature, the rate of unplanned readmissions ranges from 0.3% in cataract surgery to 11% in general admissions in Australia(Australian Commission on Safety and Quality in Health Care, 2019a, 2019c; Chua, 2022; Considine, 2019; Li, 2014). Depending on type of procedure and adverse event, elective surgery in Victoria has an unplanned hospital readmission within 28 days of 2.8 to 25.9 per 1000 separations in 2015-2016(Australian Commission on Safety and Quality in Health Care,

2019b). The estimated cases of unplanned readmissions in Australia would be estimated approximately from 1,868 to 68,528. The estimated cases of annual unplanned readmission in Victoria within 28 days would be estimated from 413 to 3,827 cases based on the incidence indicated above.

3.7 Data collection procedures and quality control

In terms of data collection, all de-identified data of patients undergoing elective surgery, including those who developed complications was provided by the CVDL database. Examples of secondary data included Indigenous status, Medicare eligibility status, language spoken at home and marital status. The ESIS and VAED linkage map identified information through patient journeys, including follow-up episodes under various hospitals. The data was therefore traceable in terms of the patient's treatment pathway. All readmissions due to the same elective surgery was monitored to calculate extra readmissions and costs in the following objectives. The selected ICD-10-AM codes captured avoidable readmissions from various complications. Linked data was available in a central cloud system for access. Regarding quality control, the data linkage request was submitted to the CVDL with completed data linkage technical specifications and codes required for project output. A research study protocol, a data flow diagram with linkage logic, and a list of researchers accessing data were included to ensure the objectives have been accurately communicated.

3.8 Measurements framework and variables

Despite the various variables available from the hospital dataset, due to the multiple variables and criteria, after studying the data specifications, we focused on the certain data of interest to ensure we were capturing the most accurate burden of interest as we aimed to compare outcomes according to the sociodemographic details provided by the hospital dataset. (Appendix)

Section B – Patient and Clinician Surveys

3.9 Study Population

Patient survey included adult patients admitted to elective surgery in Australian hospitals between 2018 to 2023. Clinician survey recruited between February and July 2023 included GPs, nurses, hospital doctors and rehabilitation workers with experience in elective surgery treatment. All participants, including both patient and clinician, undertaking surveys and will be recruited through social media like LinkedIn and forums. Links and QR codes to surveys are included in the advertisement with participant information sheet. Potential participants will be contacted through email, with an informed consent form and the opportunity to raise questions. Completion of surveys indicated consent and data collected will be deidentified. The semi-structured surveys provide an opportunity to highlight personal experiences about postoperative care and further explore health economics discussion throughout patient journey.

3.10 Sampling technique and sample size estimation

Objective two is to determine the current incidence for elective surgery in 2018-2022 according to the raw data provided by the CVDL database. (Kim & Seo, 2013) estimated sample size required for binary outcomes in correspondence to the total population. For objectives three and four, at least 217 cases for those who undergone surgery from 2018-2022 is expected to represent patients' perspective in treatment experience. This sample size determination (Lwanga, 1991) is in reference to the previous literature rate of elective surgery and unplanned readmissions, to estimate a key proportion with 95% CI, 4% margin of error, and p=0.10.

$$n = z^2_{1-\alpha/2} P(1-P)/d^2$$

P = planning proportion **N** = sample size for study group **d** = absolute margin of error (half-width) **z** = critical Z value for a given confidence level

3.11 Data collection procedures and quality control

After providing the proper introductions and obtaining consent, a standardised version of surveys was sent to participants. The consistency and completeness of collected data were assessed daily to ensure sufficient data has been collected. The researcher organised ongoing

meetings with supervisors to ensure survey questions are valid to capture the desired information associated with the objectives. Responses were captured securely on Microsoft Form and Qualtrics on a laptop. Comments were captured and coded as accurately as possible without diverting the meaning. The number of survey responses was monitored against set targets to prevent potential data quality issues due to technical difficulties or delay in clarification when required.

3.12 Measurements framework and variables

The dependent variables are indirect patient cost and wellbeing changes in terms of sociodemographic data and qualitative feedback. The selection of variables aimed to fill the gaps in the hospital administrative dataset and literature by collecting information beyond demographics and health system cost data. The survey outcomes will reflect stakeholder concerns and costs from a holistic view of the entire elective surgery journey, including the preoperative and postoperative stages. The independent variables include administrative data such as type of elective orthopaedic surgeries, follow up sessions; and sociodemographic such as age group, gender, marital status, cultural background, locality of hospital and residence. Sociodemographic data allow potential comparison of risk factors and implications on access to care in elective surgery, complications, and readmissions.

3.12.1 Patients survey

The semi-structured survey will consist of three sections(Mannan, 2020), with an unstructured section to allow participants to focus on other important issues instead of solely answering designed questions from the researcher(Tanner et al., 2013).

1. **Demographics**
    - *Gender*
    - *Age*
    - *Language used at home*
    - *Ethnicity*
    - *Annual Household Income*
    - *Type of Employment*
    - *Marital Status*
    - *Indigenous Status*
    - *Education*

2. Elective surgery characteristics

- *Year of Surgery*
- *Apart from the one indicated above, have you undergone other elective surgeries throughout the year of 2018-2021?*
- *Have you been diagnosed with complications within 90 days after the elective procedure indicated in question 10 and 11?*
- *Type of hospital for elective surgery*
- *Postcode of hospital for elective surgery*
- *Postcode of hospital/clinic for follow up sessions*
- *Postcode of Residential Address*
- *Do you have other known comorbidities? (Please specify)*
- *Type of health insurance*
- *Excluding complication episodes (if any), have you taken any leave off work for your elective surgery, including initial appointment and recovery period?*
- *If yes, how many days in total?*
- *Has anyone (family member/carer) care for you during your recovery period?*
- *Excluding complication episodes (if any), have your carer(s) taken any leave off work for your elective surgery, including initial appointment and recovery period?*
- *If yes, how many days in total?*
- *How many follow up sessions have you had after your initial elective surgery appointment?*
- *Has anyone who cared for you attended those sessions with you?*
- *Does your insurance cover any transportation costs?*
- *Please include any further comments about other costs or insurance coverage below.*

3. Complication characteristics

- *Type of Complication*
- *Have you taken any extra leave off work since you have diagnosed with a complication from elective surgery?*
- *If yes, how many days in total?*
- *Have your carer(s) taken any extra leave off work since you have diagnosed with a complication from elective surgery?*

- *If yes, how many days in total?*

3.12.2 Clinicians survey

Aim: To explore the impact on patients with complications after elective procedures, recovery experiences following surgery, and clinicians' views on primary care support received.

Design and setting: Qualitative methodology with an online questionnaire to obtain clinicians' perceptions on the impact of complications on patients following elective surgery. Clinicians are recruited through email lists, social media, and hospital noticeboards between April-November 2023.

Population: For the purpose of this study, clinicians are defined as those qualified as general practitioners, nurses, hospital doctors or rehabilitation workers.

Method: Clinicians will complete a 20-minute semi-structured online questionnaire which will be conducted using Qualtrics software.

Analysis: Thematic analysis through NVivo to understand patterns and insights in responses

Recruitment Strategy

This study aims to target specific organisations and specialty groups to correspond to the current available quantitative CVDL and survey data in the research. Initial recruitment communication will be sent to the proposed target groups through email and private messaging in social media such as Twitter and LinkedIn. Proposed target groups included:

Australian College of Nursing (ACN)
Orthopaedic Nurses Association (ONA)
Australian Nurse and Midwife Association (ANMA)
Australian Medical Association (AMA)
The Royal Australian College of General Practitioners (RACGP)
Australian Psychological Society (APS) – Surgical Psychologists
Australian Physiotherapy Association (APA)
Health Workers Union AU
Allied Health Professionals

Victorian Health Association
IPC Health
Your Community Health
CoHealth
AccessHealth

After a week, the organisation or participants received a follow-up email with participant information and a link to the questionnaire. A participant information sheet was also available on the cover page of the survey.

a. Clinicians Demographics

1. *Types of healthcare professional*
    a. *General Practitioner*
    b. *Registered Nurse*
    c. *Medical Doctor (hospital)*
    d. *Rehabilitation worker*
    e. *Other, please specify: _____*
2. *Type of setting where clinician is based*
    a. *Public hospital*
    b. *Private hospital*
    c. *Clinic (not located within a hospital)*
    d. *Aged care facility*
    e. *Other, please specify: _____*
3. *Please specify your area of specialisation (if any): _____*

b. Questionnaire – Qualitative fields

- *How common are complications following elective surgery and what types of complications occur?*
- *How would you describe the differences between follow-up sessions with complications and those without? (For instance, number of follow-up sessions, length of total patient episodes, and other extra treatments due to complications)*

- *What were the main concerns for patients with complications in terms of well-being, and how were they addressed?*
- *How would you describe the level of care provided to patients following surgery? (Assistance may include mental, financial, clinical, and other forms of social assistance.)*
- *How would you describe the level of assistance provided to clinicians in treating elective surgery complications? (Assistance may include clinic training, guidelines provided, referral information to allied health facilities, and other types of support.)*
- *Do you have any other concerns about elective surgery complications? If so, please specify.*
- *Would you suggest any potential improvements in elective surgery treatment that could benefit patients?*

3.13 Statistical analysis

1st objective: SSI burden is a broad topic that consists of various factors instead of a specific determinant. A systematic review with an objective approach was performed to collect, review and analyse all available studies among the subject, which is usually used to assess a broad perspective on an epidemiological topic (Ahn, 2018) (University of Alabama at Birmingham, 2020). Results were divided into subthemes for analysis: hospital and patients costing, wellbeing and epidemiology surveillance of SSI. The systematic review contributes evidence-based information of patients burden from a narrative lens. The presence of confounding and bias were assessed by ROBINS-I and Rob2 tools (J. A. Sterne et al., 2016), evaluating the risk of bias in estimating comparative effectiveness in harm and benefits of interventions in studies.

2nd objective: A correlation and linear regression analysis will be performed on the CVDL database using STATA software version 17 for statistical analysis. Descriptive summaries are presented as a percentage, mean and median with potential visualisation. In terms of prevalence and incidence estimation, the percentage of readmissions over total elective surgery will represent the rate of avoidable complications in Victoria. A baseline analysis test of association will investigate the relationship between readmissions and sociodemographic background available in the CVDL database.

3rd objective: The costs will be converted according to the Consumer Price Index (CPI) to determine the cost to care to ensure costs are examined under the same base year(Centers for Disease Control and Prevention, 2020). Correlation tests and linear regressions will be used to represent the association between cost burden and socioeconomic determinants in the CVDL database. Examples of socioeconomic determinants include age, gender and clinical background. The surveys conducted in conjunction with objective IV includes cost-related questions to determine patients indirect cost of illness. Questionnaire data will be analysed to reveal how complications affects financial stability. All responses were transcribed and interpreted through generating codes, then further collate them into potential themes for the definition to suggest ideas specifically and clearly.

4th objective: Linear regression analysis and correlation test will be used to predict the association between magnitude of cost and socioeconomic determinants implications in the CVDL database. For patient and clinician questionnaires, free discussion opportunity is

designed to allow participants to voice out areas relating to postoperative experience and its impacts on their daily lives. Survey data will be analysed to reveal how participants' experiences influenced postoperative care from elective surgery.

3.14 Ethical considerations

Ethical approval for the secondary de-identified data analysis of the Centre of Victorian Data Linkage (CVDL) dataset will be sought from the Medical Research Committee of the University of Technology Sydney and the Ethical Review Committee of the Centre of Victorian Data Linkage. In terms of surveys, ethical approval and consent forms will be delivered to patients before data collection.

Approvals	**Date**	**Details**
HREC UTS - ETH21-6243	25/2/2022	CVDL Database
HREC UTS - ETH22-7180	2/8/2022	Patient survey
HREC UTS - ETH23-8031	11/7/2023	Amendment on patient survey Introduction of clinician survey

It was possible that giving up time for the surveys led to a certain level of inconvenience. Recalling the postoperative experience might also lead to a certain level of emotional discomfort. All collected data was de-identified, stored securely and used only for research purposes and will not be accessible to third parties.

CHAPTER 4: EFFECTS OF POSTOPERATIVE COMPLICATION ON FINANCIAL AND SOCIETAL BURDEN AMONG ORTHOPAEDIC ADULT PATIENTS SINCE 2010

4.1 Chapter introduction

This chapter includes literature findings from a published systematic review (Manuscript I) to examine the impact of healthcare associated infections such as hospital acquired complications and SSIs on health system expenditures, patient out of pocket expenses and quality of life, addressing the objective I to determine effects of postoperative complications on financial and societal burden among orthopaedic adult patients since 2010.

4.2 Publication (International Wound Journal)

Peer review process:

Original manuscript submitted ---------- September 29, 2022

Manuscript accepted for publication ------- November 16, 2022

Manuscript published ------- December 26, 2022

Citation: Hon, Y. G. V., Demant, D., & Travaglia, J. (2023). A systematic review of cost and well-being in hip and knee replacements surgical site infections. *International wound journal*, *20*(6), 2286–2302. https://doi.org/10.1111/iwj.14032

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A systematic review of cost and well-being in hip and knee replacements surgical site infections

Yoey Gwan Venise Hon [1], Daniel Demant [1,2], Joanne Travaglia [1]

[1]School of Public Health, University of Technology Sydney, Ultimo, New South Wales, Australia.

[2]School of Public Health and Social Work, Faculty of Health, Queensland University of Technology, Brisbane, Australia.

Abstract

Objective: This systematic review examined peer-reviewed literature published from 2010 to 2020 to investigate the healthcare system costs, hidden out-of-pocket expenses and quality of life impact of surgical site infections and to develop an overall summary of the burden they place on patients.

Introduction: Surgical site infection (SSI) can significantly impact patients' treatment experience and quality of life. Understanding patients' SSI-related burden may assist in developing more effective strategies aimed at lessening the effects of SSI in financial and wellbeing consequences.

Inclusion criteria: Peer-reviewed articles on adult populations (over 18 years old) in orthopaedic elective hip and knee surgeries published from 2010 to 2020 were considered. Only publications in English and studies conducted in high-income countries were eligible for inclusion.

Methods: A search strategy based on the MESH term and the CINAHL terms classification was developed. Five databases (Scopus, EMBASE, CINAHL, Medline, Web of Science) were searched for relevant sources. Reviewers categorized and uploaded identified citations to Covidence and EndNoteX9. Reviewers will assess article titles, abstracts and the full text for compliance with the inclusion criteria. Ongoing discussions between reviewers resolved disagreements at each selection process stage. The final scoping review reported the citation inclusion process and presented search results in a PRISMA flow diagram.

Results: Four main themes were extracted from a thematic analysis of included studies (N=30): Hospital costing (n=21); Societal perspective of health system costing (n=2); Patients and societal wellbeing (n=6), and Epidemiological database and surveillance (n=22)

Conclusion: This systematic review has synthesized a range of themes associated with the overall incidence and impact of SSI that can inform decision making for policymakers. Further analysis is required to understand the burden on SSI patients.

Keywords: Surgical site infections, elective surgery, hip replacement, knee replacement, quality of life, out-of-pocket cost

Declaration of interest: None

INTRODUCTION

The World Health Organisation defines surgical site infections (SSI) as a form of healthcare-associated infection (HAI) after operative procedures. Superficial SSI develops within 30 days, while deep, organ or space SSI occurs up to 90 days post-surgery.(World Health Organisation, 2018b). HAIs vary among procedures; common complications include wound, urine, and blood infections, mainly caused by widely used antimicrobials, resulting in multi-resistance in microorganisms. In high-income countries, seven inpatients out of every 100, will experience at least one HAI, compared to 15 out of 100 admissions in low- and middle-income countries(World Health Organisation, 2018a).

Despite being one of the most preventable HAIs, SSI continues to pose a significant global burden on morbidity, mortality, and higher costs for healthcare systems and service payers. The rate of SSI in the first month is 12.3% globally, varying from 9.4% in high human development index (HDI) countries like the United Kingdom to 23.2% in low HDI countries like South Sudan(Collaborative, 2018; Sawyer & Evans). Up to 20% of caesarean section patients in Africa suffer from a wound complication, risking their health and their capacity to care for newborns. Surgical site infection, which affects 3% of procedures(Si et al., 2014; Worth et al., 2015), is also one of the most frequent post-operative complications in Australia(Morris et al., 2015). In high-income countries, hospitals detected 45% of SSI after discharge, leading to increased intentional follow-ups, revealing an additional increase in SSI incidences(Sawyer & Evans, 2018; Woelber et al., 2016).

The frequency of SSI varies significantly across countries and is greatly influenced by surgery performed. The highest infection rates for elective procedures in high-income countries like France were at 2.81% and 1.72% in gastrointestinal and gynaecological surgeries respectively(Astagneau et al., 2009). In contrast, in the United States, obstetrics and gynaecology have the lowest infection rate of 0.06%(de Lissovoy et al., 2009). Total joint arthroplasties in Europe and the United States are at an estimated incidence of 2.91% and 3.7%, respectively, with a rise in the severity of complications, as an increasing burden to older populations (Grammatico-Guillon et al., 2015). Based on a study (Wilson et al., 2008) performed in acute care hospitals in England, the incidence rates for total hip replacement (Eriksen et al.) and hip hemiarthroplasty (HH) are 1.4 and 2.3 SSIs

per 1,000 postoperative hospitalisations, respectively. Revision surgery associated with a 2.7% infection risk, which was noticeably higher than the 1.1% likelihood of infection in the initial surgery. The rate of THR and HH vary between hospitals; overall, the total incidence rates of SSI are 1.26% and 4.06%, respectively. A Singaporean study (Teo et al., 2018) has examined the overall total knee arthroplasty infection rate was 1.10%.

Apart from general surgery, no recent studies specifically examined the financial and wellbeing scope for specific elective surgery such as orthopaedics. As the most common elective procedures in high-income countries like Australia, the incidence of total joint replacement is anticipated to rise by more than 208%(Ackerman et al., 2019). Excluding the impact initiated by infections, orthopaedic elective surgeries will result in a total cost of AUD 5.32 billion (USD 3.7 billion) and AUD 3.54 billion (USD 2.43 billion) to the healthcare system and the private sector by 2030(Ackerman et al., 2019). Beyond the existing cumulative SSI incidence of 1.3 and 2.4 per 100 in hip and knee procedures, elective orthopaedic procedure in Europe also exhibits a considerable positive trend in SSI risk index and anticipated incidence(Agodi et al., 2017). Despite the epidemiological results, risk factors and primary consequences reported for surgical site infections, a comprehensive systematic review is required to evaluate the measurements of wellbeing and financial burden outcomes associated with SSI for elective orthopaedic surgeries. Future preoperative and postoperative studies are necessary to compare and dissect the burden of SSI among orthopaedic arthroplasties.

It is also recognized that SSIs negatively impact hospitals and patients in terms of mortality, morbidity, leading to high healthcare costs as well as productivity loss in the health system(Sawyer & Evans, 2018). More than 400,000 additional days are spent in the hospital by patients as a result of repeated readmissions caused by SSI, costing an additional USD 10 billion annually(World Health Organisation, 2018a). In high-income countries, hip replacements have an average of 21 per 1,000 hospitalizations due to unplanned or unexpected public hospital readmissions within 28 days. complications such as SSI is one of the main reasons(Australian Institute of Health and Welfare, 2018). The extra cost in elective surgeries ranges from 1.73 to 3.39 times higher in SSI patients(Lynch et al., 1992; Monahan et al., 2020; Pollard, 2006). Following total knee arthroplasty, SSI patients with periprosthetic joint infection required multiple procedures, including

debridement, implant removal, and revision arthroplasty(Teo et al., 2018). However, most studies associated patient cost contribution to extra follow-up episodes due to infection with the hospital payer point of view, reflecting limited research on the financial burden for patients on an individual level. A study in Spain (Alfonso et al., 2007) measured infection costs beyond the hospital viewpoint showing that SSI costs were associated with an estimated 78.7% of productivity costs, 10.8% of carer costs and 10.5% of health costs(Alfonso et al., 2007; Monahan et al., 2020), reflecting 90% of the cost related to the societal perspective in community care and productivity loss. Following elective surgery, a New Zealand study (Hart et al., 2021) found that surgical site infections also had a negative correlation with patients' quality of life and satisfaction ratings for up 60 days. Furthermore, research in the US (Sanger et al., 2014) about postoperative SSI in abdominal surgery revealed gaps in the care pathway, especially after discharge, leading to the patient the sense of disconnection from healthcare providers. Significant physical and emotional impacts of infection on quality of life include pain, fluid leakage, readmissions, and anxiety.

A comprehensive assessment of the current body of evidence is needed to identify better the scope of impacts in orthopaedic patients associated with SSI. This systematic review aimed to justify research questions further through observational data of surgical site infections and their effects at an individual level. Orthopaedic elective surgeries in the review involved hip and knee procedures and eliminated other elective surgeries such as spinal and lower abdominal surgeries. Regarding the previous projection of growing hip and knee surgeries (Ackerman et al., 2019) and their association with unexpected readmissions (Agodi et al., 2017; Wilson et al., 2008), especially in the older population(Grammatico-Guillon et al., 2015), the review objective was to investigate the epidemiology of SSI in hip and knee surgeries and related impacts regarding costs and quality of life.

METHOD

The proposed review was carried out according to the JBI scoping review methodology (Peters MDJ, 2020) and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) model(Moher et al., 2009; Page MJ, 2021; Pollock et al.). Considering JBI covers structural systematic review guidelines for prevalence, incidence, costs and impacts of interventions or procedures, the methodology aligns with the nature of surgical site infections burden research in this review.

A search strategy based on the MESH term and the CINAHL terms classification was developed. All index terms and search keywords in the search strategy were modified to adapt each included database. The following search phrases were used to look for relevant sources in a total of five databases (Medline, EMBASE, Scopus, Web of Science and CINAHL):

Concept 1 *"Surgical site complication*" OR "Hospital-acquired complication*" OR "Hospital-acquired infection*."*

Concept 2 *"Orthop?edic surgery*" OR "Orthop?edic elective*."*

Concept 3 *"Quantify*" OR "Cost*" OR "Cost-effectiveness" OR "Quality of life" OR "Health utility."*

Wildcards were used to ensure articles of either British or American spelling were identified through the search. According to the selection criteria in Table I, peer-reviewed papers published from 2010 to 2020 were reviewed, including studies on adult populations (over 18 years old) in orthopaedic elective hip and knee replacement surgeries. The reference list for all included evidence was also checked by reviewers for any additional studies. Only publications in English and studies conducted in high-income countries and published after 2010 were included. As the core concept is to demonstrate the financial and societal strain on patients due to SSI, the review converges on postoperative costing and wellbeing burden. We excluded any preoperative procedures analysis such as antibiotics usage comparison, risk assessment and management for SSI prevention.

Table 1: Selection criteria

	Inclusion Criteria	Exclusion Criteria
Population	Adults above 18 years old Orthopaedic surgeries (hip and knee only)	Paediatric patients under 18 years old General surgeries excluding orthopaedic surgeries
Study design and features	Economic Analysis Quantitative Epidemiology Burden Analysis Tools Conducted in high-income countries Published after 2010 Case study format In English Language	Prevention & Management Protocol Animal study Antibiotics Utilization Conducted in low- or middle-income countries Published before 2010 General concept or theoretic format In Other Languages

All identified citations were collated, and duplicates removed in Covidence. To maximise the retrieval of appropriate studies, two or more independent reviewers evaluated abstracts in accordance with the above criteria. Reviewers imported citations into EndNote X9, examined the full text of selected citations, documented the reasoning for eliminating sources of evidence in reporting findings. In order to report the final scoping review as shown in the PRISMA diagram (Figure 1), reviewers obtained consensus through discussion at each stage of the selection process.

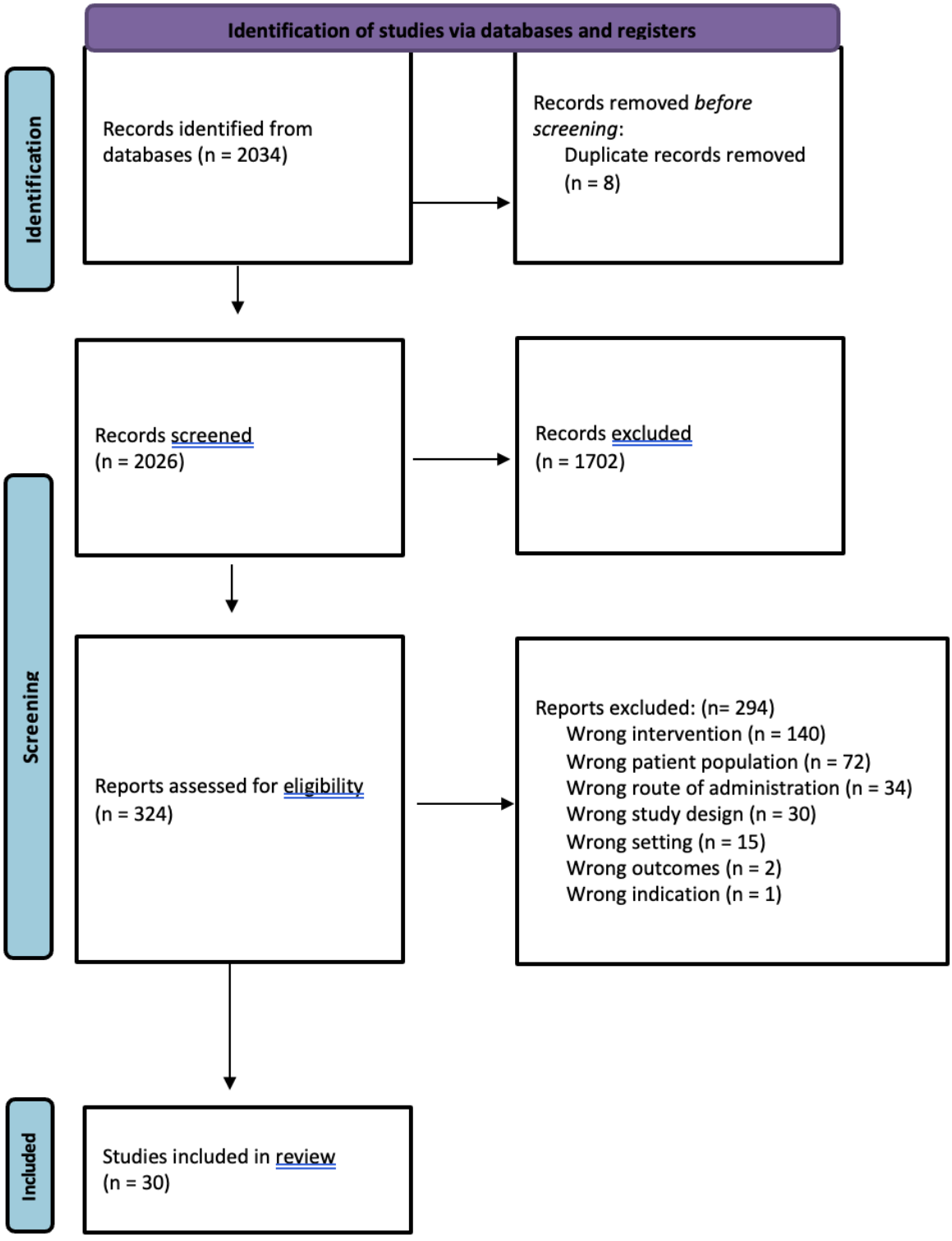
Quality assessment

As most extracted articles are case-control studies with cost-effectiveness interventions, we utilised the ROBINS-I tool (Jonathan AC Sterne et al., 2016) for quality assessments. ROBINS-I is intended for analysing the quality of studies that do not adopt randomization in allocation units, including individuals and clusters or into comparison groups. If the study is a randomized trial study, instead of ROBINS-I, we proceeded with the Rob2 tool, designed for individually randomized parallel-group, cluster-randomized parallel-group, individually randomized cross over, or matched trials(Sterne et al., 2019). Both tools evaluate the risk of bias in estimating comparative effectiveness in impacts and benefits of interventions.

Most studies are matched case-control studies; we proceeded with specifying confounding domains relevant to most studies, including the differences in co-interventions among intervention groups that potentially impact outcomes. Numerical results from the study are also assessed. Confounders including those listed in the review protocol and relevant to the setting of each study are considered preliminarily. We then performed the risk of bias assessment by utilizing potential markers to determine the level of confounding. The five domains for reviews are (1) Participant selection, (2) Intervention categorisation, (G. C. Wilson et al.) Missing Data, (Domenghino et al.) Outcome Measurement, and (5) Reporting of the Result. The overall bias will be rated in five levels: low, moderate, severe, critical, to no information. Studies were then examined under risk of bias as ROBINS-I under five domains to provide an overall bias rating. Only articles with a low to moderate overall bias risk were included.

For each criterion, bias risk assessment was graded as low, moderate, severe, critical, or no information. Of the included articles, 23 (76.7%) and 7 (23.3%) studies displayed low and moderate bias risk (Appendix: Table II). According to the guidelines (Jonathan AC Sterne et al., 2016; Sterne et al., 2019), we categorised research as low risk of bias with no or very little confounding, indicating the study is equivalent to a well-conducted randomised trial. In contrast, a study with moderate risk of bias offers sound support for a non-randomized analysis, however it is not comparable to randomised trial study. Among included studies, selection bias was the main issue with the loss of follow-ups for general patients after the initial surgery, especially those who did not develop SSI, which leads to a certain extent of missing data for comparison.

Figure 1: PRISMA Diagram (Page MJ, 2021)



A narrative review approach was selected due to substantial heterogeneity in sample size, study design, and populations of the included publications. After authors resolved any disagreements on the final interpretation of the results, data in the included studies were presented and categorized based on the characteristics of the study (Table II). Studies were further classified into four themes (Table III), while most represented more than one theme, focusing on epidemiological results, hospital costs, patient costs and/or wellbeing.

Characteristics of included studies

This systematic review included 30 publications. Table II describes the main characteristics and study design of included studies. Majority of the studies were conducted in North America, including the United States and Canada (n=14), and Europe (n=13). Of the studies that were included, two were conducted out in Australia and one in New Zealand. Cohort research designs were the most common among the studies (n=18), mainly retrospective cohort study (n=12), then followed by economic burden or costing study (n=11) and a qualitative study using a descriptive design (n=1). The population varied in the sample. Most studies include a specific population of selected procedures only, for example, total hip and knee arthroplasties (n=17), followed by the general population of all elective surgical procedures (n=11). Lastly, only patients encountered healthcare-associated surgical site infections (n=2). The sample sizes of included studies varied from 15 to 478,222.

RESULTS

Among various themes, Hospital system costing describes how patients incurred the cost of admissions and direct hospital expenses. Measurements include extra length of stay and rea cost burden evaluation focusing on hospital and health system costing (n=21). Patients and societal perspective costing describe social and indirect community follow-up costs (n=2). Patients and societal perspective wellbeing refer to the quality of life and health effects on patients, not limited to psychological and mental health, with results translated into quantitative indicators such as Quality-adjusted life years (QALYs) and Disability-adjusted life years (DALYs) (n=6). Epidemiological databases and surveillance provide general incidence and estimated prevalence of patients undertaking elective surgeries, usually up with other themes as initial background research, hence developing infections through specific databases or software (n=22).

Hospital costing (n=21)

Detailed studies associated with hospital system costing are shown in Table III. Of the 30 studies included, 19 (Adeyemi & Trueman, 2019; Anand et al., 2019; Berger et al., 2014; Bozic et al., 2015; Gow et al., 2016; Hanstein & Gaiser, 2011; Hardtstock et al., 2020; Jenks et al., 2013; Kapadia et al., 2016; Koek et al., 2019; Kurutkan et al., 2015; Merollini et al., 2013; Metsemakers et al., 2017; Peel et al., 2015; Puhto et al., 2019; Rennert-May et al., 2018; Schweizer et al., 2014; van Katwyk et al., 2019; Zawadzki et al., 2017) provided adequate data on hospital and direct health system expenses due to surgical site infection (SSI). As the sample size and timeframe measured varied, comparing cost calculations was challenging. SSIs were the central theme for most studies, with a few articles also studying other health or hospital-associated infections. Three studies (Anand et al., 2019; Metsemakers et al., 2017; Puhto et al., 2019) assessed direct hospital costs particularly, with two cohort studies (Metsemakers et al., 2017; Puhto et al., 2019) and one cost comparison analysis(Anand et al., 2019). These studies indicated direct hospital expenses such as revision care, prolonged length of stay and pharmaceutical costs for inpatients and outpatients.

Revision care cost

A cohort study (Metsemakers et al., 2017) with 358 patents calculated the hospital costs for patients treated for tibia fractures. The multivariate linear analysis with a 95% confidence level determined hospitalization, day admission, materials and pharmaceutical costs among infections developed after fracture fixation. The mean total healthcare treatment costs were USD 45,378 in deep SSI infection patients, which was approximately 6.5-times higher in comparison with USD 6,995 in general patients. The cost of total joint arthroplasty (TJA) was examined using a negative binomial regression(Peel et al., 2015). Over the first 30 days after TJA, the base cost for patients without modifying variables was AUD 13,060. (USD 8,997). Since SSI contributed an additional $97 million AUD (USD 65.9 million) in arthroplasty expenditures in the first 30 days following surgery, it is a substantial cost driver. Another study, (Puhto et al., 2019), with a population of 1768, also demonstrated that infections tripled the cost of a TJA. Wound care and procedures as the most expensive services for infection revisions care. The mean cost of a TJA was €7200 (USD 7,336), with an excess expense of €18,900 (USD 19,257) for a prosthetic joint infection. A two-stage revision costs €44,600 (USD 45,444). Other extra costs for debridement, antibiotics, and implant retention treatment were €12,800 (USD 13,042).

Prolonged length of stay

A cohort research (Peel et al., 2015) further supported the extended median length of stay of four days and the 4% readmission rate in the first 30 days after index joint arthroplasty. Given that the extra length of stay is another significant consequence of SSI, a cost-comparison analysis in the US (Anand et al., 2019) estimated the relationship between medical harm and hospital care cost in 12 states. A linear regression model showed that SSI is one of the most expensive inpatient harms, costing an additional USD 30,000 for each index stay due to infection. The hospital costs of the 90-day additional SSI and other blood infection events are the highest, exceeding USD 34,000.

The societal perspective of health system costing (n=2)

Of the studies reviewed, two were economic burden studies. The first calculated hospital costing from a societal perspective(Kurutkan et al., 2015), and the second evaluated patients' wellbeing based on social care costs(Parker et al., 2018).

Employment power loss

SSI is classified as one of the healthcare-associated infections in hospitals. An economic burden study (Kurutkan et al., 2015) reviewed social costs attributed to healthcare-associated infections (HAI) patients for all surgeries. The general HAIs expenditure is Turkish lira (TRY) 832,167 (USD 46,846). In addition to communal costs of TRY 6,013,101 (USD 338,501), the financial worth of the work power loss suffered by the HAIs working-age patients was TRY 126,154 (USD 7,102). HAIs patients experience 14 times longer inpatient stay with a treatment expenditure of 23 times higher.

Societal care system cost

An economic burden study (Parker et al., 2018) measured total expenses for patients and caregivers in the National Health Service (NHS) and Personal Social Services (PSS). The variation in overall NHS and PSS expenses throughout a one-year follow-up between patients with and without SSIs was £1242 (USD 1,487). In the deep SSI group, costs were higher from 0 to 6 months and from 3 to 6 months after index surgery. Nevertheless, over the course of 6 to 9 months, total expenses were higher among individuals without deep SSI. However, the deep SSI population in this study is relatively small (n=35). Hence, the reliability and potential to generalize this finding to a larger population is uncertain.

Patients and societal wellbeing (n=6)

Two studies (Andersson et al., 2010; Matza et al., 2019) exclusively report patients' wellbeing through interviews and translate results into disutility rating and quality of life impact through content analysis. Several studies concentrated on standard health utility scores and SF-36 measurements in Quality-adjusted life years (QALYs) or Disability-adjusted life years (DALYs) (Cassini et al., 2016; Koek et al.; Parker et al.; Zacher et al., 2019)

Interview study

An in-time trade-off interview (Matza et al., 2019) compared the health state between SSIs and non-SSIs patients undergoing joint and spinal surgeries. Lower utilities were founded in superficial SSIs, deep SSIs and deep SSIs required two-stage revision arthroplasty, and SSIs not requiring surgery. Depending on the severity of infection and treatment interventions, the disutility score of SSIs ranged from - 0.03 to - 0.32. A second interview study (Andersson et al., 2010) on the experiences of people with deep SSIs discovered a strong correlation between the development of deep SSIs and the onset of superficial SSIs. It indicated that inadequate patient-professional relationships in treatments negatively impact patients' physical and emotional wellbeing.

Health utility score

A cost analysis study (Koek et al., 2019) covered hospital costing and patient wellbeing. Cost differences for SSIs were tested with linear regression analysis. Total hip replacement (THR) expenditures per SSI were €21,569 (USD 21,977), primarily due to an extended hospital stay. Total hip arthroplasty (THA) was associated with the highest individual disease burden of 1200 DALYs/year and 250 DALYs/100 SSIs. Another economic burden study, (Parker et al., 2018)revealed that deep SSI patients had lower EQ-5D-3L derived QALYs and higher health and social care expenses over the course of the subsequent 12-month period. In contrast, there is no statistically significant correlation between total NHS and PSS expenses and QALYs produced by SF-6D during a one-year follow-up for deep SSI. Therefore, a comprehensive wellbeing measurement is required to investigate further the variance of QALYs among various health utility calculation tools.

Two database analysis studies (Cassini et al., 2016; Zacher et al., 2019) in Europe further investigated patients' wellbeing through SSI incidence in hospitals. An analysis from German (Zacher et al., 2019) estimated hospital SSI incidence as a type of healthcare-associated infection

(HAI), further adjusting for comorbidities and estimating DALYs. Regarding the average duration of inpatient hospital stay, number of discharges, and patient days, Germany has a lower HAI prevalence but a high number of HAIs per 100,000 compared to the EU. In another study, (Cassini et al., 2016) acknowledged hospitalized patients older than 65 years old have a higher SSI burden. According to median incidence and DALYs per 100,000 populations, the annual SSI incidence per 100,000 was 156.5, with 58.2 DALYs per 100,000. SSI ranked fourth among HAIs in terms of the total wellbeing burden.

A retrospective cohort study (Hardtstock et al., 2020) observed that surgical associated infection (SAI) patients have one-year post-orthopaedic mortality of 22.4%, nearly 18% higher than those without SAI. Another cohort study, (Le Meur et al., 2016)has pointed out the inpatient case mortality in patients with hip or knee arthroplasty infections was 11.4%.

Epidemiological database and surveillance (n=21)

A total of four studies (Grammatico-Guillon et al., 2015; Inacio et al., 2011; Le Meur et al., 2016; Wolford et al., 2018) mapped the epidemiology of SSI patients undergoing hip and knee arthroplasty or both.

Database projection

According to a burden prediction study(Wolford et al., 2018), more than 15 million initial and revision orthopaedic elective surgeries will be performed between 2020 and 2030, leading to an estimation of 77,000 postoperative complications. SSIs post hip joint replacements accounted for 54% of all SSIs following arthroplasties. The overall number of SSIs from hip and knee arthroplasties will increase by 13% and 14%, respectively, with the elderly accounting for 60–70% of these procedures and infections.

Retrospective incidence estimation

The incidence rate of hip or knee arthroplasty infection (HKAI) was calculated by a cohort study(Le Meur et al., 2016). With a readmission rate of 1.1%, the first two months following surgery accounted for 70% of HKAIs. In a population of 1739 patients, the incidence rate of HKAI was reported to be 1.76%. Another cohort study, (Grammatico-Guillon et al., 2015), revealed the 1-year HKAI incidence as 1.31%, with density incidences in hip and knee being 2.2 and 2.5 per 100 person-years, respectively. During the initial 30 days following surgery, 30% of HKAI

incidents occurred, while there is an increased chance of infection in individuals who are 75 years or older. A validation study (Inacio et al., 2011) performed an electronic screening analysis. With the 9.5% of possible SSIs estimated from 42,173 total joint replacement procedures, 1.04% of case-patients resulted in SSI.

Hospital costing and database analysis involved sixteen articles(Adeyemi & Trueman, 2019; Berger et al., 2014; Bozic et al., 2015; Gow et al., 2016; Hanstein & Gaiser, 2011; Hardtstock et al., 2020; Jenks et al., 2013; Kapadia et al., 2016; Merollini et al., 2013; Peel et al., 2015; Rennert-May et al., 2018; Schairer et al., 2014; Schweizer et al., 2014; Shepard et al., 2013; van Katwyk et al., 2019; Zawadzki et al., 2017). Hospital raw data is commonly analysed initially to provide incidence and demographics as a reference for further total cost analysis. Applying data from hospital database, a cohort study (Schweizer et al., 2014) conducted an analysis at all surgical patients who underwent common surgeries. SSI patients bear double in-hospital care and postoperative costs after orthopaedic surgery such as primary hip or knee arthroplasty compared to general patients. A cost analysis (van Katwyk et al., 2019) demonstrated hospital costs of SSI from a return of investment perspective. Combining with the 5-year SSI incidence, the $624,384 USD invested in surgical quality improvement programs reduced SSI incidence by 2.88%. The investment yielded US$3.07 for every dollar invested and saved US$1.4 million from avoided infections. Another non-intentional retrospective cohort study, (Hardtstock et al., 2020), reported that knee surgeries with a hazard ratio of 0.8 were associated with a lower surgical associated infection risk than hip surgeries. SAI patients were also associated with 4.4 times and 7.7 times hospitalizations and hospital days.

In terms of healthcare resources allocation in inpatient, outpatient and readmissions, this study (Peel et al., 2015) concluded 4% of readmissions occurred within 30 days after index joint arthroplasty, with a majority of 74% developed a SSI. Patients with periprosthetic joint infections (PJI) incurred higher expenditures, according to matched case-control research(Kapadia et al., 2016). Following total knee arthroplasty, PJIs increased the rate of readmission by almost four times, the average length of stay by two times, and the episode cost per patient by nearly five times. Due to these factors, the mean annual healthcare cost of PJI patients was $116,383 USD, compared to $28,249 USD in the control group(Kapadia et al., 2016). Another matched case-control study,

(Adeyemi & Trueman, 2019), also concurred that SSI was related to a noticeably longer length of stay. The extra costs of SSI in joint replacement procedures varied from $12,689 USD to $12,890 USD. 0.72% of 158,516 patients were readmitted due to SSI within a 90-day episode of care period. Regarding age, 0.84% of adults older than 45 years old had infection-related readmissions. It was also found that patients undergoing older patients encountered more revision THA, leading to higher care costs(Bozic et al., 2015).

An economic burden study (Rennert-May et al., 2018) identified the incidence of complex SSI from a local infection prevention and control database with a population size of 24,512. In complex SSI patients, the mean 12-month total expenses were substantially higher. After standardising for patient characteristics, the extent of the cost disparity remained the same at CAD$95,321 (USD 73,597) versus CAD$19,893 (USD 15,374). A cost of illness study (Hanstein & Gaiser, 2011) used a prediction for infections in primary hip and knee arthroplasties following an SSI incidence estimation in Germany. The research also examined treatment costs such as medical and pharmaceutical expenses, concluding SSI revision for hip and knee arthroplasty incurred additional costs of at least € 22,407,350 (USD 22.8 million) and €13,760,280 (USD 14 million), respectively.

DISCUSSION

This systematic review examines SSI rates and consequences in health systems through the lens of hospitals and patients' burden from 30 published studies in 2010 to 2020. All included studies reported data from high-income countries. Extracted articles acknowledge that SSI leads to complex clinical and economic hardships in healthcare and social systems. Articles mainly concentrate on the following subthemes to explore the size of the burden. Due to a lack of uniformity among multiple studies, hospital-related healthcare costs are challenging to compare(Dehkordi et al., 2021; Jahan et al., 2016).

Hospital incidence and costing

SSIs, contribute to post-surgery infections in hip and knee replacements as one of the leading healthcare or hospital-associated infections. Several studies (Parker et al., 2018; Peel et al., 2015; Zacher et al., 2019) support the prevention and surveillance of SSI to utilize resources for treatment planning and improvement through providing background epidemiological data and cost determinants to demonstrate complication outcomes. As hospital incidence analysis is usually the base reference for health system costing estimation, a range of comprehensive SSI incidence analyses over time in different countries were found in this review. However, the study population size varied, limiting generalization and comparison among hospitals or countries.

Upon evaluating hospital expenses from incidence analysis, many factors were associated with postoperative SSIs rising hospital costs. For instance, patients age 65 or above(Cassini et al., 2016; Wolford et al., 2018), or 45 or above(Adeyemi & Trueman, 2019), were more prone to develop SSIs, deriving higher financial strain to hospitals than younger patients during SSI treatments. Older populations are associated with higher infection risk, yet there was no specification and unified definition for an age range of the older population, which will lead to variance in reporting the impact of complications. Also, due to the inconsistent study population, as some studies (Cassini et al., 2016; Le Meur et al., 2016; Wolford et al., 2018) included all adult patients, while one (Adeyemi & Trueman, 2019) focused on adults older than 45 years old, additional information will be required to reflect the relationship between age groups SSI incidence in the future, to assist policymakers in implementing equitable health services and ensure better patient experiences.

Preventable hospitalizations after elective surgeries contributed as a major factor in hospital costings. Most hospital cost analysis primarily focuses on the length of stay and readmission studies as raw data and patient records were initially available in the hospital database. Some studies (Hanstein & Gaiser, 2011; Metsemakers et al., 2017; Puhto et al., 2019) also further examined the pharmaceutical and debridement costs provided to patients upon admission. All relevant studies (Adeyemi & Trueman, 2019; Anand et al., 2019; Berger et al., 2014; Bozic et al., 2015; Gow et al., 2016; Hanstein & Gaiser, 2011; Hardtstock et al., 2020; Jenks et al., 2013; Kapadia et al., 2016; Koek et al., 2019; Kurutkan et al., 2015; Merollini et al., 2013; Metsemakers et al., 2017; Peel et al., 2015; Puhto et al., 2019; Rennert-May et al., 2018; Schweizer et al., 2014; van Katwyk et al., 2019; Zawadzki et al., 2017) agreed that SSI negatively impacted the length of stay and number of revision care to a certain extent. In terms of readmissions, the cost of two-stage revision due to deep SSI was exceptionally high(Matza et al., 2019; Puhto et al., 2019). The revision timeframe in studies ranged from 30 days, 90 days to a year post-surgery, which is believed to be associated with the type of SSI of interest: superficial, deep SSIs or both. Studies should include further discussion of the kind of SSIs attempted to capture. Social care and national health system costs also required further investigation. An intervention (Parker et al., 2018) with a relatively smaller population size described costs in deep SSIs might not be as high as those without deep SSIs during specific treatment periods. Still, there were insufficient studies, making it challenging to conclude on social care costs.

Therefore, future studies and policies should aim to close the gap in hospital and social care costs and clarify the relationship between types of SSIs and cost factors, such as revisions comparison between superficial and deep SSI patients.

Patient costing and wellbeing

Regarding the previous section of social care expenses in the health system, individual-level patient costs were included in studies(Kurutkan et al., 2015; Parker et al., 2018). Research is gradually trending towards this direction, but there is still a substantial research gap due to limited studies conducted solely on hip and knee replacements. This lack of evidence leads to insufficient data on how orthopaedic surgeries and complications impact patients' lives during or after their

treatment journey, providing finite information for decision makers to generate a recovery program that considers health equity among patients with various backgrounds and conditions.

Studies focusing SSI on other surgeries, such as vascular surgery, agree infections may have devastating consequences, affecting the physical and emotional health of patients both while they are being treated in hospitals and after discharge(Totty et al., 2021). Most studies reporting health system costs pointed out concerns in cost underestimation due to limitations in incorporating the societal burden of SSI into their calculation. Although the impact of SSIs on hospitals is well established, the field is still developing and further research can demonstrate the value of patient-centred interventions in minimizing surgical site infections(Tartari et al., 2017).

However, no actual patient out of pocket costs were measured in the included studies. Although public hospital patients are covered with support like Medicare or private insurance in most high-income countries, indirect costs like loss of employment days, extra transportation, and inconvenience due to readmissions have always been neglected. A study (Parker et al., 2018) discussed loss in employment power in SSI patients. The rest of the studies interpret patient costs as a burden to the societal perspective of health systems instead of focusing on patients' financial struggles. As various SSI patients do not often return to the same hospital or seek assistance in the community, it might be complex to trace patients postoperatively. Future research can considerably investigate SSI patients' journeys to capture social care, and indirect patient costs better.

Several studies (Andersson et al., 2010; Cassini et al., 2016; Hardtstock et al., 2020; Koek et al., 2019; Matza et al., 2019; Parker et al., 2018; Zacher et al., 2019) introduced patient well-being measurement through health utility scores and interviews. Most studies related to SSI hospital costs instead of patients' wellbeing; Measurement of quality of life might be complicated as surveys or interviews require patients to recall unpleasant memories. For articles examining patients' wellbeing, two (Matza et al., 2019) provided an interview opportunity to express views and struggles towards SSI treatment pathways beyond preassigned questions. Few studies (Cassini et al., 2016; Hardtstock et al., 2020; Koek et al., 2019; Matza et al., 2019; Parker et al., 2018; Zacher et al., 2019) measured disutility, mortality, and changes in quality-of-life years with DALY

and QALY. They all represented a negative association of quality of life. More detail and constructive analysis of how SSI leads to wellbeing changes in different patents demographics will be worth measuring. A study (Parker et al., 2018) used a standardized SF-36 survey to measure overall patients' wellbeing in terms of mortality. Like the revision costing section, a guided timeframe will be ideal for interpreting the types of SSIs considered. It will clarify whether the research was on wellbeing for superficial SSIs within 30 days postoperative or other deep SSIs beyond this timeframe.

Future studies can investigate patients' voices and connect them with quantitative research like health utility scores, improving patient recovery pathways and resources allocation.

Strengths and limitations

From 2010 to 2020, the articles were primarily on hospital systems, emphasizing health system expenditure and resource allocation to provide decision-making guidelines for policymakers to utilize resources better. There was also an enhanced focus on patient wellbeing since 2016, with numbers of studies published from 2018 to 2019, suggesting a transition in societal and quality of life impact.

Hospital database analysis was essential for estimating SSI incidence in elective surgeries, especially inpatients. A few studies utilized reliable patient data to perform an incidence projection for future policy planning. However, some outpatients developed SSI in the community. When the population is seeking additional social care due to SSI, there is a chance that the hospital database failed to capture them accordingly. Another limitation for incidence and database monitoring is that some SSI follow-ups do not return to the same hospital. Methods to recapture patients through patients' identifiers and hospital locality codes differ among countries. Some patients were out in the community seeking assistance due to SSI, so expenses reflected social care instead of hospital costing. However, few articles about societal costing from the health systems or patients' perspective, mainly concerning hospital costs. The relationship between postoperative SSI incidence and primarily indirect costing remained uncertain and required additional research.

The included studies were mainly observational in terms of characteristics, with most of the data collected retrospectively in a database cohort for various periods and across different years. With a wide range of population sizes, comparison, and generalization of results were problematic. Few post-discharge outcomes studies were available, which may be due to the difficulty of tracking revision care handled by the community instead of hospitals, recruiting or monitoring SSI patients for wellbeing and financial investigations post-surgery.

A primary key strength of this review is that it sheds light on future research methodology in capturing SSI counts accurately to be epidemiologically reliable. It identifies a research gap in SSI patient financial and wellbeing measurement. An extensive research base in hospital costings highlights a lack of focus on the societal and patient burden. Considering societal and economic aspects through the lens of both health systems and patients guides future studies to present a fuller picture of the SSI burden.

Research gaps and future opportunities

The review provides adequate data to support a hypothesis that SSI burdens health systems and patients. It also reveals that infections following orthopaedic procedures are linked to severe financial hardship, high risks of mortality and morbidity(Andersson et al., 2010; Hardtstock et al., 2020; Kapadia et al., 2016; Metsemakers et al., 2017; Parker et al., 2018; Peel et al., 2015; Wolford et al., 2018; Zacher et al., 2019).

The extent to which the review answers the research question is sufficient regarding current background hospital incidence and cost. Further work in educating preventable hospitalizations (Peel et al., 2015; Zacher et al., 2019) and economic evaluation (Parker et al., 2018) will be the next step in enhancing policy planning and risk reduction. However, with only eight studies evaluating the impact of patients' costs and wellbeing, research should focus on reducing socioeconomic impact (Metsemakers et al., 2017) apart from treatment strategies on direct costs from readmission, pharmaceuticals, and length of stay.

Future studies designed and implemented based on evaluating indirect and out-of-pocket costs borne by patients instead of hospitals will provide an entire perspective on the total costs associated

with postoperative SSI. Patient mortality and morbidity were also measured as a comprehensive study from the hospitals' incidence estimation and resource monitoring. Due to insufficient patient-professional relationships, patients' concerns should be addressed when planning individual care (Andersson et al., 2010). Hence, upcoming patient wellbeing studies should concentrate on the feedback and potential improvements towards the SSI experience.

CONCLUSION

This systematic review has synthesized a scope of themes associated with the overall incidence and burden of SSI that can advise potential policymakers to future decision-making. The return on investment on preventable hospitalizations supports the introduction of surveillance and prevention programs to lessen the burden for patients and health systems. Further analysis is required to understand the hardships behind patients with postoperative SSI. This potential data, incorporated with the review findings, can be integrated into the health economics of SSI control and treatment, strengthening the body of evidence for future policy framework.

Table II. Characteristics of included studies (n= 30)

Reference	Country	Year(s)	Type of Study	Population	Sample Size (n=)	Themes	Risk of bias
Hardtstock, F. Heinrich, K. Wilke, T. Mueller, S. Yu, H. (Hardtstock et al., 2020)	Germany	2020	Cohort (Non-interventional retrospective)	Adult patients from 2012 to 2015 who underwent at least one of the chosen procedures	74,327	(i)(iv)	Moderate
Zacher, B. Haller, S. Willrich, N. Walter, J. Sin, M. A. Cassini, A. Plachouras, D. Suetens, C. Behnke, M. Gastmeier, P. Wieler, L. H. Eckmanns, T. (Zacher et al.)	Germany	2019	Database analysis (R package)	Healthcare associated infections patients in 2011-2012	478,222	(Edwards Jr et al.) (iv)	Low
van Katwyk, Sasha Thavorn, Kednapa Coyle, Doug Moloo, Husein Forster, Alan J. Jackson, Timothy Schramm, David (van Katwyk et al.)	Canada	2019	Return-on-investment analysis (Retrospective case costing study)	Patients admitted to hospitals and underwent surgery from April 2010 to January 2015	A teaching hospital providing tertiary care with 1,118 beds.	(i)(iv)	Low
Puhto, T., Puhto, A. P., Vielma, M., & Syrjälä, H. (Puhto et al.)	Finland	2019	Cohort (Retrospective)	Patients who underwent total joint replacements in the Oulu University Hospital from 2013 to 2015.	18 aseptic revisions, 42 prosthetic joint infections, and 1708 complete joint arthroplasties without problems were all eligible for evaluation.	(i)	Low
Matza, L. S., Kim, K. J., Yu, H., Belden, K. A., Chen, A. F., Kurd,	United Kingdom	2019	Qualitative study - Interview	Participants from the community had to be UK citizens over 18 years old and	213 participants attended interviews; 201 participants completed interview.	(Edwards Jr et al.)	Low

Reference	Country	Year(s)	Type of Study	Population	Sample Size (n=)	Themes	Risk of bias
M., Lee, B. Y., & Webb, J. (Matza et al.)				have the ability to comprehend interview questions.			
Koek, M., van der Kooi, T., Stigter, F., de Boer, P. T., de Gier, B., Hopmans, T., de Greeff, S. C., & Burden of SSI Study Group (Koek et al.)	Netherlands	2019	Cost-analysis (Retrospective)	Patients included in the 2001 National SSI Surveillance Network	Matching 122 individuals without SSI to 62 individuals with SSI under the same type of surgery	(i)(Edwards Jr et al.) DALYs	Moderate
Anand, P. Kranker, K. Chen, A. Y. (Anand et al.)	United States	2019	Cost comparison analysis	State Inpatient Databases for 12 states from the Healthcare Cost and Utilization Project from 2009 to 2011.	Not stated	(i)	Low
Adeyemi, A., & Trueman, P. (Adeyemi & Trueman)	United States	2019	Case control study with propensity score matching	SSI-related hospital readmission patients vs non-SSI patients during the 90-day treatment episode after total orthopaedic arthroplasty in reference to the Nationwide Readmissions Database in 2013.	48,143 patients above the age of 45 who satisfied the inclusion criteria were found	(i)(iv)	Low
Wolford, H., Hatfield, K., Paul, P., Yi, S., & Slayton, R. (Wolford et al.)	United States	2018	Database-projected SSI consequences	Referring to the Nationwide Inpatient Sample, participants	247,733,509 (2015) for projection	(iv)	Low

Reference	Country	Year(s)	Type of Study	Population	Sample Size (n=)	Themes	Risk of bias
				experienced joint arthroplasty from 2012 to 2014. National Healthcare Safety Network Data from 2012 to 2015 were also used to derive stratified complex SSI rates			
Rennert-May, E. D., Conly, J., Smith, S., Puloski, S., Henderson, E., Au, F., & Manns, B. (Rennert-May et al.)	Canada	2018	Economic burden	Patients who experienced primary joint replacements from April 1, 2012, to March 31, 2015, in Alberta, Canada	24,512	(i)(iv)	Low
Parker, B., Petrou, S., Masters, J., Achana, F., & Costa, M. L. (Parker et al.)	United Kingdom	2018	Economic burden	Patients from the Major Trauma Network in the United Kingdom, which consists of 24 specialist trauma hospitals.	460	(Edwards Jr et al.)	Low
Zawadzki, N., Wang, Y., Shao, H., Liu, E., Song, C., Schoonmaker, M., Shi, L. (Zawadzki et al.)	United States	2017	Cohort (Retrospective)	Patients who discharged from hospitals through the MS-DRG 470 total joint arthroplasty in various states between 2009 and 2013	Not stated	(i)(iv)	Moderate
Metsemakers, W. J., Smeets, B., Nijs, S., & Hoekstra, H. (Metsemakers et al.)	Belgium	2017	Cohort	All patients who underwent surgical treatment for tibia fractures of types 41, 42, and	358	(i)	Moderate

Reference	Country	Year(s)	Type of Study	Population	Sample Size (n=)	Themes	Risk of bias
				43 between January 1, 2009, and January 1, 2014			
Le Meur, N., Grammatico-Guillon, L., Wang, S., & Astagneau, P. (Le Meur et al.)	France	2016	Cohort (Retrospective)	Patients who received joint replacements in 2011	1,739	(iv)	Low
Kapadia, B. H., Banerjee, S., Cherian, J. J., Bozic, K. J., & Mont, M. A. (Kapadia et al.)	United States	2016	Case-control (Matched)	Patients who experienced total hip replacement surgery between 2007 and 2011, including those who developed SSIs	16 consecutive SSI cases matched at ratio of 1:2 with 32 non-SSI controls from 2458 patients.	(i)(iv)	Low
Gow, N., McGuinness, C., Morris, A. J., McLellan, A., Hardy, A. E., Munro, J. T., Roberts, S. A. (Gow et al.)	New Zealand	2016	Case-control (Retrospective)	All patients, including those with SSI after joint replacements in their first year of SSII programme, from 1 March 2013 to 28 February 2014	710 bed tertiary referral centre matched at ratio of 1:2.	(i)(iv)	Low
Cassini, A., Plachouras, D., Eckmanns, T., Abu Sin, M., Blank, H. P., Ducomble, T., Haller, S., Harder, T., Klingeberg, A., Sixtensson, M., Velasco, E., Weiß, B., Kramarz, P., Monnet, D. L.,	Switzerland	2016	Databases analysis (Incidence estimation)	Database estimates of the occurrence of specified HAIs from the point prevalence survey from the European Centre for Disease Prevention	273,753 patients in 1,149 hospitals	(Edwards Jr et al.)(iv)	Moderate

Reference	Country	Year(s)	Type of Study	Population	Sample Size (n=)	Themes	Risk of bias
Kretzschmar, M. E., & Suetens, C. (Cassini et al.)				and Control from 2011 to 2012			
Peel, T. N., Cheng, A. C., Liew, D., Buising, K. L., Lisik, J., Carroll, K. A., Choong, P. F., & Dowsey, M. M. (Peel et al.)	Australia	2015	Cohort (Retrospective)	Patients receiving total joint replacements at a facility in Melbourne, Australia, from January 2011 to June 2012.	827	(i)(iv)	Low
Kurutkan, M. N., Kara, O., & Eraslan, İ. H. (Kurutkan et al.)	Turkey	2015	Economic Burden	Collection of patients data including those diagnosed with HAIs between 2011 and 2013 by the Infection Committee of the Düzce University Research and Application Hospital	749	(i)(Edwards Jr et al.)	Low
Grammatico-Guillon, L., Baron, S., Rosset, P., Gaborit, C., Bernard, L., Rusch, E., & Astagneau, P. (Grammatico-Guillon et al.)	France	2015	Cohort (Retrospective)	Hospital database of patients in a French region who had their index hip or knee replacements in the previous five years.	In a population of 2.5 million, 39 private and public hospitals treated 32,678 patients with arthroplasty codes.	(iv)	Low
Bozic, K. J., Kamath, A. F., Ong, K., Lau, E., Kurtz, S., Chan, V., Vail, T. P., Rubash, H., & Berry, D. J. (Bozic et al.)	United States	2015	Cohort (Retrospective)	Patients who underwent total joint arthroplasty revision surgery were assessed with the Nationwide Inpatient	235,857 THA revisions and 301,718 TKA revisions	(i)(iv)	Low

Reference	Country	Year(s)	Type of Study	Population	Sample Size (n=)	Themes	Risk of bias
				Sample between October 1, 2005, and December 31, 2010			
Schweizer, M. L., Cullen, J. J., Perencevich, E. N., & Vaughan Sarrazin, M. S. (Schweizer et al.)	United States	2014	Cohort (Retrospective)	129 Veterans Affairs (VA) hospitals providing surgical care to patients. SSI-related expenses for veterans who underwent surgery in fiscal year 2010.	54,233 VA patients had procedures	(i)(iv)	Low
Schairer, W. W., Sing, D. C., Vail, T. P., & Bozic, K. J. (Schairer et al.)	United States	2014	Cohort	Patients from a single institution	1,415	(i)(iv)	Low
Berger, A., Edelsberg, J., Yu, H., & Oster, G. (Berger et al.)	United States	2014	Cohort (Retrospective)	Major elective surgery patients who received the procedure between January 1, 2007, and December 31, 2009	327,618	(i)(iv)	Low
Shepard, J., Ward, W., Milstone, A., Carlson, T., Frederick, J., Hadhazy, E., & Perl, T. (Shepard et al.)	United States	2013	Cohort (Retrospective)	Individuals who were admitted to the selected four hospitals from January 1, 2007, to December 31, 2010	25,849 surgical operations of interest and 399,627 inpatient admissions	(i)(iv)	Low
Merollini, K.M., Crawford, R.W. & Graves, N. (Merollini et al.)	Australia	2013	Cohort (Retrospective)	Patients receiving primary THA and infection treatment in Queensland hospitals	114	(i)(iv)	Low

Reference	Country	Year(s)	Type of Study	Population	Sample Size (n=)	Themes	Risk of bias
				between January 2006 and December 2009			
Jenks, P. J., Laurent, M., McQuarry, S., & Watkins, R. (Jenks et al.)	United Kingdom	2013	Cohort (Retrospective)	Patients at NHS Trust Plymouth Hospitals who received major surgical procedures between April 2010 and March 2012.	University hospital with 1,200 beds, 13,854 emergency surgical procedures and 58,203 elective procedures were carried out.	(i)(iv)	Low
Inacio, M. C., Paxton, E. W., Chen, Y., Harris, J., Eck, E., Barnes, S., Namba, R. S., & Ake, C. F. (Inacio et al.)	United States	2011	Validation	Patients who underwent total joint arthroplasty between January 2006 and December 2008 within a major health maintenance organization (HMO).	42,173	(iv)	Low
Hanstein, T. J. B., & Gaiser, G. (Hanstein & Gaiser)	Germany	2011	Cost of illness	Data from Krankenhaus-Infektions-Surveillance-System (KISS) module was utilised to project SSI cases in primary total joint replacements throughout Germany.	372,851	(i)(iv)	Moderate
Andersson, A. E., Bergh, I., Karlsson, J., & Nilsson, K. (Andersson et al.)	United States	2010	Qualitative study – Interview	Patients who had undergone a medical examination with a deep SSI diagnosed	15 patients from Sahlgrenska University Hospital were selected.	(Edwards Jr et al.)	Moderate

Reference	Country	Year(s)	Type of Study	Population	Sample Size (n=)	Themes	Risk of bias
Themes (i) Hospital costing (n=21) (ii) The societal perspective of health system costing (n=2) (iii) Patients and societal wellbeing (n=6) (iv) Epidemiological database and surveillance (n=22)							

Table III. Themes of included studies

Reference	Theme (i)	Theme (Edwards Jr et al.)	Theme (Edwards Jr et al.)	Theme (iv)
Hardtstock, F., et al. (2020)	X			X
Zacher, B., et al. (2019)			X	X
van Katwyk., et al. (2019)	X			X
Puhto, T., et al. (2019)	X			
Matza, L. S., et al. (2019)			X	
Koek, M., et al. (2019)	X		X	
Anand, P., et al. (2019)	X			
Adeyemi, A., & Trueman, P. (2019)	X			X
Wolford, H., et al. (2018)				X
Rennert-May, E. D., et al. (2018)	X			X
Parker, B., et al. (2018)		X	X	
Zawadzki, N., et al. (2017)	X			X
Metsemakers, W. J., et al. (2017)	X			
Le Meur, N., et al. (2016)				X
Kapadia, B. H., et al. (2016)	X			X
Gow, N., et al. (2016)	X			X
Cassini, A., et al. (2016)			X	X
Peel, T. N., et al. (2015)	X			X
Kurutkan, M. N., et al. (2015)	X	X		
Grammatico-Guillon, L., et al. (2015)				X
Bozic, K. J., et al. (2015)	X			X
Schweizer, M. L., et al. (2014)	X			X
Schairer, W. W., et al. (2014)	X			X
Berger, A., et al. (2014)	X			X
Shepard, J., et al. (2013)	X			X
Merollini, K.M., et al. (2013)	X			X
Jenks, P. J., et al. (2013)	X			X
Inacio, M. C., et al. (2011)				X
Hanstein, T. J. B., et al. (2011)	X			X

Reference	Theme (i)	Theme (Edwards Jr et al.)	Theme (Edwards Jr et al.)	Theme (iv)
Andersson, A. E., et al. (2010)			X	
Total	21	2	6	22

4.3 Chapter summary

This chapter described the findings of a published systematic review that summarised the overall impact of surgical complications in elective surgery. The findings suggested evidence on hospital costing, societal cost on health system, patient wellbeing and epidemiological database surveillance on 30 published studies on orthopaedic surgery in reference to high income countries such as Australia. The following chapter quantify an epidemiolocal overview on elective procedures by examining the effects of avoidable readmissions versus sociodemographic characteristics of patients.

CHAPTER 5: POSTOPERATIVE COMPLICATIONS AND AVOIDABLE READMISSION IN ELECTIVE SURGERY FROM 2018 TO 2022

5.1 Chapter introduction

This chapter included a journal article (Manuscript II) to represent current epidemiology framework of elective surgery, emphasizing on association of sociodemographic and impact of avoidable readmission with parameters such as length of stay and hospitalisation cost. This study employed a multivariable logistic regression and ANOVA analysis to address the second and third objectives. The study found that age, cultural background, and mental health assistance requirements increased the risk of avoidable readmissions, leading to extended length of stay and potential wellbeing distress.

5.2 Publication

Peer review process:

Original manuscript submitted to Journal of Hospital Infection on 20/12/2024 with pending decision.

Author Contributions: The initial draft of the manuscript was written by Yoey Gwan Venise Hon, with expertise and academic input from Prof. Andrew Hayen and Dr. Daniel Demant. All authors reviewed and approved the final version of the manuscript.

The impact of unplanned readmissions on elective procedures in Victoria from 1 June 2018 to 31 October 2022

Yoey Gwan Venise Hon [1], Andrew Hayen[1], Daniel Demant [1,2]

[1]School of Public Health, University of Technology Sydney, Ultimo, New South Wales, Australia.

[2]School of Public Health and Social Work, Faculty of Health, Queensland University of Technology, Brisbane, Australia

Abstract

Objective: Unplanned readmission increasingly impacts patients and the health system. In the current study, the authors examine the burden on patients by comparing the epidemiology and sociodemographic of unplanned readmissions in elective surgery.

Methods: A retrospective hospital database analysis was conducted to compare elective surgery admissions and unplanned readmissions under the PI-23 definition in Victoria, Australia. Multivariable logistic regression and ANOVA were implemented for data analysis.

Results: Our study showed that 5,674 patients who received selected surgical procedures, 96 (1.7%) had unplanned 28-day readmission. Total hip and knee arthroplasty were the primary index admissions with the highest readmission rates observed, while internal orthopaedic prosthetic devices, implants, and grafts are the prevalent causes of complications. The prominent factors for unplanned readmissions were aged over 80 (OR= 4.08, 95% Cl: 1.20-13.80, p=0.024) requiring an interpreter (OR= 9.65, 95% Cl: 3.17-29.33, p<0.001) or mental health assistance (OR= 72.81, 95% Cl: 35.29-150.19, p<0.001). Regarding the hospital expenses patients incurred, the only

outlier between groups was the cost of a non-operating theatre room. All other costs and the overall average cost are significantly greater in the readmission group ($97,747) than the non-readmission group ($7,779). The ANOVA analysis demonstrates that readmission has a statistically significant impact on LOS with an extended mean length of stay of 16.45 days in the readmission group, which could increase the wellbeing burden while adjusting to postoperative changes in linkage to financial stress.

Conclusion: The study provides a clear guide on patients from a particular sociodemographic background and their risk of avoidable readmissions, providing input on what could be done in the future to focus on these patients to reduce readmission. To contextualize findings, the results can be used to reflect the importance of health equity on patients' needs and demographics, the potential to tailor better care in providing treatment and knowledge about risk factors. This study conducted readmission analysis only applies to a specific group under PI-23; another type of readmission may have various outcomes or associations with different factors. Large-scale studies should be conducted to evaluate the total burden of unplanned readmissions from patient's perspective.

Keywords

Surgical complications, elective surgery, readmissions, avoidable readmissions, unplanned readmissions

Declaration of Interest/Funding

None

Ethics

This study (ETH21-6243, ETH22-7180) was approved by the University of Technology Sydney Human Research Ethics Committees (HRECs) on 25/2/2022 and 2/8/2022.

Data availability declaration

Secondary de-identified linked data from the Elective Surgery Information System (ESIS) and the Victorian Admitted Episode Dataset (VAED), provided by the Centre for Victorian Data Linkage were deposited into CVDL Remote Microsoft Desktop with access credentials provided upon request. Analysis was based solely on data provided by CVDL and analysis results are included in this published article.

INTRODUCTION

Hospital readmissions from elective surgery are an emerging public health issue, with observed increasing mortality, avoidable complications, and extra follow-up sessions from various studies around the globe(Morris et al., 2014; Mullen et al., 2017; Straatman et al., 2015; The International Surgical Outcomes Study Group, 2016; Vogel et al., 2012). In Australia, elective surgery is defined as a planned surgery arranged in advance, with a specialist clinical assessment to determine admission within 30, 90 or 365 days based on level of urgency(Australian Institute of Health and Welfare, 2022). Hospital readmissions can be divided into planned readmissions such as routine treatment (e.g., chemotherapy) and unplanned, potentially avoidable, readmissions, such as complications(Australian Commission on Safety and Quality in Health Care, 2019c). International and Australian definitions of (Agency for Healthecare Research and Quality, 2012; Australian Commission on Safety and Quality in Health Care, 2019c; Jiang HJ, 2023; Knighton et al., 2019) hospital readmission refer to patients readmitted to the same or a different hospital within 28 to 30 days following discharge for the specified index surgical procedure, regardless of whether it's planned or unplanned.

This research focus on analysis on the extent of potential burden of unplanned readmissions on patients, including readmission that is clinically associated to the index admission and potentially preventable by appropriate planning and improved clinical management in the index hospitalisation(Australian Commission on Safety and Quality in Health Care, 2019c). Internationally, the average unplanned readmission rate following an emergency admission or elective surgery vary from 5.2% to 13.1%(Glance et al., 2014; Jacobs, 2018; Tsai et al., 2013). Specific elective procedures such as orthopaedic surgery had an unplanned return to operating room or readmission of 3.2%(Rohrer et al., 2021), while gastric bypass and colectomy had a

rate of 8.9% and 15.8% respectively(Gregory C. Wilson et al., 2015). Extra unplanned readmissions lead to inadequate allocation of resources, decrease the quality of care, and affect patient experiences in terms of prolonged length of stay and discharge disposition(G. C. Wilson et al., 2015). Comparatively, in Australia, the rate of unplanned readmissions ranged from 0.3% in cataract surgery to 11% in general surgery admissions(Australian Commission on Safety and Quality in Health Care, 2019a, 2019c; Chua, 2022; Considine, 2019; Li, 2014), estimated to cost AU$1.5B annually(Chua, 2022; Sahli, 2015). In Victoria, one in seven discharges from hospitals results into an unexpected readmission within 30 days, with 10% of these occurring within a day of discharge(Chua, 2022; Considine, 2019). Specific elective procedures such as knee replacement has an unexpected hospital readmission rate of 26.6 per 1000 separations in Victoria, which is slightly higher than the national level of 25.9 per 1000 separations in 2017-2018(Australian Institute of Health and Welfare, 2023b).

Despite the scarce resources addressing potential impact of unplanned readmissions on patient outcomes, current literature (Aubert et al., 2019; Chua, 2022; Rammohan et al., 2023; Sahli, 2015; Westley-Wise et al., 2022; G. C. Wilson et al., 2015) had an extensive focus on risk factors, concluded that readmitted patients across elective surgery encountered extended length of stays, higher mortality rates, and increased healthcare costs. Avoidable readmission can negatively impact patient finance and wellbeing, with a magnified burden on specific populations, particularly among patients with comorbidities and socioeconomically disadvantaged(Westley-Wise et al., 2022), while these groups also tend to have an increased risk of readmission(Aubert et al., 2019). The interrelating association between risk factors and readmission could aggravate the burden on quality of life, leading to distress in treatment waiting times and potential decline in quality of care. Patient physical, social, emotional, and psychological wellbeing has not been widely documented in elective surgery literature.

Nevertheless, the increased barrier in outpatient care and appropriate self-management (Carter et al., 2019; Felix et al., 2015; Zumbrunn et al., 2022) imposed a probable strain on wellbeing with concerns of early discharge, complications, and missing treatment due to lack of postoperative assistance.

The research aims to examine sociodemographic profile of patients with elective admission led to comparison of those with and without avoidable hospital readmissions. To fill the current gap in elective admission and surgical complications associations in various populations, this study provides a broad epidemiological and sociodemographic analysis across multiple patient groups to investigate the impact of avoidable readmissions. The analysis aims to quantify the relationship between social determinants, financial and wellbeing factors to elective admissions using a retrospective cohort of Australian adults admitted to National Healthcare Agreement PI-23 on unplanned readmissions in 2018(Metadata Online Registry, 2018). Particular attention will be paid to how observed relationships vary among patients with and without readmission.

Apart from baseline analysis of all elective admitted episodes, four hypotheses were preformulated:

1. To examine differences in financial and wellbeing stress effect on individuals with complications and avoidable hospital readmissions versus those who do not.
2. To investigate the extent of variation in relation to age, gender, marital status, Indigenous status, cultural background, and other social determinants of individuals.
3. To evaluate how complications and variation explain the association of readmissions according to the type of elective procedures.

4. To quantify the impact of avoidable readmissions with a health economics comparison on length of stay and follow up sessions.

METHOD

Study design

We conducted a retrospective cohort analysis in Victorian hospitals covering elective admission episodes with admission dates from 1 June 2018 to 31 October 2022, using secondary de-identified data through the Centre of Victorian Data Linkage (CVDL).

Data source

We used linked data from the Elective Surgery Information System (ESIS) and the Victorian Admitted Episode Dataset (VAED), provided by the Centre for Victorian Data Linkage in reference to the ICD-10-AM codes. The ESIS dataset is a collection of elective surgery waiting list data from approved Victorian public healthcare providers at a patient-level(Victorian Department of Health, 2023a). It captures elective surgery admission in Australia, with data including hospital locality, insurance level and procedure identifier of an elective episodic event. The VAED dataset reports admitted patient episodes from all Victorian public and private hospitals, community services such as extended care facilities, rehabilitation, and day procedure centres(Victorian Department of Health, 2023b). It consists of admitted hospital patient data, including at least one index diagnosis code, admitted procedure codes, and sociodemographic details of patients. In terms of accuracy and relevance of data, the VAED captures readmission destination of the same hospital, without adjustments for patient-specific risk factors to identify variations across rates and support improvements in performance(Australian Commission on Safety and Quality in Health Care, 2019c). The reliability and completeness of the public hospital data provides a comprehensive reference

database for data reporting in elective surgery, complications, and avoidable readmissions primarily at a hospital level, with limited scope an individual level.

Record linkage

We included all patients who underwent elective admission from 1 June 2018 to 31 October 2022. Data on the elective surgical procedure type and elective surgery episodes were recorded in ESIS. The uniquely linked patient ID recorded data on admission or postoperative follow-up sessions in the hospital in VAED.

Data quality and cleaning

Each patient was assigned a unique linked patient ID and multiple admitted episode IDs across the ESIS and VAED datasets for each admitted episode. Admitted episode IDs were used for initial filtering to ensure that only the date and type of admission of interest were captured. Patients were linked across multiple datasets of diagnoses, costs, and comorbidities calculations, using a unique admitted episode ID. We only include admitted episodes with ID matched across all datasets (Appendix). Patients who underwent other surgical procedures, with missing admission date, procedure, or diagnosis code, with admission dates out of study period range, and involved selected surgical procedure other than index admission are excluded from this study.

Study Variables

The primary outcome of interest was PI-23-defined (Metadata Online Registry, 2018) readmissions within 28 days in reference to the principal procedure and diagnosis of index admission and readmission respectively. Principal procedures of interest under PI-23

definitions included “knee and hip replacement, tonsillectomy, adenoidectomy, hysterectomy, prostatectomy, cataract surgery and appendicectomy, represented in ICD-10-AM codes T80–88, E89, G97, H59, H95, I97, J95, K91, M96 or N99”(Metadata Online Registry, 2018). Patient demographics, wellbeing characteristics such as duration of stay and intensive care hours, and cost characteristics such as availability of insurance, direct and indirect cost to care are all outcome measures (Appendix 1) to examine financial and wellbeing impact among groups with and without avoidable readmissions.

Statistical Analysis

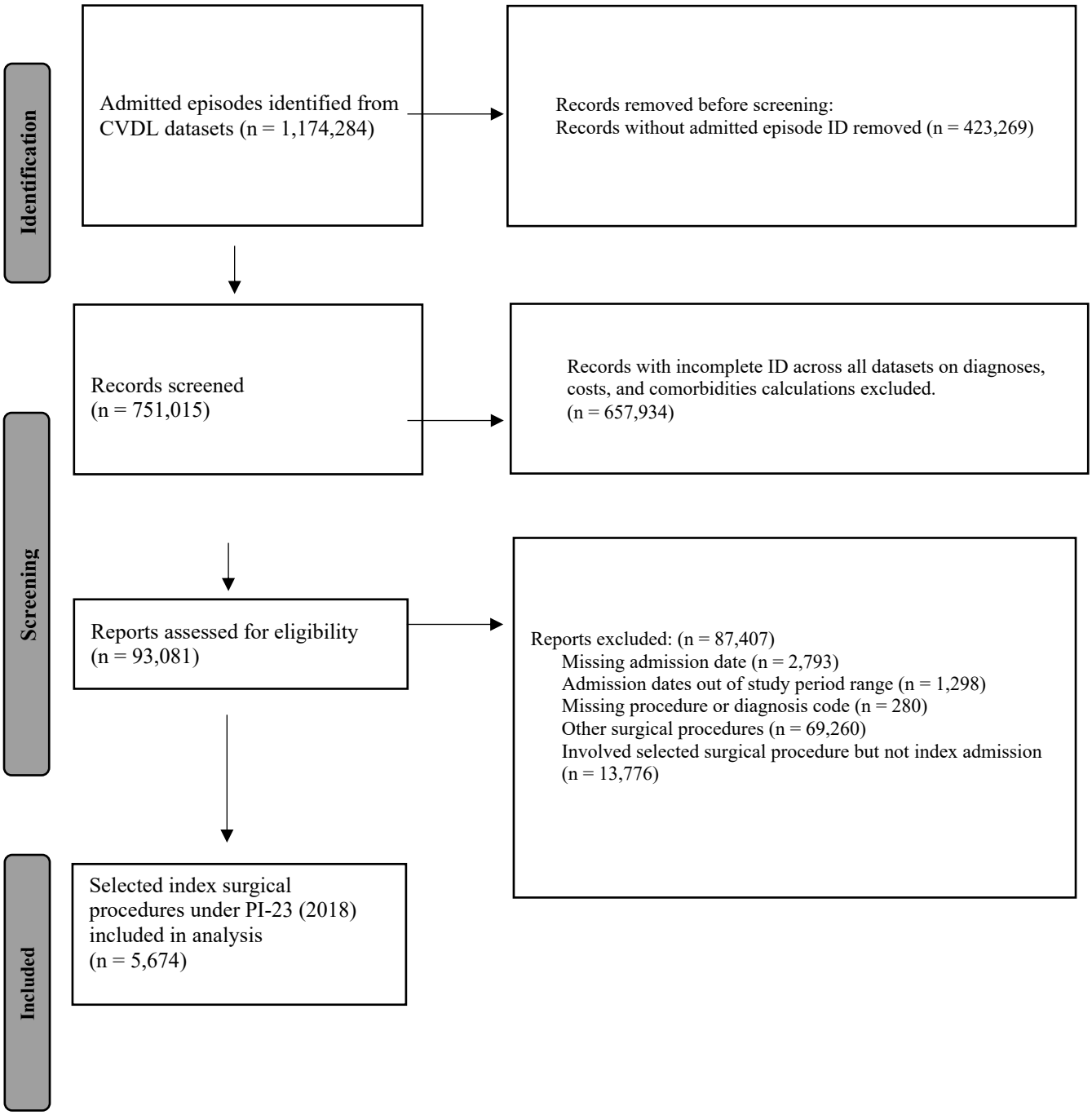
Analysis was performed by Stata 18 on Microsoft Remote Desktop in July 2023 on 5,674 patients with and without readmission. Descriptive statistics on demographics, type of surgery, and complications were presented as actual counts retrieved from the database, and percentages were calculated for each readmission group. Multivariable logistic regression was performed with continuous sociodemographic variables to identify risk associations between readmission groups. Only variables associated with outcomes with statistical significance at the $p<0.05$ level were considered. Data was presented with an adjusted odds ratio with 95% confidence level to reduce confounding by measured covariates. One-way ANOVA was conducted for continuous variables, including length of stay, intensive care hours and cost to care, to evaluate the effect of readmissions on mean differences between readmission groups. Apart from $p<0.05$ indicating statistical significance, we also considered interpretation of p-value as a continuous index of evidence(Andrade, 2019).

RESULTS

Out of 1,174,284 admitted episodes identified from CVDL datasets, 751,015 episodes with admitted episode ID in one of the datasets met the criteria for additional investigation. These episodes were then linked across multiple patient administrative datasets on diagnoses, costs, and comorbidities calculations (Appendix). Only admitted episodes with presence of unique ID matched across all datasets and with a principal diagnosis of elective surgery were included. Full matching of individual ID provided comprehensive framework of patient characteristics to ensure accurate review of episodes. Hence, a total of 93,081 admitted episodes were included. All ESIS or VAED records with admission or readmission dates before 1 June 2018 and after 31 October 2022 were excluded at this stage. Among the 93,081 admitted episodes of interest, 13,776 had procedures and diagnosis code related to elective surgical procedures, with 5,674 episodes treated as elective surgical admissions with the procedure codes under the National Healthcare Agreement: PI-23.

Among 5,674 patients who underwent selected procedures, the selection criteria returned 5,578 patients with elective surgical index and no readmission throughout the study period, regardless of days from admission date. A duplication checks on a unique linked person ID was used to validate the data. 96 readmissions satisfy the criteria with elective surgical index admission and primary readmission diagnosis ICD-10-AM codes within 28 days (Figure 1).

Figure 1. Patient selection flow chart



Descriptive statistics of patient characteristics

The proportion of patients over the age of 80 was higher in the readmission group (n = 30; 31.3%) compared to those who did not return (n = 300; 5.4%), followed by those aged 40-49 in the readmission group (n = 16; 16.7%) versus those had no readmission (n = 573; 10.3%). Certain age groups, such as those aged below 30, 30 to 39 and 60 to 79, have a higher proportion of patients who do not require readmission. Females comprised slightly more than half of each group with and without readmissions (n = 58; 60.4% versus n = 2,866; 51.5%). The percentages of separated marital status for both with and without readmission groups were 3.1% and 17.5%, respectively. The country of birth of patients who did not require readmission was primarily Australia (n = 4,344; 77.9%), and no interpreter was required in most episodes (n = 5,505; 98.7%), whereas 45.8% of readmitted patients were born overseas and 31.3% required an interpreter. Both groups had the same percentage of Indigenous patients.

The number of distribution of hospital type among groups varies; those with readmission were primarily from public hospitals (n = 87; 90.6%) without insurance (n = 82; 85.4%). Patients who did not require readmission had a similar distribution in terms of public hospital type (n = 2,972; 53.3%) and 48.4% had insurance. Less than 2.1% of readmission population was indicated with intention to readmit at admission, with a minimal number of patients under hospital in the home (n = 2; 0.02%), which compares to 1% of non-readmission population are in either situation. Almost half of the readmission population required mental health assistance (n = 44; 45.8%), whereas less than 0.5% of non-readmission population needed mental health support at admission (Table 1)

Table 1. Patient characteristics under selected elective surgical procedures from 1 June 2018 to 31 October 2022

Variables	Without Readmission (n = 5,578)	With Readmission (n = 96)
Gender		
Female	2,865 (51.36)	58 (60.42)
Male	2,713 (48.63)	38 (39.58)
Age years		
below 30	1,315 (23.57)	15 (15.62)
30-39	878 (15.74)	9 (9.38)
40-49	573 (10.27)	16 (16.67)
50-59	693 (12.42)	15 (15.62)
60-69	1,019 (18.27)	5 (5.21)
70-79	800 (14.34)	6 (6.25)
above 80	300 (5.38)	30 (31.25)
Marital status		
De facto	1,359 (24.36)	41 (42.71)
Married	3,242(58.12)	52 (54.17)
Separated	977 (17.51)	3 (3.13)
Country of birth		
Australia	4,344 (77.88)	52 (54.17)
Overseas/Unallocated	1,234 (22.12)	44 (45.83)
Indigenous status		
No/Unallocated	5,520 (98.96)	95 (98.96)
Yes	58 (1.04)	1 (1.04)
Interpreter Required		
No/Unallocated	5,505 (98.69)	66 (68.75)
Yes	73 (1.31)	30 (31.25)
Type of hospital		
Public	2,972 (53.28)	87 (90.63)
Private	2,606 (46.72)	9 (9.38)

Insurance Level		
Yes	2,697 (48.35)	14 (14.58)
No/unknown	2,881 (51.65)	82 (85.42)
Hospital in the home		
Yes	55 (0.99)	2 (0.021)
No	5523 (99.01)	94 (97.92)
Intention to readmit		
Yes	56 (1.00)	2 (2.08)
No	5522 (98.99)	94 (97.92)
Mental health support		
Yes	24 (0.43)	44 (45.83)
No	5554 (99.57)	52 (54.17)

Multivariable logistic regression

A multivariable logistic regression was performed to investigate the effects of patient characteristics on the risk of unplanned readmission (Table 2). Patient above 80, required an interpreter or mental health support were associated with an elevated risk of preventable readmissions.

Compared to patients who aged 30-39 as a reference, patients aged above 80 years (adjusted OR = 4.08, 95% Cl: 1.20-13.80, p = 0.024) were 4 times more likely to associate with unplanned admission. Furthermore, those who required an interpreter (OR = 9.65, 95% Cl: 3.17-29.33, p<0.001) or mental health assistance (OR = 72.81, 95% Cl: 35.29-150.19, p <0.001) were 9 and 73 times more likely to return to hospital respectively, indicated as the most significant factor for avoidable readmission.

However, the comparison between groups of Indigenous status, gender, country of birth, insurance level, intention to readmit at admission, and in the hospital in the home program (p>0.05) did not reach statistical significance.

Table 2. Multivariable logistic regression on patient characteristics and unplanned readmissions

Variables	Without Readmission (n = 5,578)	With Readmission (n = 96)	p-value	Adjusted Odds Ratio (95%CI)
Gender				
Female	2,865 (51.36)	58 (60.42)		Ref.
Male	2,713 (48.63)	38 (39.58)	0.443	1.23 (0.73-2.07)
Age years				
below 30	1,315 (23.57)	15 (15.62)	0.69	0.83 (0.33-2.08)
30-39	878 (15.74)	9 (9.38)		Ref.
40-49	573 (10.27)	16 (16.67)	0.077	2.24 (0.92-5.45)
50-59	693 (12.42)	15 (15.62)	0.097	2.18 (0.87-5.47)
60-69	1,019 (18.27)	5 (5.21)	0.965	1.03 (0.32-3.25)
70-79	800 (14.34)	6 (6.25)	0.299	1.84 (0.58-5.83)
above 80	300 (5.38)	30 (31.25)	0.024	4.08 (1.20-13.80)
Marital status				
De facto	1,359 (24.36)	41 (42.71)		Ref.
Married	3,242(58.12)	52 (54.17)	0.096	1.83 (0.90-3.73)
Separated	977 (17.51)	3 (3.13)	0.1	0.18 (0.023-1.39)
Country of birth				
Australia	4,344 (77.88)	52 (54.17)		Ref.
Overseas/Unallocated	1,234 (22.12)	44 (45.83)	0.445	0.77 (0.39-1.51)
Indigenous status				
No/Unallocated	5,520 (98.96)	95 (98.96)		Ref.
Yes	58 (1.04)	1 (1.04)	0.773	1.35 (0.18-10.26)

Interpreter Required				
No/Unallocated	5,505 (98.69)	66 (68.75)		Ref.
Yes	73 (1.31)	30 (31.25)	<0.001	9.65 (3.17-29.33)
Type of hospital				
Public	2,972 (53.28)	87 (90.63)	0.096	2.24 (0.87-5.78)
Private	2,606 (46.72)	9 (9.38)		Ref.
Insurance Level				
Yes	2,697 (48.35)	14 (14.58)		Ref.
No/unknown	2,881 (51.65)	82 (85.42)	0.071	2.02 (0.94-4.34)
Hospital in the home				
Yes	55 (0.99)	2 (0.021)	0.231	2.50 (0.56-11.22)
No	5523 (99.01)	94 (97.92)		Ref.
Intention to readmit				
Yes	56 (1.00)	2 (2.08)	0.134	3.49 (0.68-17.87)
No	5522 (98.99)	94 (97.92)		Ref.
Mental health support				
Yes	24 (0.43)	44 (45.83)	<0.001	72.81 (35.29-150.19)
No	5554 (99.57)	52 (54.17)		Ref.

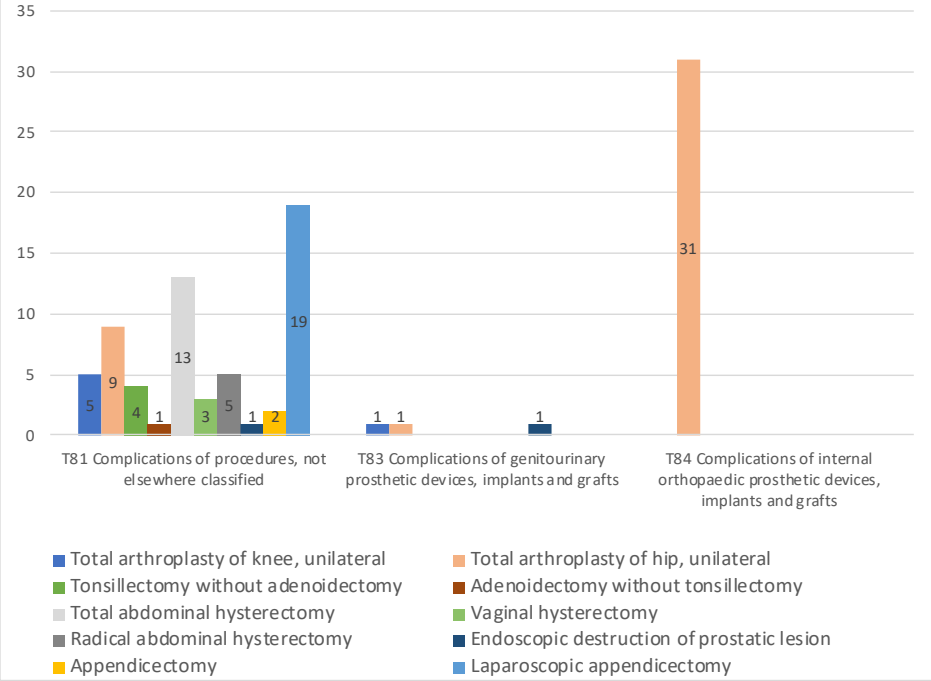
Reasons of unplanned readmissions

In reference to the ICD-10-AM codes (Independent Health and Aged Care Pricing Authority, 2024; World Health Organisation, 2020) (Appendix 2), T81 complications of the procedure (n = 62) were the most common reason for readmission (n = 96), followed by T84 complications of the internal orthopaedic prosthetic device, implants, and grafts (n = 31) and T83 complications of genitourinary prosthetic devices, implants, and grafts (n = 3) (Table 3). Total hip arthroplasty had the highest incidence of complications (n = 40) among all index-selected procedures, followed by total knee arthroplasty (n = 19) and total abdominal hysterectomy (n = 13). Total hip arthroplasty accounted for all T84 complications during the study period (Figure 2).

Table 3. Type of complications in unplanned readmissions under PI-23 (n = 96)

Variables	n	Percentage
T81 complications of the procedure	62	65%
T83 complications of genitourinary prosthetic devices, implants, and grafts	3	3%
T84 complications of the internal orthopaedic prosthetic device, implants, and grafts	31	32%

Figure 2. Type of principal procedure in complications under PI-23 (n = 96)



ANOVA analysis on wellbeing: length and stay and hours of intensive care

One-way ANOVA was used to compare the effect of readmissions on length of stay (LOS) and hours of intensive care. There were two groups of participants: without readmission (n = 5,578) and with readmission (n = 96). The mean value of LOS and intensive care hours in the readmission group were higher than the non-readmission group (16.45± 0.399 days and 16.86 ± 11.92 hours). However, only LOS reached statistical significance ($F_{1,5,672} = 1691.66$, $p<0.001$) while intensive care hours did not demonstrate statistical significance ($F_{1,87} = 2$, $p = 0.161$). While interpreting p-value as a continuous index of evidence, the most likely interpretation was that intensive care hours in readmission might not be better or worse than without readmission(Andrade, 2019), which the extra 11.92 intensive care hours possibilities were also compatible with the data recorded in this study.

ANOVA analysis on cost: direct and indirect costs to care

Cost analysis only included episodes with no missing expense fields (n = 68); patients were categorised into readmission (n = 44) and non-readmission group (n = 24). A one-way ANOVA was performed to assess the impact of readmissions on the cost to care. The readmission group reported statistical significantly higher mean direct and indirect costs compared to the non-readmission group ($74,908.87 ± $12,272.50 and $15,058.47 ± $2,252.37). Both cost comparisons between groups reached statistical significance ($p<0.001$). As a parameter involved in readmission, indirect cost ($F_{1,66} = 44.7$, $p<0.001$) had a more significant effect than direct cost ($F_{1,66} = 37.26$, $p<0.001$).

Readmission and cost to care

Figures 3 and 4 depict the cost-type distribution of care with readmission. In terms of direct cost, allied health cost had the highest increase variation ($56.6 versus $3,029.4) for readmission, followed by nursing cost ($806.8 versus $16,031.5). The only outlier was the cost of a non-operating theatre room ($105.3 versus $23.5), which patients who did not require

readmission paid more than those who did. Regarding indirect costs, patients who required readmission incurred higher expenses in every category. Similar to direct costs, allied health had the highest increase variation due to readmission ($6.7 versus $536.8), followed by administration ($111.5 versus $2,720.1) and nursing ($125.6 versus $1761.6).

Figure 3. Direct cost to care and readmission (n = 5,674)

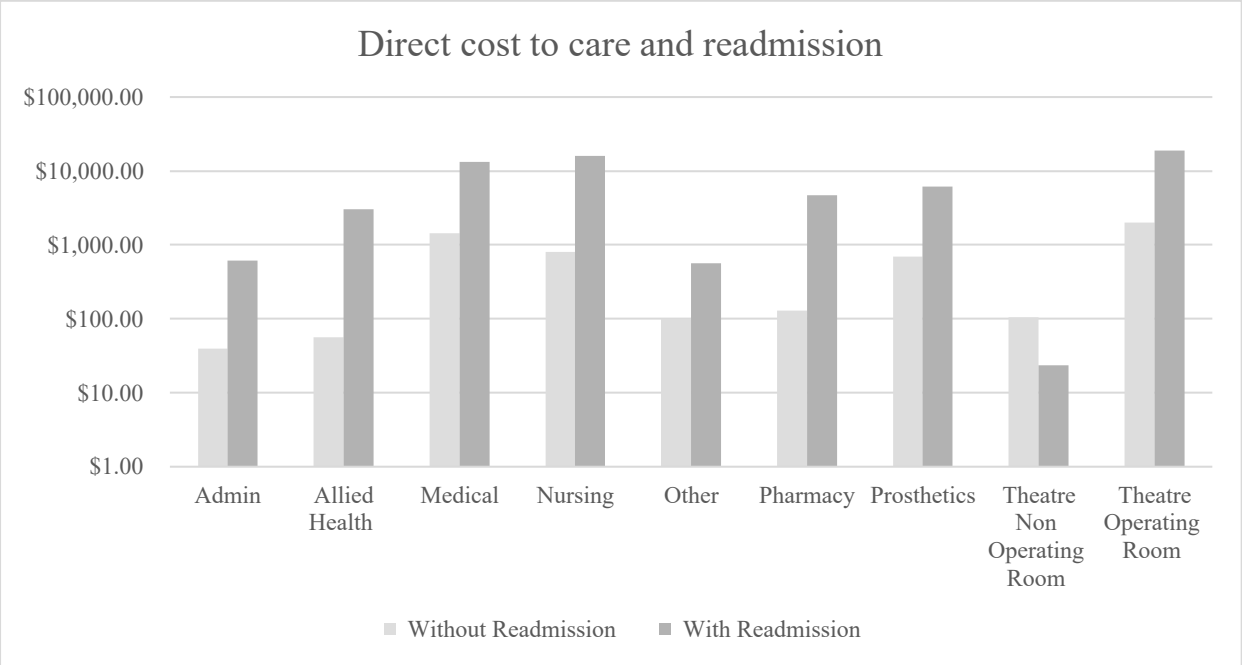
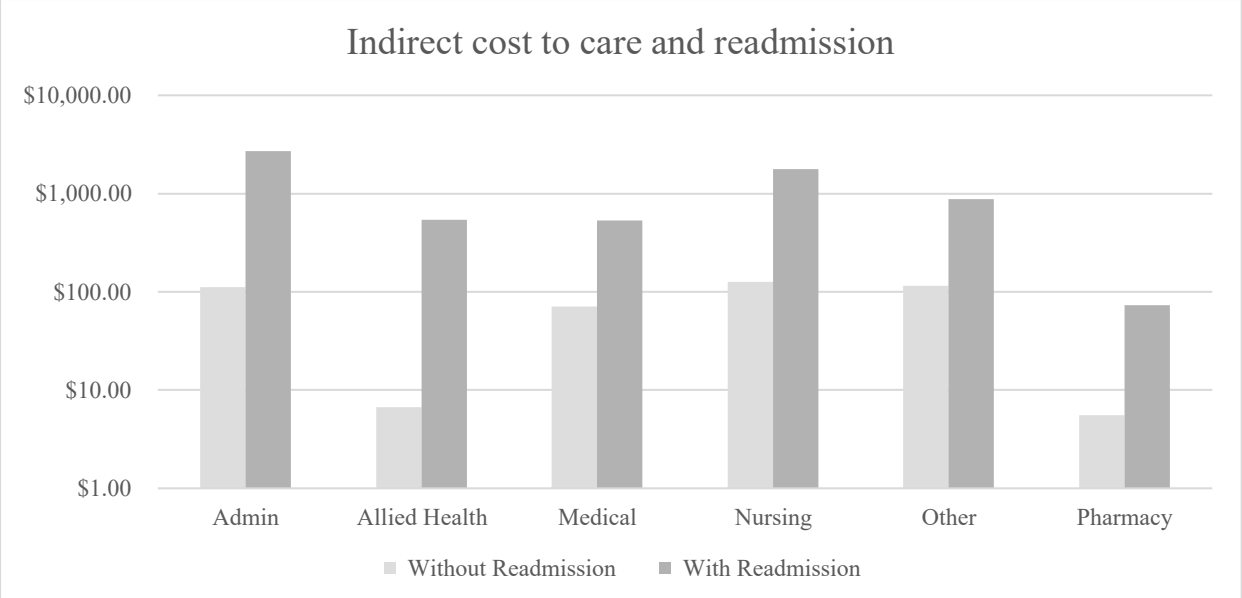


Figure 4. Indirect cost to care and readmission (n = 5,674)



DISCUSSION

The objective of this study was to better understand the epidemiology of unplanned readmission in elective surgical procedures by examining risks through sociodemographic characteristics financial and wellbeing factors among patient groups. As one of the rare studies focusing on the consequences of 28-day readmissions, our main findings further contribute to knowledge about hospital readmissions.

Risk factors and unplanned readmission

While extensive research has concentrated on various aspects of unplanned readmissions, limited studies have revealed the relationship between sociodemographic factors and the risk of readmission under PI-23 definition. Our study showed that of 5,674 patients who received selected surgical procedures, 96 (1.7%) had unplanned 28-day readmission, presenting an average among all selected procedures in Victoria. An overview of demographic distribution concluded females (60.4%) had a greater contribution in the readmission group, while gender distribution was reasonably balanced in the non-readmission group. The percentage of patient who was born in Australia was higher in the non-readmission group (77.9%), and most of them do not requiring an interpreter (98.7%), compared to only slightly more than half of the patients in the readmission group was born in Australia (54.2%) and required an interpreter (68.8%).

A multivariable logistic regression analysis explored the relationship between variables and readmissions. The findings demonstrated that aged over 80, required an interpreter, or mental health assistance were all prominent reasons for unplanned readmissions. Further investigations could concentrate on the communication of follow-up support, examining the scope of assistance provided to measure whether information has been delivered adequately to suit the needs of various stakeholders such as patients and their carers from different age and cultural groups.

Total hip and knee arthroplasty were the primary index admissions with the highest readmission rates observed, while internal orthopaedic prosthetic devices, implants, and grafts were the prevalent causes of complications. Sociodemographic factors indicated statistically significant odds and emerging associations with hospital readmission. For instance, population aged over 80 will grow by more than 220% by 2047 in Australia (Ludbrook, 2022) tend to have an extended LOS (Eskandari et al., 2022), which was also validated by this study that readmission is closely associated with ageing population and prolonged length of stay.

Some sociodemographic variables also demonstrated a substantial rise in odds of readmission. However, there were no statistically significant variations between groups based on gender, Indigenous status, country of birth, insurance level, whether the patient is in the hospital in the home program, or any intention to readmit during admission. This result interestingly contradicted the findings that patients in surgical units with a higher Charlson Comorbidity Index, use of medications and under Hospital In The Home were known to have increased odds of readmission (Glans et al., 2020), similarly to increased risk of early readmissions in indigenous Australians (Sharma Y., 2018). However, the readmission rate in other studies may not represent the same set of surgical procedures as PI-23 in this study, which general elective surgery like total knee arthroplasty was precisely categorised into distinct procedure codes to represent unilateral, bilateral, and total arthroplasty. Even if the same set of procedures were implemented, odds may vary due to evolving policy or classification schemes over time, affecting the readmission rate. With multiple procedures, factors and complications leading to readmissions, this study focused on PI-23 avoidable readmission. Common reasons for general surgical readmission were pain, readmission due to the same diagnosis and surgical site

infections. More than half of readmissions involve continuing medical care after the initial admission (Chidambaram R., 2022).

Given the wide range of PI-23, only three (T81, T83, and T84) out of 20 complications were observed, which may due to the majority of orthopaedic surgery followed by abdominal hysterectomy (Metadata Online Registry, 2018). Further investigation should explore data across a broader timeframe and population to examine the extent of association of other factors on specific type of complications.

Cost implications

Hospital cost was estimated from data provided by the CVDL under Victorian Cost Data Collection (VCDC) using admitted diagnosis-related groups (DRG) with the standard weighted inlier equivalent separation (WIES), acted as a reference point for a given financial year. The calculation reflected the cost of a single care episode in comparison to the average cost across all episodes (Lee et al., 2022).

In terms of the hospital expenses incurred by patients, the only outlier between groups was the cost of a non-operating theatre room. All other costs and the overall average cost was significantly greater in readmission ($97,747) compared to non-readmission ($7,779). The finding was similar to the view that hospital harm significantly increased length of hospital stay and costs (Lauren et al., 2019), especially in intensive care unit (Kannan et al., 2023). Readmitted patients generated 7940% more indirect allied health costs, which typically results in a longer recovery period or follow-up referrals in both the hospital and community. The reason for the inflated administrative and nursing costs may be related to the additional resources and data collection required at hospital readmission. For instances, nurses rather than

surgeons performed wound management tasks like dressing changes, monitoring, and evaluation.

The multivariable logistic regression and descriptive analysis revealed that while more than 90% of readmitted patients were linked to public hospitals, insurance status did not indicate a higher likelihood of readmission with statistical significance. Most of the care in Victoria's public hospitals is provided at no cost to all Australians, with more than 80% of citizens and permanent residents obtain a Medicare insurance benefit annually (Harris B., 2019) including coverage in the hospital clinical services, medication, hospital accommodation, doctors' and specialists' fees and operating theatre expenses(Victorian Department of Health, 2015). In contrast, private patients can choose their own specialist and insurance coverage. Given that most of the readmission group (85.42%) lacked health insurance, there may be additional out-of-pocket expenses that they are liable for apart from the greater hospital direct and indirect costs. Due to finite knowledge particularly in specific surgical groups, future investigation can investigate the relationship of hospital type and insurance level to obtain more information regarding patient costs in each setting. For instance, a comparative discussion can examine postoperative care and discharge preparation between public and private hospitals to ascertain stages of patient journey that affect the likelihood of readmission. Further research can determine factors associated with cost to care, effectiveness on level of care from various perspectives understand more about treatment experience.

Wellbeing implications

In the context of findings that hospitalisation negatively affects wellbeing of patients and carers(Alzahrani, 2021), this study compared readmission groups and presented hospitalisation as the type of hospital, length of stay (LOS) and intensive care hours. Intensive care units tend

to lead to higher cost when comparing patients in and not in ICU(G. C. Wilson et al., 2015), this study showed intensive care hours tend to be 16.9 times more in the readmission group, but with insufficient statistical significance, we can't conclude it is one of the factors leading to readmission; more research is required to reconcile these differences. The ANOVA analysis demonstrated an extended mean length of stay of 16.45 days in readmission group with statistical significance, which could increase wellbeing burden while adjusting to postoperative changes, in linkage to financial stress such as missed workdays and the need of a carer.

Given that an extended LOS can exacerbate anxiety and increase feelings of expression(Alzahrani, 2021), it could further impact people who required mental health assistance as comorbidities or concerns before admission. In this study, mental health assistance required in index admission refers to patients who previously received, referred to, or potentially needed psychiatric, psychological, or mental health-related treatments or services. The multivariable logistic regression analysis reflected a significant association between the requirement of mental health assistance and readmission, supporting an extended view that patients with mental illness as comorbidity had incurred more bed days(Crossley & Sweeney, 2020; Siddiqui et al.). Other study concurred on the importance for effective and efficient communication between general practice and mental health services on care delivered to postoperative patients(Zhou et al., 2023). Wellbeing concerns for readmission groups can arise in delay or lack of follow-up assistance, premature discharge(Eric Alper, 2023), insufficient community care, and inadequate support for vulnerable groups or patients with comorbidities, which is particularly relevant during transition of care, whether the information was explained thoroughly by healthcare professionals to patients or was shared among healthcare professionals to ensure comprehensive care.

Only 66 out of the 5,578 admitted episodes considered comorbidities, such as diabetes, cellulitis, or social behaviours like alcohol and tobacco use, homelessness, and family violence. Due to extensive missing fields with no information provided, identification of comorbidities was out of the study scope, preventing conclusions about how comorbidities and other adverse events affect readmission rates. Since few studies focused exclusively on patient wellbeing following specific surgical procedures, additional studies could help assess the size of the burden patients must bear. Perhaps a qualitative study is beneficial to collect feedback beyond a standardised quantitative survey, allowing the provision of adequate support in a diverse patient group. It is worthwhile to also consider socioeconomic characteristics such as employment status, education, and income level to comprehend the factors affecting mental and psychological health and readmission.

Strengths and Limitations

The main advantage of obtaining data directly from the hospital system via CVDL and data linkage was routinely recorded, which provided validity and comparability across admitted episodes with various backgrounds and comorbidities over time. This study is one of the few analyses that provided an objective comparative analysis under PI-23, specifically with elective surgical admission.

There are several limitations to this study. Different data collection methods used by various staff members could result in a primary diagnosis code error, a person ID that was incorrectly linked, or missing fields. Some elective procedures were thought of as day surgery with no expectation of readmission, so only information that was deemed mandatory may have only been collected during the initial admission, resulting in missing information in the dataset.

Due to incomplete fields in cost and wellbeing measurements of episodes, only 68 out of the 5,674 episodes contained comprehensive data for those analysis. As previously mentioned, the case mix funding method with weighted inlier equivalent separation (WIES) was used to estimate admitted episode costs from the hospital database to determine the average cost of care. Therefore, rather than having an exact estimation value, there is a chance that a patient with a comparable demographic had undergone the same type of surgery with an equivalent amount of stay, resulting in an identical average cost. Therefore, if a patient was transferred to care in the community or readmitted, further investigation needs to be made on those costs. Similar to cost, there were 68 wellbeing episodes available for analysis, but neither the readmission (n = 44) nor the non-readmission (n = 24) groups had any cases indicated by the Charlson Comorbidity Index variable. Missing fields prevented comorbidities index and conditions like cellulitis and diabetes from being sufficiently representative to compare as there was no true case for comparison to the remaining selected episodes in the cohort. There was little information available for other factors, such as those involving alcohol, tobacco, homelessness, and family violence due to undefined records leading to unclear outcomes.

Only patients who undergone a limited range of surgical elective procedures by the PI-23 were covered in this study. With the Australian Government's decision to suspend elective surgery from 1 April 2020 to 28 February 2022 in both public and private hospitals due to COVID-19 (Premier of Victoria, 2022), it may have reduced the sample size for particular procedures and limited the complications observed to those connected to specific admitted episodes. In multivariable logistic regression, the odds ratios for variables lied between indicated range. The confidence levels of variable such as mental health services were however wide, which indicated the sample size was rather small, but result did not occur due to chance and was statistically significant ($p<0.05$). Additional investigation is also necessary to fully

comprehend treatment referral or access after discharge as the database is not intended to evaluate impacts of socioeconomical factors, such as family and social assistance in treatment journey.

Since allied health services were the primary factor in the rise of hospital expenses due to readmission, future research can continue to examine community health services costs after discharge to investigate the cost to care beyond the hospital level. Due to the nature of the database, linked person ID referred to hospital patients only. Patient tracking can be challenging if a patient receives follow-up care in the community or at a private hospital, such as returning to aged care nurses and allied health professionals for wound care. Based on the current knowledge gaps, this is particularly concerning for vulnerable groups such as those who require an interpreter, without a Medicare card or hospital insurance, require mental health assistance, and older population who might face extensive financial and wellbeing burden after discharge. Further research from the perspective of the readmitted patient is required to obtain a complete picture.

CONCLUSION

This study demonstrates major trends in the adjusted odds of unplanned readmission among various factors. With a highlight of selected surgical procedures, the study examines the distribution of surgery type, complications, magnitude of wellbeing and cost implication by comparing readmission and non-readmission groups.

Concerning the factors contributing to high odds of readmission, future policymakers can tailor preventative programs on complications for specific cohorts to facilitate health equity and literacy. The older population might need further preventive measures when undergoing

elective surgery with increased attention in follow-up care. Patients who require an interpreter will need further assistance in admission and discharge communication with interpreters and translators, language support to ensure understanding of care information. Communication, such as discharge summary between health professionals from different settings, are also required to be accurate to ensure all-rounded care is provided to patients with vulnerable needs such as mental health concerns.

Following the high costs of allied health for readmission groups, rather than merely concentrating on hospitalisation costs, further research could emphasize on out-of-hospital journeys by examining recovery care with allied health professionals such as physiotherapists and psychologists in discharge locations like community health centres, rehabilitation services, private practices, and aged care facilities. Further assessment of the type of insurance and insurance coverage will assist in estimating out-of-pocket costs of patients during admission or leaving the hospital for care.

The study provides a clear guide on patients from a particular sociodemographic background and their risk of avoidable readmissions, providing input on what could be done in the future to focus on these patients to reduce readmission. To contextualise findings, the results can be used to reflect the importance of health equity on patients' needs and demographics, the potential to tailor better care in providing treatment and knowledge about risk factors. This study conducted readmission analysis only applies to a specific group under PI-23; another type of readmission may have various outcomes or associations with different factors. Large-scale studies should be conducted to evaluate the total burden of unplanned readmissions from patient’s perspective.

APPENDIX 1 – Variables of interest

Variables	Description
Gender	Female/Male
Age (years)	Age in years (below 30, 30-39, 40-49, 50-59, 60-69, 70-79 or above 80)
Marital status	De facto/Married/Separated
Country of birth	Australia/Overseas/Not stated
Indigenous status	Australian Aboriginal and/or Torres Strait Islander origin (Yes/No/Not stated)
Interpreter required	Interpreter requirement indicatetd at initial admission (Yes/No/Not stated)
Type of hospital	Type of hospital (Public/Private)
Insurance level	Presence of patient's insurance election, for a given episode (Yes /No)
Hospita in the home	Indication of care under Hospital In The Home (HITH) program of the Department of Health, Victoria: *admitted care in the comfort of the patient's home or other suitable location (Department of Health, 2024)* at initial admission
Intention to readmit	The intention of the responsible clinician, at the time of the patient's separation from hospital, to readmit the patient within 28 days.
Mental health support	Mental health support requirement indicated at initial admission
Type of complications	Reported in CVDL dataset under ICDDiagnosisCode in reference to ICD-10-AM codes
Type of principal procedure	Reported in CVDL dataset under ProceduresConcatenated in reference to ICD-10-AM codes
Length of stay	Reported in days in CVDL dataset
Intensive care unit hours	Reported in hours in CVDL dataset
Direct hospital cost	Total of administrative, allied health, medical, nursing, pharmacy, prosthetics, theatre (non operating and operating room) and other costs categorised in VAED dataset
Indirect hospital cost	Total of administrative, allied health, medical, nursing, pharmacy and other costs categorised in VAED dataset

APPENDIX 2 – ICD-10-AM codes (Independent Health and Aged Care Pricing Authority, 2024; World Health Organisation, 2020)

T81 complications of the procedure**, T83** complications of genitourinary prosthetic devices, implants, and grafts and **T84** complications of the internal orthopaedic prosthetic device, implants, and grafts

ICD-10-AM code	***ICD-10-AM code descriptor of map***
T81.0	*Haemorrhage and haematoma complicating a procedure, not elsewhere classified*
T81.1	*Shock during or resulting from a procedure, not elsewhere classified*
T81.2	*Accidental puncture and laceration during a procedure, not elsewhere classified*
T81.3	*Disruption of operation wound, not elsewhere classified*
T81.4	*Wound infection following a procedure, not elsewhere classified*
T81.5	*Foreign body accidentally left in body cavity or operation wound following a procedure*
T81.6	*Acute reaction to foreign substance accidentally left during a procedure*
T81.7	*Vascular complications following a procedure, not elsewhere classified*
T81.89	*Other complications following a procedure, not elsewhere classified*
T81.81	*Complication of inhalation therapy*
T81.82	*Persistent postprocedural fistula, not elsewhere classified*
T81.83	*Pain following a procedure, not elsewhere classified*
T81.84	*Postprocedural emphysema*
T81.9	*Unspecified complication of procedure*
T83.0	*Mechanical complication of urinary (indwelling) catheter*
T83.1	*Mechanical complication of other urinary devices and implants*
T83.2	*Mechanical complication of graft of urinary organ*
T83.3	*Mechanical complication of intrauterine device*
T83.41	*Mechanical complication of other prosthetic devices, implants and grafts in male genital tract*
T83.42	*Mechanical complication of other prosthetic devices, implants and grafts in female genital tract*
T83.5	*Infection and inflammatory reaction due to prosthetic device, implant and graft in urinary system*
T83.61	*Infection and inflammatory reaction due to prosthetic device, implant and graft in male genital tract*
T83.62	*Infection and inflammatory reaction due to prosthetic device, implant and graft in female genital tract*
T83.89	*Other specified complications of genitourinary devices, implants and grafts*
T83.81	*Haemorrhage and haematoma following insertion of genitourinary prosthetic devices, implants and grafts*
T83.82	*Embolism and thrombosis following insertion of genitourinary prosthetic devices, implants and grafts*
T83.83	*Pain following insertion of genitourinary prosthetic devices, implants and grafts*
T83.84	*Stenosis following insertion of genitourinary prosthetic devices, implants and grafts*

T83.85	*Erosion of genitourinary mesh and other prosthetic materials*
T83.9	*Unspecified complication of genitourinary prosthetic device, implant and graft*
T84.0	*Mechanical complication of internal joint prosthesis*
T84.1	*Mechanical complication of internal fixation device of bones of limb*
T84.2	*Mechanical complication of internal fixation device of other bones*
T84.3	*Mechanical complication of other bone devices, implants and grafts*
T84.4	*Mechanical complication of other internal orthopaedic devices, implants and grafts*
T84.5	*Infection and inflammatory reaction due to internal joint prosthesis*
T84.6	*Infection and inflammatory reaction due to internal fixation device [any site]*
T84.7	*Infection and inflammatory reaction due to other internal orthopaedic prosthetic devices, implants and grafts*
T84.89	*Other specified complications following insertion of internal orthopaedic prosthetic devices, implants and grafts*
T84.81	*Haemorrhage and haematoma following insertion of internal orthopaedic prosthetic devices, implants and grafts*
T84.82	*Embolism and thrombosis following insertion of internal orthopaedic prosthetic devices, implants and grafts*
T84.83	*Pain following insertion of internal orthopaedic prosthetic devices, implants and grafts*
T84.84	*Stenosis following insertion of internal orthopaedic prosthetic devices, implants and grafts*
T84.85	*Metallosis following insertion of internal orthopaedic prosthetic devices, implants and grafts*
T84.9	*Unspecified complication of internal orthopaedic prosthetic device, implant and graft*

5.3 Chapter summary

This chapter described the findings of a published manuscript that provided a quantitative overview of characteristics in elective surgery, patients and cost to care in Australia. The results demonstrated prominent factors for unplanned readmissions were aged over 80 (OR= 4.08, 95% Cl: 1.20-13.80, p=0.024) requiring an interpreter (OR= 9.65, 95% Cl: 3.17-29.33, p<0.001) or mental health assistance (OR= 72.81, 95% Cl: 35.29-150.19, p<0.001). Among a cohort of 5,674 patients, 96 (1.7%) had unplanned PI-23 readmission, with orthopaedic surgery as the highest chance of readmission. Avoidable readmission led to an overall average cost of $97,747 and mean extended length of stay of 16.45 days, implicating financial and wellbeing impacts on patients. The next chapter qualifies treatment experience on postoperative care from the perspectives of patient, carers and clinician, aiming to better understand elective surgery consequences and journey after hospital discharge.

CHAPTER 6: POSTOPERATIVE EXPERIENCE OF PATIENTS AND CLINICIANS IN AUSTRALIA

6.1 Chapter introduction

This chapter includes a published article (Manuscript III) that assessed postoperative care experience of elective surgery patients after hospital discharge. As discussed in the literature gaps (Chapter 2), there was limited study on qualitative feedback from perspective of patients on financial and wellbeing consequences beyond the hospital viewpoint. This mixed-methods study evaluated treatment experience from patients and relevant stakeholders to identify evidence to enhance the efficiency, quality, and equity of postoperative care.

6.2 Manuscript #3

Author Contributions: The initial draft of the manuscript was written by Yoey Gwan Venise Hon, with expertise and academic input from Prof. Andrew Hayen and Dr. Daniel Demant. All authors reviewed and approved the final version of the manuscript.

A mixed-methods study of elective surgery experience of patients and clinicians in Australia

Yoey Gwan Venise Hon[1], Daniel Demant[1,2], Andrew Hayen[1]

[1]School of Public Health, Faculty of Health, University of Technology Sydney
[2]School of Public Health and Social Work, Faculty of Health, Queensland University of Technology, Brisbane, Australia

Abstract

Objective: Level of communication and involvement of patients and clinicians highly associate with elective surgery experiences. In this study, the authors aim to better understand postoperative journey by mapping across patient pathway and clinician insights to dissect potential enhancements in surgical care benchmarks.

Methods: Two open-ended surveys examined treatment experience with elective surgery and complications admission were completed by adult patients and clinicians between 2018 and 2023. Participants were invited via email lists, social media, patient forums, and flyers distributed in hospital and community care noticeboards. Descriptive statistics and Pearson chi-square test were implemented for quantitative data with Stata 18 and Microsoft Excel. Inductive thematic analysis was conducted for qualitative data with NVivo 12.

Results: Clinicians who completed the survey were primarily registered nurses (9/22, 40.9%) or based in public hospitals (6/22, 27.3%). Most patients undertook hip replacement (7/20, 35%) or had complications within 90 days post-operation (7/20, 35%), which could result in at least $4041.96 in out-of-pocket expenses for each elective surgery episode in a public hospital. The patient survey revealed several key topics: financial coverage, work leave, communication, and care access. Themes identified in the clinician survey included the impact of complications, postoperative mapping, time cost to care, well-being concerns and antibiotics usage. The respondents raised general challenges and potential improvements in care provision, such as the degree of care offered to patients regarding social, clinical, and financial assistance and the level of assistance provided to clinicians.

Conclusion: Non-English-speaking backgrounds and in public hospitals were associated with a higher risk of complications. Prolonged recovery may create distress due to additional follow-up and increased out-of-pocket costs. Prioritising patient education during discharge and optimising handover between health providers across services could improve early and effective complications diagnosis.

Keywords
Elective surgery, patient experience, clinician experience, surgical complications, postoperative care

Declaration of interest
None

Ethics
This study was approved by the University of Technology Sydney Health and Medical Research Ethics Committees (Ref. ETH22-7180 and ETH23-8031) on 2/8/2022 and 11/7/2023 respectively.

INTRODUCTION

Elective surgery is planned surgery booked in advance after it is deemed medically necessary by a specialist after clinical assessment (State of Victoria, 2023). It may be classified to various levels of urgency but excluding those conducted due to emergency presentation (Australian Institute of Health and Welfare, 2024a). According to the Australian Institute of Health and Welfare, most elective procedures performed in Australia are undertaken in private hospitals. In 2022-23, 735,500 patients were admitted to public hospital elective surgery waiting lists, with general surgery as the most common surgical specialty. Analyses have demonstrated disparities in association of sociodemographic on elective surgery and complications. At perioperative stage, higher waiting times were found in general elective speciality, particularly among Indigenous Australians (Australian Institute of Health and Welfare, 2024a). Poor patient outcomes are also common after inpatient surgery (The International Surgical Outcomes Study Group, 2016). Women, age, comorbidity, surgical severity, and duration were risk factors of extended hospital stays, severe complications, re-admissions, and deaths(Reilly et al., 2022). Global studies indicated more than 16% of elective patients developed one or more postoperative complications(The International Surgical Outcomes Study Group, 2016), with an estimated 25% overall complication rate (Ghaferi et al.). Apart from increased hospitalisation cost and decreased days survive at home(Reilly et al., 2022), complication could also lead to a triple increase in annual mortality rate(Fowler et al., 2022). In Australia and New Zealand, 44.3% of unplanned readmissions to intensive care unit were the result of elective surgeries, occupying more than 15% of total bed days, leading to a 14.5% increase of hospital mortality compared to patients without adverse events (Emerson et al.).

Current literature focused on the perioperative and intraoperative phases of elective surgery, with several postoperative studies emphasising the quantitative impact of complications to the health systems at a population level. A perioperative study in the Netherlands on hand and wrist surgical patients identified insecurity, staff reassurance, loneliness, and a lack of information were negatively associated with the overall patient journey. Lack of control was the most prominent feeling prior to surgery, followed by acceptance and curiosity during surgery, and relief as the dominant experience following surgery (Ridder et al., 2018). Regarding care provision experience by clinicians, an Australian public hospital study demonstrated treatment experience indicators

such as hospital-initiated postponement rates and length of stay in elective surgery care can be improved by establishing a separate elective surgery facility (Lowthian et al.), with a focus on redesigning the clinical process in perioperative services. An intraoperative survey on neurosurgical treatment experience revealed staff are more confident while agreeing that there were no adverse effects on surgical outcomes on the day of surgery admission. Overall, 79% of patients reported satisfaction to theatre acceptance times (Sofela et al., 2013), with limited further investigation emphasized on actual adverse effects after surgery.

Recent research mainly aimed to understand the effects of surgery, define appropriate levels of perioperative care (The International Surgical Outcomes Study Group, 2016) and preventive measures on complications by focusing on quantitative assessment, such as patient-reported outcome measures from a health system's perspective. However, there was limited qualitative discussion on postoperative care, which also contributes a significant part of the surgical recovery journey. International studies consistently view experience in the hospital setting rarely consider patient-centred care as treating patients as unique individuals according to sociodemographic and values.

According to global studies on quantitative measures of patient wellbeing, level of communication and trust with health providers were associated with around 6% lower likelihood of reported complications (Black et al., 2014), improving nursing practice and having a certain level of independence in making decisions based on accurate information can help patients positively perceive their hospital experience (Bavin, 2023). In a Swedish interview study, patients admitted for elective procedures expressed an interest in meaningful involvement in their care in terms of communication with healthcare professionals and continuity of care. Patients, however, require more guidance on how to actively participate in their care, as factors such as ability, willingness, and lack of experience can all influence involvement (Unbeck et al.). Hence, this study aims to fill the gap by associating the trend and impact of postoperative care in Australia, by collecting qualitative responses from both patients and clinicians who are involved in the treatment process. Apart from examining information with a quantitative model on sociodemographic data and wellbeing of patients, a primary focus will be on feedback from an individual level to determine

issues encountered by patients and treatment providers in postoperative journey to better tailor care in the future.

To the best of our knowledge, no mixed-methods study has been conducted in Australia to describe overall treatment experiences, particularly lacking qualitative input from patients and clinicians on postoperative care in elective surgical procedures. Current clinician feedback analyses are mainly concerned with waiting times and improving hospital efficiency and quality of care, with limited understanding of post-surgery satisfaction and follow-up experience. Research trends are listed primarily from a preoperative perspective, with minimal connection to postoperative circumstances such as complications, and with few additional descriptions of patient or clinician perspectives on reducing elective surgery concerns.

Further study is therefore required to map across the postoperative journey, particularly allowing patient and clinician insights after the entire recovery process to dissect potential enhancements in surgical care benchmarks. As a result, this study aims to better understand elective surgery experiences by providing a more indicative view of postoperative care and the impact of complications. The mixed-method approach enables all stakeholders involved in an elective surgery treatment to voice concerns and suggestions for further improvement, adding value to future hospital policy, design interventions and preventative measures on complications through better support patients and care providers after hospitalisation.

METHODS

Study Design

This mixed-methods study examined experience with elective surgery and complications admission between 2018 and 2023 through online questionnaires. Two surveys collating sociodemographic and postoperative feedback were completed by patients and clinicians who had undergone or provided elective surgery treatment. The adjustment of patient survey and addition of qualitative data collection from clinician are explained in the *Justification of study design* section in this Chapter.

Participants

Adult patients admitted to elective surgery in Australian hospitals between 2018 to 2023 were invited to participate via social media, patient forums and flyers distributed in hospital and community care noticeboard. Clinicians, including GPs, nurses, hospital doctors and rehabilitation workers, were recruited through email lists, health professionals' associations and hospital noticeboards between February and July 2023. All data were handled confidentially, and the results were anonymous. Online questionnaires were conducted in the format of Microsoft Form and Qualtrics.

Data collection

The semi-open survey questions in both surveys aimed to investigate elective surgery care and postoperative impact on patients through creating an opportunity for participants to share further information on treatment experience and feedback such as cost to care, wellbeing, impact of complications and improvements area. The choice of semi-structured questions (Hargreaves & Seale, 1981; Mannan, 2020) allowed production of feedback and use for evaluation to determine if there is close alignment of unnamed? financial and wellbeing impacts on elective surgery.

The patient survey consisted of standard questions on socioeconomic demographics, type of surgery and presence of complications with follow-up questions on availability of carer, insurance, and wellbeing. (Appendix 1). Clinician survey included demographics and specialisation of health professionals, with a focus on postoperative complications, amount of primary support received and feedback on follow-up care (Appendix 2).

Data analysis

The retrospective data was analysed using quantitative analysis and qualitative content analysis to thematically examine responses from patients (n=20) and health professionals (n=22) who were admitted to or provided treatment on elective surgery. All information that might identify survey participants was removed before analysis.

Quantitative

In terms of quantitative analysis, descriptive statistics wase analysed using Stata 18 and Microsoft Excel. Frequency and percentage values for all responses were calculated. Discrete variables were compared using the Pearson chi-square test. Differences between variables were considered as statistically significant if the p-value is <0.05.

Qualitative

For qualitative analysis, the findings from the open-ended questions were analysed by thematic analysis to contextualise and generate patterns demonstrate insights in responses. The design of open-ended questions in both patient and clinician surveys was in reference to (Jowsey et al., 2021) and to enhance understanding of treatment experience, views, beliefs and behaviours and to apply a more flexible methodology to gain richer and deeper information. With Inductive thematic analysis (Naeem et al., 2023), this study aimed to evaluate the key phrases from open-ended questions to generate patterns, collate into codes then group into themes to develop a conceptual framework demonstrating the results with NVivo 12.

RESULTS

Quantitative results

a. Characteristics of clinicians (n=22)

A total of 22 clinicians completed the treatment experience survey. Participating clinicians were mostly registered nurses (9/22, 40.9%), followed by hospital doctors (6/22, 27.3%), rehabilitation workers (5/22, 22.7%) and GPs (2/22, 9.1%). Clinicians were mostly based in public hospitals (8/22, 36.4%), community clinics (7/22, 31.8%) and aged care facilities (4/22, 8.2%) with a specialisation in occupational or physiotherapy, infectious diseases, and general medicine.

b. Characteristics of patients (n=20)

Patients were mostly aged under 30, followed by age groups of 40-49 and 30-39. There were slightly more females than males in the study, while 50% of the participants were married.

Australian contributed 30% of the overall population. Over half of the patients spoke English at home, while none of the participants had an Aboriginal and/or Torres Strait Islander background. A quarter of respondents reported a household income ranged from $100,000 to $149,999. Over half of the participants were in full-time appointment and had a Master graduate. (Figure 1).

Most patients undertook elective surgery in 2021, with a hip replacement being the most common type of surgery, followed by other procedures and coronary artery bypass graft. More than one-third of participants had a carer during their recovery period or had known comorbidities such as diabetes, osteoporosis, anxiety/depression, high blood pressure and cholesterol. Only one participant had undergone more than one elective surgery within the study period (Figure 2).

Comparing patients with and without complications, there was an equal percentage of participants admitted to public and private hospitals, respectively, for initial elective surgery. Seven participants had complications within 90 days post-operation, 20% had healthcare-associated infections, and 15% led to unplanned readmission due to surgical complications. We compared clinical and demographics (Figure 1), elective surgery characteristics (Figure 2) of patients with and without complications 90 days after surgery using the Pearson χ^2 test for categorical variables, with $p<0.05$ considered significant. Language used at home ($\chi^2 = 13.81$, $P = 0.055$) and type of hospital admission ($\chi^2 = 10.77$, $P = 0.001$) demonstrated statistically significant association to post-operative complications within 90 days.

The duration of baseline leave days for patients and carers did not reflect a significant association with postoperative complications within 90 days in statistical analysis (Figure 2). The extra indirect cost to care pattern was presented in comparison to extra leave days after complications (Figure 3) and insurance coverage versus follow up sessions (Figure 4) for health economics discussion.

For those without complications, baseline leave days for patients and carers ranged from none to 10 days or more, depending on the type of surgery undergone. In comparison to patients with complications, two did not required extra leave days after complication, with other five patients encountered at least 4-6 days to 10 days or more extra leave days off work since diagnosed with a complication. In addition to baseline leave days, those five patients with complications could result in a total leave day for at least 5-9 days to 20 days or more (Figure 3). In terms of leave days distribution of carer, three carers did not require extra leave days since their patients were diagnosed with complication, with other four carers had at least 1-3 days to 10 days or more extra leave days off work. In addition to baseline leave days, those four carers who were looking after patients with complication could result a total leave day for at least 1-3 days to 20 days or more (Figure 3).

Apart from extra leave days off work, the number of follow-up sessions since the initial elective surgery appointment varied while the coverage of transportation cost for those sessions to attend follow-up sessions (Figure 4) revealed patients with complications had follow-up sessions ranging from 1-3 to 7-9 days after initial elective surgery, with six out of seven had no insurance coverage for transportation cost to attend follow up sessions. Further comments from patients' responses about other costs or insurance coverage are included in the qualitative results section.

Figure 1. Demographic characteristics of patients (n=20)

Characteristics	Complications within 90 days		Total (n,%)	χ^2, *P*
	Yes	**No**		
Age				8.2784, 0.142
Under 30	4	2	6 (30)	
30-39	0	3	3 (15)	
40-49	1	5	6 (30)	
50-59	0	2	2 (10)	
60-69	1	1	2 (10)	
70-79	0	0	0 (0)	
80 or above	1	0	1 (5)	
Gender				1.17, 0.279
Female	5	6	11 (55)	
Male	2	7	9 (45)	

Language used at home				13.81, 0.055
English	1	10	11 (55)	
Other Languages	7	2	9 (45)	
Ethnicity				9.01, 0.436
Australian	1	5	6 (30)	
Other Ethnicity	6	8	14 (70)	
Annual household income				4.40, 0.623
$0-$24,999	1		1 (5)	
$25,000-$49,999	1		3 (15)	
$50,000-$74,999	1		3 (15)	
$75,000-$99,999	2		3 (15)	
$100,000-149,999	1		5 (25)	
$150,000 or more	1		4 (20)	
Prefer not to answer	0		1 (5)	
Type of employment				10.41, 0.237
Full time	3	8	11 (55)	
Part time	2	0	2 (10)	
Self employed	0	1	1 (5)	
Student	0	1	1 (5)	
Student with full-time employment	0	1	1 (5)	
Student with part-time employment	0	1	1 (5)	
Student; Unemployed	0	1	1 (5)	
Unemployed (looking for a job)	1	0	1 (5)	
Unemployed (not looking for a job)	1	0	1 (5)	
Marital status				4.18, 0.383
Married	2	8	10 (50)	
De facto	2	2	4 (20)	
Single	2	2	4 (20)	
Divorced	0	1	1 (5)	
Widowed	1	0	1 (5)	
Education				6.08, 0.108
Under Year 12	1	1	2(10)	
Year 12	2	0	2 (10)	
Bachelor	2	10	12 (60)	
Master	2	2	4 (20)	

Figure 2. Elective surgery characteristics of patients (n=20)

Characteristics	Complications within 90 days		Total (n,%)	χ^2, *P*
	Yes	**No**		
Type of surgery				8.80, 0.185
Cataract extraction	1	0	1 (5)	
Coronary artery bypass graft	0	3	3 (15)	
Hysterectomy	0	1	1 (5)	
Other procedures, did not specify	1	5	6 (30)	
Septoplasty	1	0	1 (5)	
Total hip replacement	3	4	7 (35)	
Total knee replacement	1	0	1 (5)	
Year of surgery				4.26, 0.235
2018	1	2	3 (15)	
2019	2	3	5 (25)	
2020	0	5	5 (25)	
2021	4	3	7 (35)	
Type of hospital admission				10.77, 0.001
Public	7	3	10 (50)	
Private	0	10	10 (50)	
Undergone more than one elective surgery during study period				0.57, 0.452
Yes	0	1	1 (5)	
No	7	12	19 (95)	
Presence of known comorbidity				1.83, 0.176
Yes				
No	3	2	5 (25)	
	4	11	15 (75)	
Type of comorbidity				15.60, 0.271
None/Not applicable	4	8	15 (75)	
Anxiety and depression	0	1	1 (5)	
Hypertension and type II diabetes	0	1	1 (5)	
Type II diabetes	1	0	1 (5)	
Asthma	1	0	1 (5)	
Osteoporosis and type II diabetes	1	0	1 (5)	
Presence of carer				0.66, 0.417
Yes	6	9	15 (75)	
No	1	4	5 (25)	

***Baseline patient leave days**				1.70, 0.792
None	2	3	5 (25)	
1-3 days	3	4	7 (35)	
4-6 days	0	2	2 (10)	
7-9 days	1	3	4 (20)	
10 days or more	1	1	2 (10)	
Baseline carer leave days				3.00, 0.558
None	3	5	8 (40)	
1-3 days	3	4	7 (35)	
4-6 days	0	1	1 (5)	
7-9 days	0	2	2 (10)	
10 days or more	1	1	2 (10)	

**Baseline refers to initial elective surgery appointment and planned follow up appointments in association to surgery, excluding any complications related sessions.*

Figure 3. Leave days off work

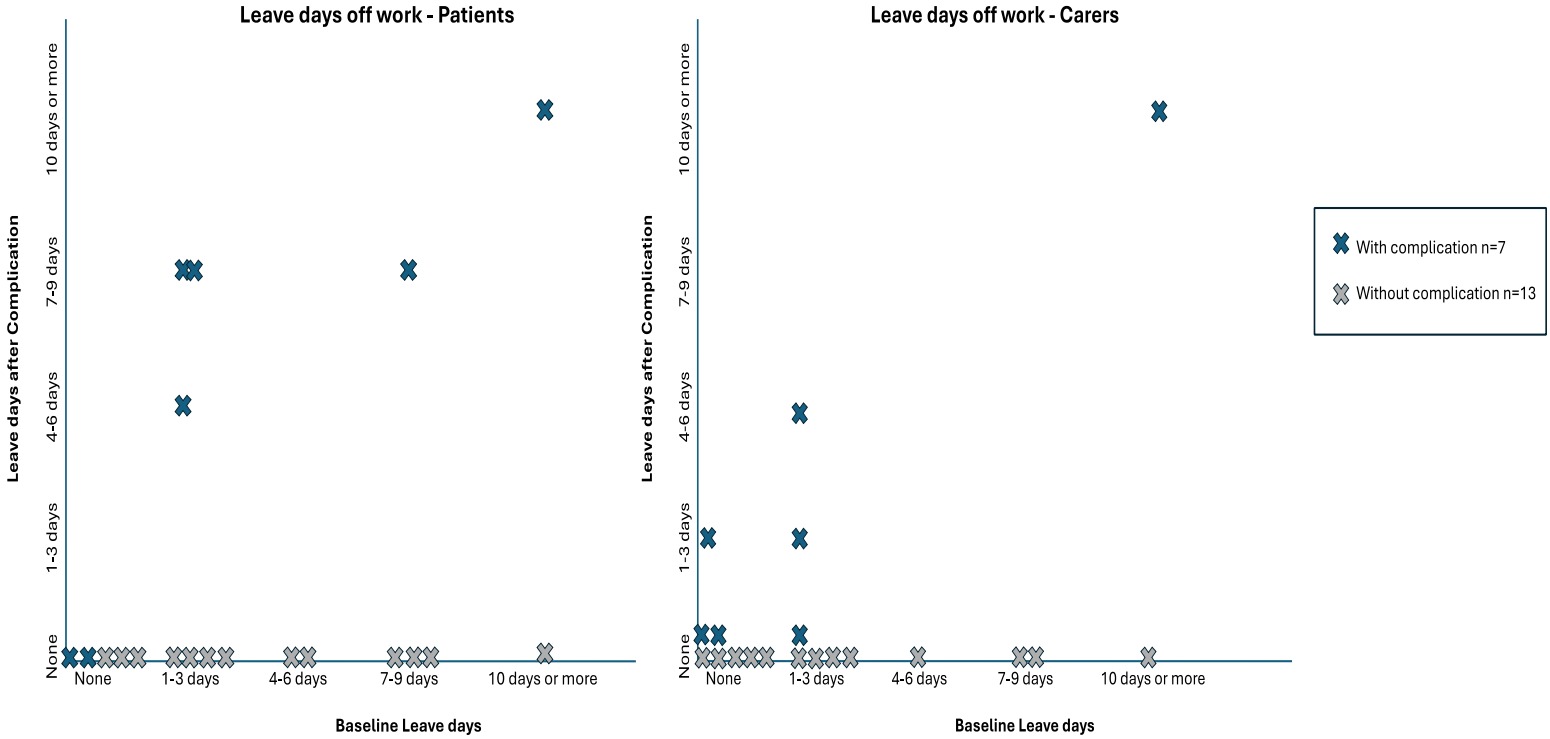
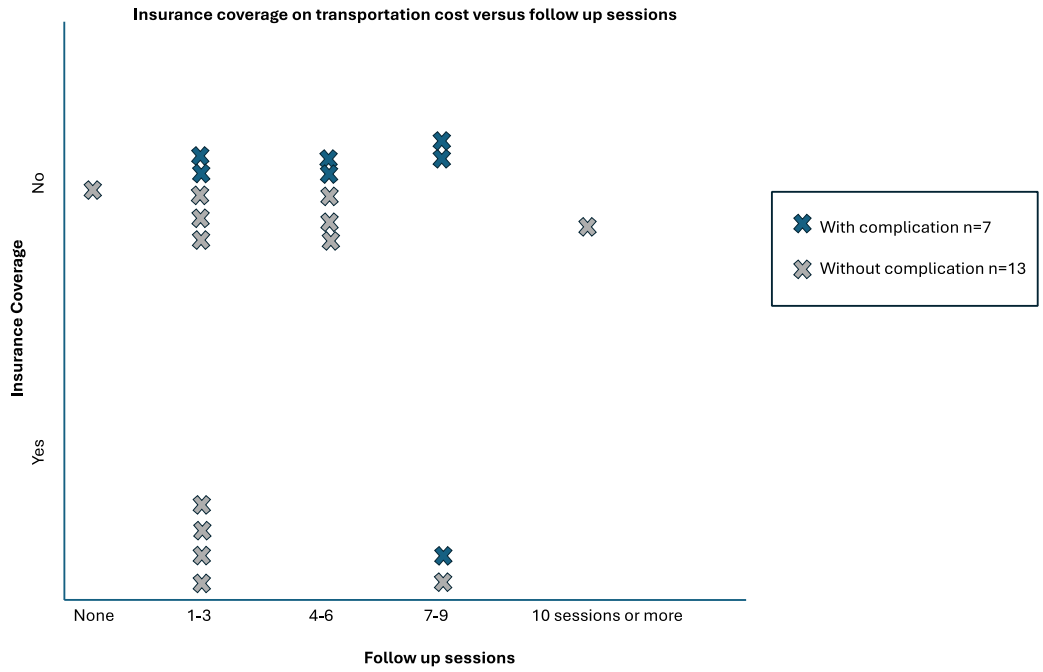


Figure 4. Insurance coverage versus follow up sessions



Qualitative results

Overall, 20 patients and 22 clinicians participated in the online questionnaires. Patient survey demonstrated sociodemographic characteristics of elective surgery admissions, presence of complications and comments towards the financial and general wellbeing of patient journey. The clinician survey focused on the treatment experience of elective surgery, including frequency, type and impact of complications, level of care and assistance to patients and clinicians, and reflections on potential improvements in postoperative care.

A. Patient survey

Regarding feedback on elective surgery, four main themes were identified from patients regardless of the presence of complications:

i. Financial coverage

All participants with complications were with Medicare only. There was mainly an optimistic view towards insurance for people without complications, as all of them were admitted to private hospitals, with only one indicated with no private insurance.

Patients without complications:

"Cover was incredible. Out of pocket cost was approximately $1,500 including hospital stay excess and medications". [Female patient, 46 years].

"Insurance covered many different access (such as actual surgery, cost of staying at the hospital, etc), but we were still out of pocket with some expenses". [Female patient, 22 years].

Patients with complications:

"Transportation cost was not covered … I'm only on Medicare". [Female patient, 28 years].

In general, participants expressed positive feedback towards private insurance coverage with hospitalisation costs, certain kind of out-of-pocket cost was seen in elective surgery but mostly covered by private insurance. Medicare reimbursed hospitalisation cost for both cohort but those with complications demonstrate other out of pocket expenses, chances are if they were required to return to hospital, transportation cost are not covered for follow up sessions.

ii. Leave from work

Leave days off work was the second theme that emerge from financial coverage and type of hospital admission. The level of leave reimbursement depends on workplace and insurance coverage, which could lead to incurred indirect time cost and leave days off in carers and patients. If the patient was unemployed and carer was as the only source of household income, the lack of financial support could also result in distress besides the pain and anxiety from surgery, affecting wellbeing of both patient and carer.

Patients without complications:

"Insurance covered everything, and my workplace allowed sick leave" [Male patient, 50 years].

Patients with complications:

*"…time off work not covered… "[*Female patient, 28 years].

*"jobless, husband took care of me with days off… "[*Female patient, 45 years].

In summary, patient expressed days off were required for elective surgery. According to the quantitative results, people with complications required extra time off due to extended length of stay. Challenges are those extra time offs and leaves might not be covered by work and insurance, leading to financial burden particularly from complications.

iii. Communication

A new theme which is closely related to the clinician survey has evolved and further identified in the clinician survey results. One patient with complication indicated miscommunication issue, aligning with treatment experience issue clinician survey concluded:

"Bathing communicated incorrectly, thought I could bath but actually not, led to infection on wound". [Male patient, 26 years].

No other comments from patients in relation to communication issue as further feedback section with extended responses on transportation costs and coverage issue. This theme is however extensively discussed later in the clinician survey.

iv. Access to care

One comment from each cohort pointed out location concerns in relation to follow up and initial elective surgery appointment:

"Follow up care referred wasn't close to home…" [Male patient, 26 years].
"Public transport such as train, bus was limited " [Male patient, 34 years].

The health economics section further dissected cost to care in terms of patient journey mapping on where patients attended surgery and access after discharge to community care.

B. Clinician survey

Themes were identified under the following headings, apart from demographics collection, semi-structured questions were framed by the questions used in the interview. Reponses are mainly classified from the survey questions (Appendix 2) into the following themes:

i. Characteristics of complications

Health professionals under various specialisation and setting could face specific postoperative elective surgery and complications. Within the category of characteristics of complications, two domains emerged through the thematic analysis.

Frequency of complication

By providing a general picture on postoperative complications, the frequency ranged from relatively uncommon to occasionally as to have cases once or twice a month, depending on the location and specialisation of practice:

"*Relatively uncommon, can include infection, clots, kidney injury, wound failure, outcome failure"* [Clinician 1 - Medical doctor in public hospital]

"More common in older patients" [Clinician 2 – RN in aged care facility]

Complication is occasionally seen in clinic settings, with explained characteristics:

"Occasionally patients come in with infected wound after keyhole surgery" [Clinician 3 – GP in clinic]

"Likely to have cases once or twice a month" [Clinician 5 – GP in clinic]

"Unsure in general but most patients come from arthroplasty" [Clinician 4 – Rehabilitation worker in postoperative physiotherapy clinic]

Some contradictory comments in terms of how common complications are after elective surgery, ranging from relatively uncommon and occasionally in general to more common in older patients.

Type of complication

Most of the respondents regardless of site and specialisation flagged wound infection and pain as the main concern in hospital, clinic, and aged care facility. Extensive response from nurses and GPs shared similar experience of treating wound infections patients as reported:

"SSI/AMR/SWD" [Clinician 10 - Medical doctor in infectious diseases unit of public hospital]

"Wound infection and pain" [Clinician 13 – RN in public hospital]

Some clinicians in private hospital and aged care facility also mentioned about complications like pressure injury (PI), antimicrobial resistance (AMR), ulcer, and urinary retention.

ii. Impact of complications

Clinicians were asked to describe the differences between patients with and without complications. Prompts for thought such as number of follow-up sessions, length of total patient episodes, and other extra treatments due to complications were provided. Clinicians agreed complication led to certain level of impact on patient lives and healthcare resources. There are four domains with narrative introduction of postoperative journey, time cost to care, wellbeing concerns and the use of antibiotics.

Postoperative mapping

Discussions were mainly at various stages of pathway to reflect at which further assistance could be provided to avoid enhancing risk of complications and unnecessarily extended treatment journey:

"I mostly saw patients with post operative complications that presented to ED - generally would be seen by a surgeon, and admitted, occasionally taken to theatre, with a relatively longer length of stay. Would be seen in outpatient clinics for a longer period" [Clinician 1 - Medical doctor in public hospital]

"Patients tend to revisit outpatient clinic once to follow up on wound in 1.5 months, if infection is found during that time, we will advise them to follow up with GP, if not, they will have to follow up with GP instead eventually." [Clinician 6 – Orthopaedic nurse in public hospital]

"Those with complications attend multiple clinics for different purposes" [Clinician 11- Rehabilitation worker in physiotherapy at aged care facility]

Time cost to care

The routine recovery time was described with length of stay and pathways to follow up after discharge. Extra length of stay due to additional sessions and dressing change time was reported in postoperative complication such as wound infection:

"20-30 mins/session to change dressing, clean and wash wound" [Clinician 2 – RN in aged care facility]

"Dressing alternate days. 2months" [Clinician 15 – RN GP clinic]

"1 extra session in hospital then likely to GPs, unsure afterwards" [Clinician 12- RN in private hospital]

Wellbeing concerns

Pain and its consequences were the central theme, with a certain level of uncertainty regarding patient well-being from clinicians. Reports of feeling that the patient 'did not know what to do' and prolonged recovery time could lead to stress and concerns, which were closely associated with the time cost to care:

"Concerns about how they would cope at home (e.g., patients with difficult social situations)" [Clinician 1 - Medical doctor in public hospital]

"… unable to drive and return to work, fatigue and slow recovery" [Clinician 5 – GP in clinic]

"… affecting quality of sleep due to stress and pain" [Clinician 7 – Orthopaedic surgeon in private hospital]

"… smell of wound and lack of mobility after surgery lead to more serious PI" [Clinician 9 - RN in aged care facility]

"Concern about how long the healing process can take" [Clinician 11- Rehabilitation worker in physiotherapy at aged care facility]

Use of Antibiotics

A few indications of the use of antibiotics through time cost and wellbeing themes approached the discussion of AMR concerns on treatment courses across various health services:

"With infected wound antibiotics are prescribed with follow ups schedule in a week or two, treatment tend to complete in a month" [Clinician 3 – GP in clinic]

"Usually prescribe antibiotics for those with complications and ask them to return for check-up, likely 2 extra sessions comparing to who only requires regular monitor" [Clinician 5 – GP in clinic]

"AMR leads to extra f/us, SSI and SWD normally referred to nurse then community" and "questions about time to heal, smell, pain and use of antibiotics" [Clinician 10 - Medical doctor in infectious diseases unit of public hospital]

iii. Level of care provided to patients

Clinicians were invited to describe the level of care provided to patients following surgery; assistance in terms of the level of care expands into domains of social, clinical, and financial support and their challenges.

Social assistance

Vulnerable needs are often addressed at the time of admission if known, with concerns focusing on social assistance after discharge where patient might need re-identify themselves for extra follow up.

"Social assistance and mental support are available to those indicated at admission" [Clinician 7 – Orthopaedic surgeon in private hospital]

"For day surgery such as elective surgery, insufficient of mental support as there is a quick turnaround time for patients, we are not keeping patients hospitalised for long, aiming for discharge as soon as possible" [Clinician 8 – RN in private hospital]

Clinical assistance

Recovery exercise, knowledge to care wounds and pain management assistance are required. Public hospital setting may not provide sufficient assistance post-discharge. Clinicians used words such as 'tricky', 'low' to describe degree of postoperative care.

"Variable level, could be tricky in a public hospital setting outside of direct clinical support" [Clinician 1 - Medical doctor in public hospital]

"Depends on whether the patient is aware of the infection" [Clinician 3 – GP in clinic]

"Some will get referred to clinics but some not as prolonged pain for example will take time to become a concern" [Clinician 11- Rehabilitation worker in physiotherapy at aged care facility]

"Urge to recover create stress, long term recovery period and the right recovery exercise is required avoid counterproductivity in healing, incision site check on those with complications require other follow up session with wound care specialist" [Clinician 16 –Rehabilitation worker in occupational therapy at clinic]

Financial assistance

There was no limited comment on financial support in the clinician survey, with some discussion of availability of Medicare in public hospitals, while the current system relied on patients to return to their GP after discharge for coverage.

"Financial: Medicare coverage, referrals made for other concerns with patient's obligations to attend" [Clinician 10 - Medical doctor in infectious diseases unit of public hospital]

"Not much, usually discharge on the same day or next day then to GP, depends on whether patient returns to GP" [Clinician 12- RN in private hospital]

Challenges

Nurses in various settings rated support level as low. Follow-up sessions were mostly attended at the patient's own discretion with unclear status after discharged and minimal guidance offered to identify whether patient should return earlier to seek care to avoid complication:

"Most support relate to wound care in aged care but not education with patients on PI, challenging to advise them to stay at a certain level of physical activity due to age" [Clinician 9 RN in aged care facility]

"Take home advice in terms of wound care are insufficient or poorly communicated, most of them failed to keep wound dry which leads to an infection" [Clinician 5 – GP in clinic]

iv. Level of assistance provided to clinician

Clinicians were invited to express views towards assistance in clinical training, provision of guidelines, referral information to allied health facilities, and other types of support. A certain level of training is provided to clinicians with guidance to treat and prevent infection using antibiotics. However, patients could be able to follow up in the community, meaning effective liaisons are required across health services instead of being limited to within the hospital.

Availability of training

*"Currently antibiotics are used to treat most wound infections, IPC training provided in hospital***"** [Clinician 7 – Orthopaedic surgeon in private hospital]

"Training and guidance for health professionals are sufficient…" [Clinician 3 – GP in clinic]

"Variable level of support - e.g., on general surgery, would be taught by consultant surgeons on managing complications from medical perspective, but guidelines were limited and allied health training (such as how to refer to dietitians or allied health) was minimal (this was in the context of upper GI surgery, so surgeries like bariatric surgery)" [Clinician 1 - Medical doctor in public hospital]

Challenges

"Slip given to patient to go back to GP" [Clinician 13 – RN in public hospital]

"Low. Patients are usually not informed" [Clinician 14 – RN in clinic]

v. Other concerns

The survey concluded with an opportunity for clinicians to provide other concerns and considerations for postoperative care, which was out of the researcher's set questions to gain new insights. Clinicians raised concerns about the level of assistance in patients in terms of comorbidity management along with elective surgery, such as mental health and resourcing management:

"*Often mental health would be a challenging comorbidity to manage on the surgical ward. E.g., depression, schizophrenia was often poorly managed by surgical team and patients were discharged home without their adequate management due to resourcing (limited C-L psychiatry cover). This would have impacts on surgical complications with respect to how patients may adhere to post op care (e.g., attending reviewing appointments, taking medications)"* [Clinician 1 - Medical doctor in public hospital]

vi. Potential improvements

In reference to issues on lost to follow ups, education, and communication after discharge indicated in both surveys, clinicians advised enhancing current postoperative care through a clearer handover with GPs and home care coordination with patients to prevent complications:

"*Ensure discharge summary and guidelines to patient/carer are clearly communicated"* [Clinician 8 – RN in private hospital]

"Incentives or assistance to increase mobility to prevent PI" [Clinician 9 - RN in aged care facility]

"Guide of allied health services available around their area if they encounter concerns" [Clinician 11- Rehabilitation worker in physiotherapy at aged care facility]

"Specialist clinic or work with certain community care to ensure attended appointment" [Clinician 13 – RN in public hospital]

"Reduce use of antibiotics by preventing infections" [Clinician 5 – GP in clinic]

DISCUSSION

The patient and clinician surveys integrated an indicative overview of characteristics and impact of elective surgery and complications via postoperative care pathway mapping. To the best of our knowledge, this is the first report to focus on the experiences of patients and clinicians involved in elective surgery treatment. As this study includes a wide range of clinicians from various backgrounds including aged care nurses, infectious disease physicians, GPs and other rehabilitation allied health professionals in the community, the frequency and type of complications are determined by the speciality and the place of work of clinicians. The primary objective of the patient survey was achieved by analysis of sociodemographic and elective surgery features, while allowing patients to report level of impact on daily routine, financial assistance and overall wellbeing. In addition to the extensively reported complication cost to the health system, this study also assessed the cost to care from the perspective of patients on an individual level. Major themes discovered from the patient survey are related to health economics discussions about financial coverage, absence from work, and the impact of complications.

Characteristics of elective surgery

In terms of the characteristics of elective surgery, the response from clinicians revealed wound infection as the most common complication, with the presence of pain, occasional PI and ulcer, typically found in the older population, in which an Australian study indicated older patients undergoing surgery had high rates of comorbidities and postoperative complications, leading to mortality and morbidity which put significant demands on critical care services (McNicol et al., 2007).

Patient who speaks a language other than English at home ($\chi 2 = 13.81$, $P = 0.055$) or admitted to a public hospital ($\chi 2 = 10.77$, $P = 0.001$) had a statistically significant association with post-operative complications within 90 days. Our result aligns with AIHW report for 2021-22, there are almost 3 times more potentially avoidable hospitalisations in public hospitals than in private (Australian Institute of Health and Welfare, 2024b) with the prevalence of surgical site infections two times greater in operations conducted in public hospitals compared private hospitals (Fisha et al., 2019). It is generally recognised that complications can result in significant costs to healthcare systems. Patients with complication such as surgical site infections, apart from increased inpatient

care, might lead to elevated surgery and ward cost of for those with SSI (Strobel et al., 2022). In Australia, SSI in public hospitals may result in a total direct cost of A$323.5 million, with an average cost per case at A$18,814, which was 2.5 times the average per capita spending on health (Royle et al., 2023).

Health economics and cost to care

The baseline in this study refers to the time point at which follow-ups are associated with the initial elective surgery regardless of complications. Patients who have had different types of surgery may have varied baseline leave days from work. Individuals who had the same baseline leave day off work of 1 to 3 days may have to take an extra 4 to 9 days off work if complications arise (Figure 3). In reference to the Australian full-time adult average weekly ordinary time earnings of 1,886.50 in November 2023 (Australian Bureau of Statistics, 2023), taking four days off work due to complications might result in a loss of $1,509, excluding baseline days off for initial elective appointment and its associated follow-ups. Similarly, most carers in our research are family members who have their own occupations and have taken time off to care for patients and attend part of or all follow-up sessions. Most patients surveyed required at least 1 to 3 follow-up visits after their first elective appointment, with no reimbursement for transportation costs (Figure 4). Even though follow-up sessions are often held at a health facility near the participant's home (Department of Health, 2023), some attendees noted that access to public transportation and follow-up sessions might be challenging, while a certain level of transportation expense is out of pocket to attend those sessions.

A complication within 90 days could result in at least $4041.96 in out-of-pocket expenses for each elective surgery episode in the case of a full-time employed male survey participant from a non-English speaking background who is admitted to a public hospital for a knee replacement and does not have insurance coverage for transportation costs. The cost estimate is divided into baseline and complication leave days off work for both the patient and the carer, with transportation costs calculated based on the postcode of the follow-up sessions and place of residence. The patient had 4 to 6 follow-up appointments, some of which attended with carer and the expense of transportation was not reimbursed by insurance. With 12.57 kilometres on the road and a one-way cost of $14.66 based on the postcodes reported in the survey, the minimum direct out-of-pocket

cost to drive return trip for four sessions is at least $117.28, according to fuel price estimates in Australia in 2023 (Edlington, 2023). In reference to the gender specific full-time adult average weekly ordinary time earnings of $1,981.30 in November 2023(Australian Bureau of Statistics, 2023), with baseline and complication leave days of 1 to 3 days and 7 to 9 days, respectively, taking eight leave days for both elective surgery and complications costs at least $3170. His carer attended baseline and complication appointments of 1 to 3 days each, totalling at least $754.6 for taking two days off work, in reference to the full-time adult average weekly ordinary time wages of $1,886.50(Australian Bureau of Statistics, 2023).

Apart from a prolonged recovery period, complications may therefore lead to significant direct and indirect out-of-pocket costs. This financial strain adds onto the pain and distress about slow recovery, resulting in wellbeing impact for patient and carer with altered daily routines due to follow-up and unexpected increase in length of stay. Clinician survey pointed out that some healing processes may take up to more than a month, requiring patients to alternate dressings for two months, with each session taking up to 30 minutes to clean and wash the wound. Beyond the leave days off work stated in the patient survey, there is a potential that patients may have to return to work before fully recovering, with the well-being challenges listed in the clinician survey, such as the smell of wounds, pain, concerns about the recovery duration, with postoperative care often occurs at home or in community services.

Level of postoperative assistance

As a result, clinicians participating in the survey evaluated the degree of assistance offered to patients in terms of financial, social, and clinical support. As previously discussed, financial assistance was unclear after discharge, in which most out-of-pocket expenses occurred, resulting in cost as a barrier to those not covered (Dixit & Sambasivan, 2018). Besides Medicare coverage for patients at public hospitals and GPs, clinicians' feedback also stated that it is entirely up to the patient if they decide to follow up. A lack of incentive indication in postoperative clinical support may result in patients being lost to follow-up. Social assistance is often known during admission, with care provided by postoperative nurses, while patients found a caring and compassionate bedside manner valuable in the discharge process (Jones et al., 2023). However, as most elective surgery only takes a few days or more, patients' requirements may not be known to other

community care post-discharge which prevented further assistance. The communication framework may also have an impact on the scheduled follow-ups following their initial elective surgical appointments, which was particularly apparent in feedback from clinicians. Variation in care methods among clinicians and providers could result in discrepancies in preventing and managing complications (Javed et al., 2023). Clinicians who specialise in postoperative care, such as aged care nurses and GPs, have stated that the level of assistance provided to patients is relatively low, with a lack of support in patient education in terms of wound care and wellbeing, and advice to care was poorly communicated, resulting in infections and an extended recovery period.

Concerning the level of assistance provided to clinicians, there is a positive outlook on clinical training and guidelines on managing complications, with main concerns centred on communication with patients and community services after discharge to ensure the patient is receiving adequate clinical assistance, particularly how the surgical team delivers effective summary to community health professionals for postoperative care. Several responses from GPs and nurses from clinics in the community suggested the level of support to clinicians is 'low' and 'minimal' without further elaboration. Community settings such as GP clinics may not receive the same level of support on complications and postoperative care compared to hospital settings, leading to concerns on chances of lost to follow up, resulting in complications due to inability of early detection.

Justification of study design

Original design

The original intention of this study was to concentrate on orthopaedic surgery and its potentially avoidable complications only. The intended semi-structured survey on demographics, SF-36 and phone interview framework was planned to assess the short- and long-term effects of complications. The initial plan was to collect deidentified demographics and obtain further consent from patients on an SF-36 survey and a follow-up phone interview to collect qualitative feedback on elective treatment surgery. The SF-36 scores were planned to compare patients with and without complications in association with socioeconomic determinants and demographics such as Indigenous status and birth language.

Challenges

The recruitment constraints were, however, primarily attributed to the suspension of elective surgery from 1 April 2020 to 28 February 2022 in both public and private hospitals due to COVID-19 (Premier of Victoria, 2022), which led to limited eligible admitted patients and challenges in communicating and recalling patients from the community. Recruiting participants for the survey was complex, especially for day elective surgery, where patients might have initial surgery or follow-up sessions in various public and private hospitals or the community. Limited demographic survey participants have reported complications, with only five providing email and phone numbers for the intended SF-36 follow-up survey and phone interview. None of the participants responded to the follow-up communication sent by the researcher, leading to a discussion on ethics amendments and ways to obtain sufficient representative data for postoperative pathways.

Adjusted design

Ethics amendments ETH22-7180 were later approved to enhance the scope of recruitment for the patient survey (Objective III) due to the limited level of participation. The research participants expanded from public hospitals to both public and private hospitals to capture as many participants as possible to reflect the complications burden in hospitals. A qualitative study with clinicians was also approved under ethics amendment ETH23-8031 to explore the impact on patients with complications and recovery experiences following surgery through obtaining clinicians' views on primary care support received.

Strengths and limitations

The patient survey was initially distributed to gather demographics and financial support feedback on elective surgery. Since the aim and responses from the patient survey are to provide a forum to report out-of-pocket expenditures and the impact of elective surgery, the theme was less emphasis on wellbeing and more on potential financial stress and issues. The clinician survey was released later in conjunction with the former survey, aiming to collect more specific comments on postoperative care to bridge the limited responses in patient survey. Clinicians discussed treatment experience regarding postoperative assistance, communication, complications, and impact on patient wellbeing. The extended themes may appear insignificant in the patient survey, which reflected the importance to consider treatment experience from multiple perspectives.

In terms of limitation, there has been a lack of previous studies that focus solely on patient levels of well-being and out-of-pocket costs; future research should further quantify wellbeing to compare status before and after surgery with indicators based on patients' perspectives rather than only relying on qualitative feedback from patients and clinicians.

Implications for practice

This study provides an in-depth review of the elective surgery pathway, with challenges and areas for improvement reflected in patients' adhesion and education towards postoperative care, particularly for public hospitals with limited surgery turnaround times. Our study results contextualised broader to countries like Canada and France, which have similar healthcare systems and comparable follow-up frameworks in elective surgery care with Australia (Dixit & Sambasivan, 2018), resulting in concerns in discharge planning due to lack of patient experience and clinical outcomes data between healthcare providers. The primary point of contact after discharge could facilitate communication across health services, particularly for patients who require many follow-up visits with different providers. Communication may be enhanced to ensure all necessary information have been circulated when patient visit various sites for follow-up, rather than only relying on patients to deliver clinical history. Besides, as preventive therapy plays a critical role in recovery management (Scalise et al., 2016), home care education particularly for patients with known comorbidities, social assistance needs or from a non-English speaking background could be improved by infographics with prospective information on when to seek care instead of waiting for scheduled postoperative follow to detect early wound complications. This study raised challenges in preventing complication after discharge, identified current priorities in effective use of antibiotics, reducing financial and wellbeing burden on patients through eliminating avoidable readmissions and extra length of stay, maximising the benefits of each session to ensure care has been completely communicated to carers and patients from a postoperative perspective.

Policy and future research

Most elective procedures are performed during the day, and patients are followed up by the community, at home, or in the hospital after initial discharge, regardless of complications. Due to the complexity of infection prevention, effective interventions before, during, and after surgery are

essential (Ching, 2024). As postoperative care is part of the recovery journey but often neglected upon discharge and transfer of care, future research should examine the relationship between postoperative pathway and recovery indicators such as length of stay, extent of impact on financial and well-being at a larger scale, supporting the prevention of adverse events beyond during hospitalisation. Examining postoperative communication between patients and clinicians could reveal if accuracy and level of communication are associated with the risk of complications, particularly for patients from culturally diverse backgrounds. Comparative analysis on postoperative care, sociodemographic and risk of complications could improve health equity and strengthen quality and effective care provision. Apart from limiting to hospitals and intensive care units, health systems research should enhance health economics discussion on preventing unplanned readmissions in community care providers as the primary contributor in postoperative care.

CONCLUSION

Our study identified opportunities to enhance postoperative care based on patient and clinician treatment experiences. Patients with non-English speaking backgrounds and in public hospitals were known to be at a higher risk of complications; additional follow-up sessions and leave days from work from the prolonged recovery period of a complication may cause distress due to increased out-of-pocket costs for patients and carers. Clinicians aimed to enhance postoperative care and prevent complications by improving handover between health professionals, particularly for patients with comorbidities and social assistance requirements, prioritising patient education in preparation of discharge. Further considerations can be taken in the future on home care and health services access guidelines for patients and carers to ensure early and effective detection of complications.

APPENDIX 1: Patient survey

Demographics

Gender

Age

Language used at home

Ethnicity

Annual Household Income

Type of Employment

Marital Status

Indigenous Status

Education

Elective surgery characteristics

Year of Surgery

Apart from the one indicated above, have you undergone other elective surgeries throughout the year of 2018-2021?

Have you been diagnosed with complications within 90 days after the elective procedure indicated?

Type of hospital for elective surgery

Postcode of hospital for elective surgery

Postcode of hospital/clinic for follow up sessions

Postcode of Residential Address

Do you have other known comorbidities? (Please specify)

Type of health insurance

Excluding complication episodes (if any), have you taken any leave off work for your elective surgery, including initial appointment and recovery period?

If yes, how many days in total?

Has anyone (family member/carer) care for you during your recovery period?

Excluding complication episodes (if any), have your carer(s) taken any leave off work for your elective surgery, including initial appointment and recovery period?

If yes, how many days in total?

How many follow up sessions have you had after your initial elective surgery appointment?

Has anyone who cared for you attended those sessions with you?

Does your insurance cover any transportation costs?

Please include any further comments about other costs or insurance coverage below.

Complication characteristics

Type of Complication

Have you taken any extra leave off work since you have diagnosed with a complication from elective surgery?

If yes, how many days in total?

Have your carer(s) taken any extra leave off work since you have diagnosed with a complication from elective surgery?

If yes, how many days in total?

APPENDIX 2: Clinicians survey

Demographics

Types of healthcare professionals (GP/nurses/hospital doctors/rehabilitation workers/other to specify)

Type of setting clinician based in (public hospital/private hospital/clinic/aged care facility/other to specify)

Type of medical specialties (Please specify)

Questionnaire

How often are complications seen after elective surgery?

How would you describe the differences between follow-up sessions with complications and those without?

For patients with complications, what were the main concerns in terms of well-being?

How would you describe the amount of support provided to patients post-surgery?

How would you describe the amount of support offered to clinicians in treating elective surgery complications?

Would you suggest any potential improvements in elective surgery treatment that could benefit patients?

6.3 Chapter summary

The chapter indicates treatment experience at an individual level through mapping postoperative journey, level of assistance, challenges, and potential improvements. The prolonged recovery period led to distress due to physical discomfort and increased out-of-pocket costs, especially for public hospital patients from a non-English-speaking background. Clinicians suggested improving communication between health professionals across various settings and enhancing patient education prior to hospital discharge, particularly those with comorbidities and social assistance requirements. The next chapter focuses on the general discussion of the thesis.

CHAPTER 7: GENERAL DISCUSSION

This thesis aimed to investigate the impact of elective surgery on patients' financial and wellbeing outcomes, addressed through four objectives discussed in Chapter 3:

- First, a systematic review was conducted to examine the effects of postoperative surgical site infections among elective surgery patients since 2010, focusing on orthopaedic surgery (Chapter 4).
- Second, the epidemiology of elective surgery and postoperative complications from 2018 to 2022 was analysed (Chapter 5).
- Third, the quantitative impact on the financial and wellbeing of patients due to surgical complications, hence avoidable readmission, was estimated (Chapter 5 and 6).
- Finally, the qualitative feedback on postoperative care and wellbeing in association with complications was evaluated with patients, carers and clinicians (Chapter 6).

7.1 Discussion of main findings

The major findings of this thesis are summarised into four themes:

1) Overview of impact of surgical complications on health and societal systems;
2) Association of patient sociodemographic and risk factors on postoperative complications;
3) Effects of avoidable readmission on financial outcomes;
4) Implications of preventable complications on wellbeing consequences.

7.1.1 Overview of findings of surgical complications on health and societal systems

Results from chapters two, four and five positioned a comprehensive outline on parameters associated with impacts of surgical complications. The findings demonstrated surgical complications as a primary avoidable factor in current hospital expenses, mainly accrued by multiple revisions and prolonged length of stay. Societal costing referred to employment power loss and community follow-up care, while the impact was evaluated by health utility scores, with finite resources in a qualitative study on patient wellbeing.

The literature review in Chapter two found comprehensive international studies that examined the epidemiology and prevention of health-associated infections (HAIs) and their financial implication to the hospital, with minimal individual measurements on patient outcomes. Regarding the

systematic review in Chapter four, limited literature in high-income countries captured complication impacts at an individual level, preventing the generalisation of data across Australia. Future research is needed in Australia to investigate postoperative care outcomes and the association of complications with various patient groups, directing towards health equity beyond perioperative prevention of complications.

As one of the most common elective types of surgery with increasing waiting times in Australia (Australian Institute of Health and Welfare, 2024a), an initial focus on orthopaedic surgery in Chapter four reflected patients who sought additional clinical care and social assistance due to the development of hospital-acquired complications such as surgical site infections after discharge. Among complications and readmissions in Australia and New Zealand, a study (Story, 2013) reported an estimation of 30 complications per 100 patients, with many developing more than one defined complication, leading to at least an extra week of hospitalisation and a decrease in morbidity (Manekk et al., 2022). Chapters two and four identified variations in readmission timeframe and classifications across complications and avoidable readmissions in studies. Results also highlighted that consistent reporting of complications is required to improve data quality and generalisation in burden measurements (Domenghino et al., 2023; Manekk et al., 2022). The multiple definitions anticipated a need to address a specific reference of avoidable readmission, like PI-23, in Chapter five, to ensure accuracy and validity in comparing the burden across patient groups.

Readmitted patients with complications may be identified in hospitals, community, or lost to follow-up. Additionally, readmissions to a different hospital or setting from the initial elective surgery make tracking the treatment journey a challenge. While Chapter six surveyed the community feedback on postoperative care, Chapter five first provided an overview of those who returned to the same or different hospitals, using unique patient ID mapping to capture readmission across facilities. The data linkage results identified 5,674 elective surgical episodes under procedure codes in National Healthcare Agreement PI-23 on unplanned readmissions in 2018 (Metadata Online Registry, 2018), with hip and knee replacements as the most common type of surgery with avoidable readmissions due to ICD-10-AM codes T81 (Complications of procedures) or T84 (Complications in the internal orthopaedic prosthetic device, implants, and grafts).

Complications of procedures in T81 and the internal orthopaedic prosthetic device, implants, and grafts in T84 previously led to over 65% of deaths occurring due to complications of surgical and medical care (Australian Institute of Health and Welfare, 2005). Data from the admission database indicated that only 68 out of the 5,674 episodes contained comprehensive data for wellbeing measurements such as the Charlson Comorbidity Index and mental health assessment, preventing mortality prediction for patients with specific comorbid conditions (Charlson et al., 1987), and establishment of adequate social assistance by referring to the limited admission data. The missing social and psychological status information for day elective admissions identified a gap in the well-being effects and societal consequences of elective surgery patients. The lack of information prevents equity and reduces quality in care provision, which establishes a research direction for the coming chapters to investigation how sociodemographic factors and collection of admission data are associated with postoperative care feedback.

Through hospital database analysis in Chapter five, indicators such as duration of stay, hours of intensive care, and direct and indirect hospital expenses such as nursing, theatre, and pharmaceutical costs were used to examine the association between effects of elective surgery for various patient groups. The average cost of care for episode of care was estimated in this study according to the type of surgery and length of stay through case-mix funding, a general estimation of hospitalisation cost in a population. The actual level of care and exact individual cost may vary, with limited research capturing patient differences beyond general case-mix groups (Hopfe et al., 2016). An Australian study controlled for differences in case-mix and reported that Indigenous patients had at least 5% higher cost compared to non-Indigenous patients in a urban setting, while remote Indigenous patients had a third higher average cost than metropolitan non-Indigenous patients (Malyon et al., 2013).

Literature findings implied the importance of investigating the impact on financial and wellbeing outcomes according to clinical and sociodemographic factors, such as assistance requirements, comorbidities, age and cultural backgrounds, to better predict resource use. Chapters four and five also found discrepancies in postoperative care, specifically in a community follow-up, as the hospital database only captured admission episodes, limiting knowledge of the actual financial impact and wellbeing status after discharge. A study (Abu-Sheasha et al., 2020) assessed models

of surveillance for complications and concluded that low-cost inpatient surveillance might be less effective and prone to detect more severe SSI compared to other surveillance strategies. While ensuring a defined patient pool to conduct measurements on impact parameters, the results provided insight into the need for a cost-effective, qualitative approach to address avoidable readmissions in the community through obtaining feedback in postoperative care beyond the hospital system.

7.1.2 Association of patient sociodemographic and risk factors on postoperative complications

The literature review in Chapter two reviewed the impact of complications on the patient. For instance, a US study (Kaye et al., 2009) presented older SSI patients with four times mortality rate and nearly three times longer postoperative hospitalisation with double hospital charges. While one of the main challenges for population in high-income countries such as the United States, Canada, and Australia are ageing population and the rapid migration pattern due to economic opportunities and political or personal circumstances (United Nations Department of Economic and Social Affairs - Population Division, 2022), limited studies from high-income countries analysed the association between sociodemographic characteristics and avoidable readmissions, complications, and postoperative characteristics. With diverse cultural, ethnic, and socioeconomic statuses in these countries, health equity and inclusiveness associate to sociodemographic, are the main parameters that justify and improve patient experience in future care provision. The results from Chapters five and six hence revealed that certain patient characteristics are more prone to complications, followed by addressing the impact on specific groups in future sections.

Most avoidable readmissions associated with surgical complications are more likely to occur at the hospital of index elective surgery (Schwarzkopf et al., 2019) and within 30 days of discharge (Dharap et al., 2022; Schwarzkopf et al., 2019; Tevis & Kennedy, 2013). Chapter five compared patient characteristics across the non-readmission and readmission groups from selected surgical procedures within 28 days after surgery. The findings revealed that in comparison to reference age group of 30-39, being aged over 80 years (OR= 4.08, 95% Cl: 1.20-13.80, p=0.024), requiring an interpreter (OR= 9.65, 95% Cl: 3.17-29.33, p<0.001) or needing mental health assistance (OR= 72.81, 95% Cl: 35.29-150.19, p<0.001) were factors that led to unplanned readmissions. Despite

various views (Aburto et al., 2020; Keulen et al., 2021; Schwarzkopf et al., 2019; Xie et al., 2022) towards the postoperative timeframe when complication or readmission rate peaks, majority of studies reached a common ground that most complications occur up to 90 days after surgery. Certain post-surgical complications up to 90 days, such as wound discharge after elective joint arthroplasty (Keulen et al., 2021) had a more significant complication and readmission rate (Keulen et al., 2021) and cost (Schwarzkopf et al., 2019) over 30 days instead of 90 days. Chapter six aimed to overcome literature inconsistency in days of burden measurements, therefore extended further to capture both postoperative complications and costs up to 90 days to maximise the inclusion of potential factors beyond first the 30 days, concluded that language used at home ($\chi 2 = 13.81$, $P = 0.055$) and type of hospital admission ($\chi 2 = 10.77$, $P = 0.001$) were also factors associated with late complication readmissions.

Another finding from Chapters five and six was that patients who require an interpreter or speaks other language at home had 9 times higher rates of avoidable readmissions within 28 days (OR = 9.65, 95% Cl: 3.17-29.33, p<0.001) and statistically significant association with postoperative complications within 90 days ($\chi 2 = 13.81$, P = 0.055), respectively. In terms of cultural background, readmission risk and days of measurement in particular elective procedures, studies agreed with Chapter five that the need for interpretation services in total shoulder arthroplasty patients may be associated with extensive length of stay of 0.88 hospital and 454% more likely to discharge to a rehabilitation facility (Kunze et al., 2023), while racial and ethnic minority populations were at increased risk of complications and mortality following spine or joint replacement surgery (Schoenfeld et al., 2014). In contrast, a study on intralingual bypass surgery concluded no association between non-English speaking backgrounds with 30-day wound complications (OR = 1.87, 95% Cl: 0.90-3.88, p<0.095) and readmission rates (OR = 1.51; 95% CI: 0.77-2.95, p< 0.478) (Inagaki et al., 2017). Despite the various results and interpretations of language use and complications across studies, further investigation should extrapolate findings to a broader population by concentrating on interactions of specific surgical procedures and key sociodemographic characteristics at various time points after surgery. Language or cultural impact evaluation should also observe if impact and risk persist beyond the commonly defined 30 to 90 days due to multiple readmissions or discharge from prolonged care and expectation of language and cultural assistance services.

Chapters five and six demonstrated age, mental health status, public hospital admission, and language background were major factors for complications and avoidable readmissions. The association of the older population with an increased likelihood of preventable readmissions, especially within 30 days, is consistent with multiple studies (Considine et al., 2019; Goldfield et al., 2008; Pham, 2023; Samuel et al., 2022) in general surgery. Chapter five and most research suggested that older age, along with comorbidity (Considine et al., 2019) such as mental health requirements, increase the chance of complications and avoidable readmission. However, the literature defined an older population as ranging from 65 years to 80 years or above in Chapter five, indicating that upcoming research should emphasize better defining vulnerable groups such as older population before further dissecting the impact of preventable readmissions. Future investigation should advocate health equity for groups throughout the entire elective surgery treatment journey, with existing health needs being addressed under a multidisciplinary care pathway at all phases in hospitals and community settings.

As noted in Chapter five, several studies also reported that surgical patients with mental health or substance use issues were more likely to be readmitted (Goldfield et al., 2008). Additionally, having pre-operative psychological health issues was a significant risk factor for surgical wounds complications (Britteon et al., 2017) or postoperative readmissions (McBride et al., 2021), leading to an extended hospital stay. In Chapters five and six, the limited responses regarding social care requirements and wellbeing on hospital admission form and stakeholder surveys reflected that attention should be given to vulnerable patient groups to address concurrent health needs with elective surgery treatment during both perioperative and postoperative care. Collecting assistance requirements during admission with targeted intervention may improve surgical outcomes (McBride et al., 2021) in noting that complications and avoidable readmissions could result in larger burden of vulnerable groups in comparison to general population. Besides, mental health symptoms should also be assessed and addressed after discharge (Benjenk & Chen, 2018), mainly when patients do not return to the same hospital but to other health services to ensure assistance in social needs to prevent further complications.

In terms of type of hospital admission, limited studies solely investigate the relationship between type of hospitals and insurance in avoidable readmission and complications. An Australian study

revealed that discharges from larger health service sites were at the highest risk of unplanned readmission (Considine et al., 2019), regardless of hospital type. Research on major surgery, including elective procedures, suggested that patients who held Medicare had two times the risk of potentially preventable readmission (Brown et al., 2021), resembling the result in Chapter six that public hospital admission led to higher risk of readmissions within 90 days. A US study also indicated that non-English speaking patients were 30% more likely to be Medicaid beneficiaries (Inagaki et al., 2017). An in-depth interpretation of the relationship between the type of hospital admission and preventable readmissions, along with interactions among distinct sociodemographic characteristics, is necessary to generalise findings across high-income countries with comparable health systems and surgical care settings. Despite the dispersed focus on risk factors, further evaluation between high-income countries could navigate the ageing population and diverse migration patterns by addressing public health insurance scheme and socioeconomic disparities in a health equity perspective during policy making and care provision.

7.1.3 Effects of avoidable readmission on financial outcomes

Results from Chapters five and six are discussed under this theme. As described in Chapters two and four, complications and avoidable readmissions directly impact hospital expenses. A finite literature evaluation of indirect and out-of-pocket patient costs has limited the perspective on the total costs associated with surgical care.

Chapter five compared the cost of care during hospitalisation among non-readmission and readmission groups. Readmission led to an extended 16.5 days of average hospital stay and more than 12.5 times total hospital expenses ($97,747 versus $7,779) due to the increased allied health, nursing, medical, pharmacy, prosthetics, and theatre operating room costs. Apart from reviewing initial elective admission costs, only limited literature (Kassin et al., 2012; Ludbrook, 2022; Stowers et al., 2015) emphasised on complication or readmission expenses as a substantial addition to the overall cost of postoperative care. A study (Heiner et al., 2008) dissected the total cost distribution of hip arthroplasty, reflecting that inpatient hospitalisation accounted for 89% of average expenses, followed by 7% and 5% in postoperative and preoperative care, respectively. Furthermore, 40% of US patients on employer-sponsored plans reported issues paying their medical fees (Durand et al., 2022; Hamel L, 2019).

Due to the paucity of comparable studies conducted in Australia, Chapter six examined out-of-pocket expenses for patients receiving postoperative care, regardless of complications. Measurement of impact has extended to the community beyond the confines of the hospital database while utilising initial surgery admission data as a baseline reference. Besides Medicare, some potential expenses, such as community follow-up sessions, or sick days missed from work, are not covered. Patients may struggle financially from unexpected expenses and limited employer support. As mentioned in Chapter six and other studies (Brown et al., 2021; Dailey et al., 2013), public hospital admission is one of the principal risks leading to readmissions within 90 days, with limited research on the relationship between the hospital insurance and out-of-pocket expenses. It is essential to evaluate patient groups discharging from various types of hospitals to dissect costs apart from Medicare coverage. Despite the positive feedback from privately insured patients in Chapter six, presence of out-of-pocket expenses beyond supplemental reimbursement could still result in at least USD 758 for an initial total hip arthroplasty appointment (Heiner et al., 2008). For public patients who had a higher chance to return to the hospital, Medicare does not cover out-of-pocket costs such as transportation, carer, and indirect time costs in their follow-up sessions.

The uncertainty in the definition of out-of-pocket costs could lead to unexpected expenses and enhance tensions in patients at various stages of care. For instance, some of the definite patient expenses involved during the attendance of initial preoperative care, such as transportation, could persist to the postoperative follow-up sessions and throughout the treatment episode. If complications or avoidable readmissions occur, these recurring prolonged expenses could increase patients' financial commitment, accumulating strain and reducing the incentives to attend care.

The out-of-pocket discussion extended to a case study in Chapter six on a male knee replacement patient from a non-English speaking background (as one of the prominent readmission risks in collation with results from Chapter five). The case findings revealed that a complication within 90 days could result in at least AUD 4041.96 out-of-pocket expenses per elective surgery episode. The cost-to-care evaluation included the direct or indirect out-of-pocket costs advised by multiple survey participants, accrued by leave days from work, follow-up sessions, carer, and transportation. The results were applied to a full-time employed public hospital patient without private insurance

and allocated follow-up location within 15km of the place of residence. It is common for public hospitals to discharge patients to health services within residential catchment areas. The survey findings connected financial outcomes with known sociodemographic risk of avoidable readmissions through a health economics discussion, revealing the potential magnitude of extra out-of-pocket costs from individual qualitative feedback.

As examined in Chapter six, apart from the accrued capital cost, the time cost of wound management also significantly impacts patients' financial and wellbeing status. Literature (Jørgensen et al., 2013) indicated that around 15% of chronic wounds in Danish home care remain unresolved one year after presentation, with 85% of total postoperative wound management costs are due to healing time, the frequency of dressing changes, and complications (Lindholm & Searle, 2016) leading to increased nursing costs. Apart from our findings in prolonged time cost borne by the alternate dressing changes and extra follow-up sessions, a Canadian study (Lee et al., 2015) also concluded that return to work and caregiver burden from a societal cost perspective are the main parameters to measure postoperative recovery effectiveness. Beyond the alignment of findings with existing literature, our survey responses further indicated that each dressing session lasted approximately 30 minutes, while complications led to extra sessions taking up to at least two months. Results further concluded that three-quarters of survey participants required at least one to three baseline follow-ups and days off work planned in association with initial elective surgery, excluding any complications-related sessions. Participants with complications required at least an extra four to nine days off from work. With a more detailed explanation of costs incurred in individual sessions, this study adds value in addressing the specific factors contributing to the costs and the reasoning behind each parameter to improve hospital care and individual experience. The unexpected, yet avoidable, increase in length of stay and recovery time not only leads to financial strain but mental and physical distress, resulting in a wellbeing impact for patients and families from altered daily routines. Future studies can consider investigating recovery challenges from treatment timeframe and patient access perspectives to tailor better interventions for surgical care.

7.1.4 Implications of avoidable complications on wellbeing consequences

Results from Chapters five and six are addressed under this theme. As presented in Chapters two and four, the current literature body should address qualitative feedback from stakeholders involved in surgical care, confining complication consequences at each recovery stage. Comprehensive studies focused on length of stay and intensive care hours from the hospital incidence estimation and resource monitoring, with a limited emphasis on patient mortality and morbidity in elective surgery.

Chapter five showed that readmission led to an extra 16.5 days of hospital stay on average. As noted in another report (Victorian Auditor-General's Office, 2015) prolonged stays affected the effective use of hospital resources, increased the risk of complications and diminished patient quality of life. Our findings also demonstrated a 16.9-hour on average increase in intensive care in the readmission group, which aligned with other literature regarding the association between extended ICU stay and increased odds of readmissions(Brown et al., 2021; Dailey et al., 2013). Other literature indicated that an extended ICU stay from complications was associated with at least a 20% higher hospital mortality rate(Rubins & Moskowitz, 1990), Few studies have used QALYs and DALYs to estimate the postoperative burden of adverse outcomes. A Canadian study (Mohtashami et al., 2020) demonstrated that key complications following inguinal hernia repair ranged from 0.01 to 12.1 DALYs, with a mean score of 0.06 DALYs for inguinal hernia. A US study concluded that complications following elective spine surgery resulted in a nearly $25,000 higher total cost per QALY gain(Chotai et al., 2017). The primarily quantitative and sparse research on the wellbeing burden of surgical readmissions resulted in the necessity to capture stakeholder input on surgical care other than standardised quantitative reporting.

In association with postoperative adjustment to financial stress, patients from various sociodemographic backgrounds encounter various levels of wellbeing burden. Chapter six dissected the impact of complications across a diverse patient, carer and clinician group to fill the gap by understanding challenges in the elective surgery journey. Survey results showed anxiety and pain from prolonged recovery periods with the financial stress of patients and carers are the main wellbeing concerns in complications. Survey findings agreed with a perioperative study (Berlin et al., 2024) that 64.3% of individuals who considered elective surgery were very or somewhat concerned about pain or discomfort, with over half of the group reporting worries about

the difficulty of recovery. Patients, especially older adult such as those aged over 80, had a higher readmission risk (Chapter five), are also concerned about the cost of carer and time needed to be off work. Chapter six discussed the time and capital cost for patients and carers, agreeing with an analysis (Hah et al., 2021) that leave from work could lead to income and productivity loss from patient and employer perspectives. The clinician survey also demonstrated that treatment for surgical wound complications lasts at least two months, with the potential to return to work before full recovery. This finding shared the view on prolonged recovery period with a study on orthopaedic elective surgery (Rossvoll et al., 1993) that more than half of the patients were incapacitated to return to work within the first year after surgery. Our finding reported postoperative care often occurred at home or in community services with wellbeing challenges in recovery duration and symptoms such as the smell of wounds and pain. An acute hospital study (Wong et al., 2012) also suggested that a transitional care management program could attain QALY gains at 28 and 84 days, with an 89% chance of being cost-effective at the £20000/QALY threshold. In correspondence to the location and nature of postoperative care, additional support to patients and carers is therefore particularly important during transition of care across hospitals and community services.

The need for mental health assistance is strongly associated with the risk of readmission, indicating the importance of improving the capture of social needs and comorbidities during admission. After controlling for preoperative psychosocial outcomes, surgical complications could significantly decline wellbeing status, leading to adverse psychosocial consequences for at least 12 months after surgery (Pinto et al., 2016). The lack of perioperative social needs in the hospital database resulted in limited support provided to vulnerable patients, who have a higher risk of readmission and complications. Inadequate communication among health services and ineffective education to patients and carers are the main wellbeing challenges affecting incentives in care. Some clinicians in this study agreed that the level of assistance was minimal after discharge, impacting patients' confidence and involvement to avoid complications in postoperative care. Another study (Andersson et al., 2010) also indicated that patient concerns should be addressed more often when planning individual care to build patient-professional relationships. In relation to this study, postoperative complications, particularly in vulnerable groups with financial stress, may hinder the process of postoperative care and lead to a vicious cycle of an extended recovery period and

wellbeing distress. In order to facilitate early complication detection, rather than focusing on one-way provision of information, practical communication across services is required to ensure data is adequately noted and circulated in postsurgical care to ensure multidisciplinary patient care.

Our findings revealed that patients who are non-English speaking or require an interpreter have a higher risk of avoidable readmissions attributed to complications. A study (Kostareva et al., 2023) also suggested that culturally and linguistically appropriate service is required to respond to individuals' demographic changes and health literacy needs. For countries with culturally diverse populations, a US study on orthopaedic patients (Dailey et al., 2013) found increased odds of readmission in African Americans, American Indians and Alaskan Natives. Similarly, in Australia, 22% of the population used a language other than English at home, while 3.4% indicated they spoke English not well or not at all in 2021 (Australian Bureau of Statistics, 2021). Effective communication with culturally diverse support, primarily after discharge, is therefore essential to ensure health quality and equity by responding to the sociodemographic characteristics of the population.

Certain level of readmission burden was evident from elective surgery stakeholders across results in this thesis. In Chapter five, vulnerable groups had a high readmission risk, while survey responses from Chapter six indicated concerns in tracking patients in the community. Despite the high incidence rate of surgical readmission and complication, existing recruitment challenges in survey respondents reflected obstacles in postoperative connection with patients. The recruitment barrier redirected to the urge on finding an adequate pathway to connect with postoperative patients and carers in the community, especially for those who required extra assistance. The limited response rate also raised concerns on whether awareness in complication or readmission should be further advocated. The low response rate from health professionals also questioned whether the current streamlined hospital service and policy also considered actions after discharge as part of quality of care in recovery pathway, or willingness to take part in research survey. As noted in Chapter six, clinicians were satisfied with the level of assistance provided to them but were reserved about the assistance provided to patients with only fragmented discussion on wellbeing status such as anxiety and quality of life. The current focus of elective surgery care should be expanded to various perspectives and settings other than hospital to discuss about rigidity concerns

and utilisation of resources to consider propensity of discharge involvement to ensure patient centre care is better connected.

7.2 Strengths and limitations

Apart from the strengths and limitations discussed in Chapter four, five and six for each manuscript, the main strength of this thesis is to raise the perspective of patients above the current hospital data reporting. The case study in Chapter six involved health economics insights on health equity according to sociodemographic characteristics, which could lead to better resource utilisation in hospitals and the community during postoperative care. This research provides a clear guide by analysing quantitative and qualitative evidence through all chapters on what needs to be revised and improved in each stage of the surgery care pathway. The analysis of principal diagnosis and complications in hospital database at Chapter five demonstrated potential generalisation to country with ICD-10 codes reporting.

We included all patients from both public and private hospitals, regardless of which state and elective surgery they have underwent in our recruitment process. The size of CVDL patient pool allowed generalisation of hospital patients with complications as potential consequences of elective surgery. Additionally, the patient and clinician questionnaire filled the existing gaps in hospital data by collecting feedback on avoidable complications from both hospital and community through rehabilitation workers, nurses, and GPs. The approach created a fuller picture from stakeholders' perspective to address cost and well-being changes in postoperative care up to 90 days, which currently most literature focused on only 30 days.

This thesis highlights findings from all Australian hospitals which should be interpreted under several limitations. Apart from the constraints in surveys recruitment, suspension of elective surgery due to COVID-19 pandemic (Premier of Victoria, 2022), could also reduce the number of eligible episodes for this study. The reallocation of hospital resources and cancellation of elective surgery could impact the record of comprehensive admission elective surgery data during the pandemic. Besides, patients and clinicians' surveys capture all types of Australian hospitals, while the defined criteria for PI-23 unplanned 28-day readmission only referred to public patients with particular index surgery returning to the same hospital. Notwithstanding the linkage of patient ID

across hospitals, additional limitations may arise from negating other elective procedures and related complications. Since tracking every patient in the community was nearly unattainable and challenging, there is a potential to underestimate rate of adverse events and readmissions in elective surgery. Confounders, such as known comorbidities and social and mental needs, are highly dependent on the data quality of the hospital database and during the transfer of care in determining the risk of complications and readmission rate. Hence, despite acknowledging the validity and accuracy of data, it is intricate to estimate the overall burden due to disparities in follow-up pathways and definitions of complications and preventable readmissions.

CHAPTER 8: CONCLUSIONS

8.1 Implications

8.1.1 Policy

With an emphasis on the prevention of complications, recent literature depicts an overview on relationship between preoperative encounter and avoidable readmission in hospital settings. Length of stay and intensive care hours are the main hospital measures of quality of care. Through reporting definitions and factors relating to complications and avoidable readmission across a broad spectrum, this study demonstrated the necessity of an extensive framework for other parameters to incorporate into quality care evaluation and prevention.

As a one-size-fits-all approach in reducing unplanned readmissions may not be effective (Considine et al., 2019), this thesis suggests that measurements in preventable readmissions could extend to socioeconomic characteristics, stakeholders involved in care, and postoperative care instead of merely relying on perioperative prevention and standard hospitalisation parameters such as length of stay. There is a level of ambiguity regarding definitions and types of readmissions and complication in current literature. Apart from a well-defined criterion, distinct patient groups should be examined under each definition to provide an overview of epidemiology and trends to better utilise and address the resource gap in the existing policy. Following the established association between social care needs such as mental health and complications, other societal risk factors could predict surgical complications and factors leading to long-term psychosocial outcomes (Pinto et al., 2016). Hospital databases and collection of perioperative information should better capture comorbidities, accommodation status, and social support requirements during elective surgery admission to improve comprehension of patient needs. Future policy interventions on postoperative follow up should aim to advocate patient centred care to increase adherence and continuity of care. For instance, combining multiple follow up appointments across specialty with multidisciplinary team at a single location or on the same day could address financial incentives, follow-up completeness and valid education to patients and carers. The application of health economics policy evaluation in terms of transportation, reduction of missed workdays and follow up sessions could mitigate financial and wellbeing stress in postoperative care and enhance engagement in quality of care.

8.1.2 Clinical practice

Regarding the qualitative feedback from stakeholders, future resources should be allocated to communication and patient education, mainly to high-risk readmission groups such as those from diverse cultural backgrounds and those admitted to public hospitals due to workload and transfer of care. In terms of improvements in practice, clinicians advised enhanced communication among health professionals and between health services and patients. For instance, patient education materials could be broadened to include wound care at home and early infection detection, advising patients on the optimum situation to seek additional care if required. Culturally competent education such as infographics and language support upon discharge can also assist patients and carers in overcoming language discordance in accessing care. By examining patient views and other societal barriers in attending care, clinicians raised incentives to follow up as one of the main challenges post-discharge. In conjunction with patient education, bulk-billed telehealth and video conferencing allow health professionals to inspect wounds remotely. This method ensures recovery satisfaction and minimises financial stress by reducing leave days off work, transportation and other out-of-pocket costs, lessening wellbeing impacts such as pain, smell and discomfort while returning to work. The results also showed that in addition to out-of-pocket expenses, access to care may be a future contributing obstacle. Social care needs and risks to readmit (Dailey et al., 2013) such as mental health assessment during admission should also be investigated apart from emphasising perioperative care. Follow-up sessions should be adapted for corresponding patient groups with continuous determination of social care needs to ensure the patient is reviewed at an agreed timeframe in support of preventative measures to sustain care coordination.

Beyond the current developed formality of care and database in hospital, an all-rounded assessment of quality of care, including readmission and complications, from various perspectives of stakeholders for instance clinicians, patients and carers, are needed to address parameters to sustain wellbeing and financial status during postoperative and transfer of care. Wellbeing could also relate to consensus of follow up sessions include take home care and community care. Provided wellbeing status were only vaguely discussed in the survey responses and current literature, a greater stress should be laid in this aspect.

8.1.3 Future research

Further health economics and qualitative studies should consider cost and wellbeing as a comprehensive framework. Apart from improvements in capturing hospital parameters, social factors such as comorbidities should also be the focus to promote efficient resource allocation without diminishing the quality of postoperative care. Instead of depending exclusively on length of stay and intensive care hours, research should integrate financial and quantitative wellbeing measurements to investigate the overall burden and effectiveness of care according to socioeconomic status. The impact of surgical complications can be determined quantitatively by DALYs, and the development of new disability weights (Lee et al., 2015) will enhance the measurement of common adverse postoperative outcomes. The current study was restricted to hospital database and recruitment of limited group of patients from the community. More research on complication and readmission rates in community health services could provide an overall perspective through addressing the nature of postoperative pathway and verifying its consequences in the community.

Knowledge gaps were identified from the viewpoints of patients and stakeholders, particularly from older populations or vulnerable groups. Since follow-up sessions and distance are the primary concerns expressed by patients in this study, only transportation and the presence of a carer are considered as out-of-pocket costs. While complications may lead to a prolonged recovery, additional studies can investigate the carer's contribution and wellbeing throughout the recovery period to further dissect the health economics aspect of readmission impact. Further research can analyse the type and extra out-of-pocket costs and the possibility of generalising interventions in other countries with comparable Medicare systems. It is known that non-private insurance is more likely to result in avoidable readmission; upcoming study can also examine the relationship between Medicare, private insurance coverage and postoperative pathway to identify factors contributing to the increased odds. Due to the paucity of literature on out-of-pocket expenses, there needs to be more evidence to generate alternative approaches in measurement and generation of financial burden results in a broader population. The definitions of complicated readmission vary depending on the investigation criteria. Future investigation is necessary to initiate practical interventions to determine the interrelation of factors influencing length of stay, discharge destination, and outcomes across patient groups. The essence is to demonstrate the magnitude and

patterns of impact and avoid disparities in knowledge for better decision-making, effective strategies and streamlined care.

8.2 Conclusions

This thesis utilised various research methods and identified findings that could enhance knowledge associated with sociodemographic on complications and level of assistance in postoperative care, thereby improving health equity and multidisciplinary care provided to elective surgery patients. Seven key findings emerged from the research of this thesis:

1. The incidence rate of PI-23 unplanned 28-day readmission is 1.7%, while wound infection is the most common complication.
2. Aged over 80, requiring an interpreter or mental health assistance is associated with PI-23 unplanned readmissions. Patients with non-English-speaking background and in public hospitals are also highly associated with complications within 90 days.
3. Avoidable readmission incurs a significantly higher average hospitalisation cost ($97,747) than the non-readmission group ($7,779), except for non-operating theatre room costs.
4. Individuals may need to take an extra four to nine days off work due to complications, resulting in at least $4041.96 in out-of-pocket expenses due to transportation, carers, and loss of workdays.
5. Avoidable readmission significantly increases the mean length of stay and intensive care hours to 16.45 days and at least 16.86 hours.
6. Postoperative recovery may take at least two months, requiring patients to alternate dressings, with each session lasting 30 minutes for wound cleaning and washing, leading to wellbeing distress.
7. Challenges in patient education and health service communication resulted in minimal clinical assistance, leading to a loss of patient incentives and obstacles in detecting early complications.

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APPENDIX

CVDL Data sources and full descriptions

Source	Column name	Report in	Description
VAED (Admin/ Demographics)	AccomodationBedDays	Admitted Episode	
	AccomodationType		
	AccountClass		
	AdmissionDate		
	AdmissionPhaseOfCareRefId		
	AdmissionSourceRefId		
	AdmissionTypeRefId		
	Age		
	BirthDate		
	CAMPUS		
	CampusId		
	CarePlanDocumentedDate		
	CarerAvailabilityId		
	CareTypeRefId		
	CountryOfBirthId		
	CriterionForAdmissionRefId		
	DiagnosesConcatenated		
	EMNL		L - elective
	hosptype		
	ICDDiagnosisCode		
	ICDDiagnosisId		
	IndigenousId		
	InterpreterRequiredId		

Source	Column name	Report in	Description
	Locality		
	LREGION		
	MaritalStatusId		
	OnsetDate		
	PatientTypeModifiedRefId		
	PatientTypeRefId		
	PreferredLanguageId		
	ProcedureBlockCode		
	ProcedureCode		
	ProcedureCodeId		
	ProcedureContractedCode		
	ProcedureContractedRefId		
	ProcedureDate		
	ProcedureDatetime		
	ProcedureDatetime		
	ProcedureNumber		
	ProceduresConcatenated		
	Program_ID		
	READMREH		
	RefugeeStatusId		
	REGION_R		
	RehabClinicalSubProgramRefId		
	RREGION		
	SamedayRefId		
	SeparationAccommodationTypeRefId		
	SeparationAccountClassRefId		

Source	Column name	Report in	Description
	SeparationModeRefId SEPREFER SourceOfReferralToPallCareRefId TransferFromCampusId TransferToCampusId		(3-163) Identification of the hospital campus the person has been transferred from, following separation from that hospital. Identification of the hospital campus to which the patient is transferred after separation from this hospital, i.e. SEPMODE = T.
VAED (Cost)	AlliedHealth ClaimDate FinancialYear FinancialYear FundingArrangementRefId HealthInsuranceStatusId HITHLOS HOSPFUND HospitalInsuranceLevelRefId IndirectAdmin IndirectAlliedHealth IndirectCoronaryCareUnit IndirectEmergencyDept IndirectImaging IndirectIntensiveCareUnit IndirectMedical IndirectNursing	Admitted Episode Cost	

Source	Column name	Report in	Description
	IndirectOther		
	IndirectPathology		
	IndirectPharmacy		
	IndirectTheatreNonOperatingRoom		
	IndirectTheatreOperatingRoom		
	IndirectTotalCost		
	IntendedDurationOfStayRefId		The intention of the responsible clinician at the time of the patient's admission to hospital, to discharge the patient either on the day of admission or a subsequent date
	IntentionToReadmitRefId		
	LengthOfStay		The intention of the responsible clinician, at the time of the patient's separation from hospital, to readmit the patient within 28 days.
	LengthOfStayTypeRefId		
	Medical		
	NFC		
	Nursing		Type of length of stay
	Other		
	PBS		Indicates if the separation is eligible for funding through the National Funding Centre Program
	Pharmacy		
	pay_grp		
	Prosthetics		
	TheatreNonOperatingRoom		
	TheatreOperatingRoom		
	TotalCost		Grouping of hospitals according to Policy & Funding Guidelines (PFGs) payment rate groups.
	wATSI		
	WEIGHT		
	wHIWIES		

Source	Column name	Report in	Description
	WIES		
	WIESFUND		
	wIFS		ATSI co-payment for Aboriginal and Torres Strait Islander
	wITD		
	wTARGET		WIES accrued for high outlier days
			Total WIES including co-payments. The WIES version, xx, changes each year.
			Funding Inlier/Outlier status – takes into account mv hours.
			Inlier/Outlier status according to actual LOS – falling within the inlier boundaries no MV adjustments.
			Indicates whether this episode is subject to the same day medical target.
VAED (Wellbeing)	AdmissionBarthel	Admitted Episode	The Barthel Index is a measure of the type and amount of assistance a patient requires to perform basic functional activities
	AdmissionBarthelDate		
	AdmissionBarthelDatetime		
	FIMscoreAdmission		Functional Independence Measure FIMTM Score, as assessed on admission
	SeparationBarthel		
	SeparationBarthelDate		
	Separationdate		
	Separationdatetime		
	Separationdatetime		
ESIS	Admission Date	Elective Surgery Episode	

Source	Column name	Report in	Description
(Admin/ Demographics)	Age ReasonForRemovalRefId SurgicalSpecialtyRefId TreatmentCampusId		 The area of clinical expertise of the surgeon who will perform the elective surgery
	DOSA_Flag ReadinessForSurgeryRefId ReasonForRemovalRefId	Elective Surgery Episode Census	Day of surgery admission flag A patient's readiness at a given point in time to undergo this episode's awaited procedure The reason a waiting episode is removed from the waiting list
	BirthDate GenderId IndigenousId Locality Postcode	Elective Surgery Patient	
ESIS (Cost)	Destination Insurance_Declaration Planned_Length_Of_Stay	Elective Surgery Episode	Identification of the Campus: • that is accepting responsibility for the patient's waiting episode • where the patient is receiving treatment under contract or similar arrangement. The patient's insurance election, for a given episode The intention of the responsible clinician at the time the patient is placed on the waiting list, to separate the

Source	Column name	Report in	Description
			patient either on the day of admission or a subsequent date
Hospital-acquired Complications Specifications HAC v3.1	3. Healthcare-associated infection	ICD-10-AM11th Edition Episode	3.2 Surgical site infection T814 - T81.4 Wound infection following a procedure, not elsewhere classified
	4. Surgical complications requiring unplanned return to theatre		4.2 Surgical wound dehiscence T813 – T81.3 Disruption of operation wound, not elsewhere classified
Classification of Hospital Acquired-Diagnoses CHADx	CHADx 1 - Postprocedural complications	ICD-10-AM10th Edition Episode	1.8 Disruption of wound T813 Disruption of operation wound NEC
			1.9 Wound infection (excluding sepsis) T814 Wound infection following a procedure NEC