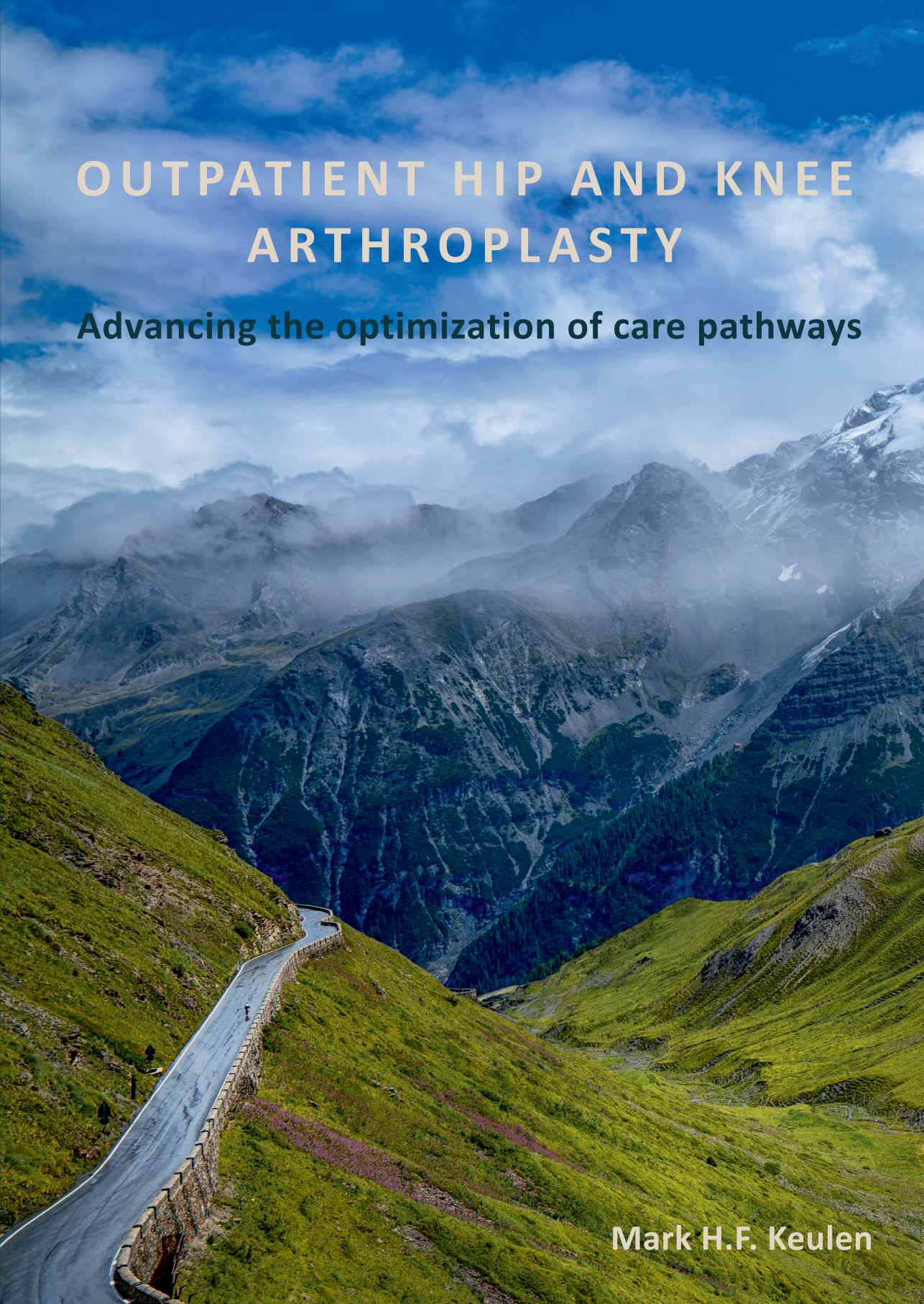
OUTPATIENT HIP AND KNEE ARTHROPLASTY

Advancing the optimization of care pathways



Mark H.F. Keulen

OUTPATIENT HIP AND KNEE ARTHROPLASTY

Advancing the Optimization of Care Pathways

by

Mark Hendrik Franciscus Keulen

COLOPHON

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PhD dissertation, Maastricht University, The Netherlands

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OUTPATIENT HIP AND KNEE ARTHROPLASTY

Advancing the Optimization of Care Pathways

DISSERTATION

to obtain the degree of Doctor at Maastricht University,
on the authority of the Rector Magnificus, Prof. Dr. Pamela Habibović
in accordance with the decision of the Board of Deans,
to be defended in public on Thursday, 30 October 2025, at 10:00 hours

by

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Voor mama

“All that I am, or hope to be, I owe to my angel mother”
– Abraham Lincoln

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PART I

General introduction

CHAPTER 1

GENERAL INTRODUCTION HISTORICAL BACKGROUND AND THESIS OUTLINE

1. HIP AND KNEE OSTEOARTHRITIS

1.1 Epidemiology and burden

Osteoarthritis (OA) is the most common chronic joint condition.[1] Weight-bearing joints, such as the hip and knee, are commonly affected.[2] The number of patients with hip or knee OA is projected to increase steadily. Although the pathophysiology of OA is multifactorial, this rise is often attributed to an aging and growing population (Figure 1), an increase in obesity, and a significant uptick in sports-related injuries (particularly for knee OA).[3-5] According to data from the Global Burden of Disease (GBD), Injuries, and Risk Factors Study, approximately 303.1 million individuals worldwide were living with symptomatic and activity-limiting hip and/or knee OA in 2017. In that year, the GBD reported a prevalence estimate of 3,754.2 per 100,000 population and an incidence estimate of 181.2 per 100,000 population, reflecting increases of 9.3% and 8.2%, respectively, since 1990.[6, 7]

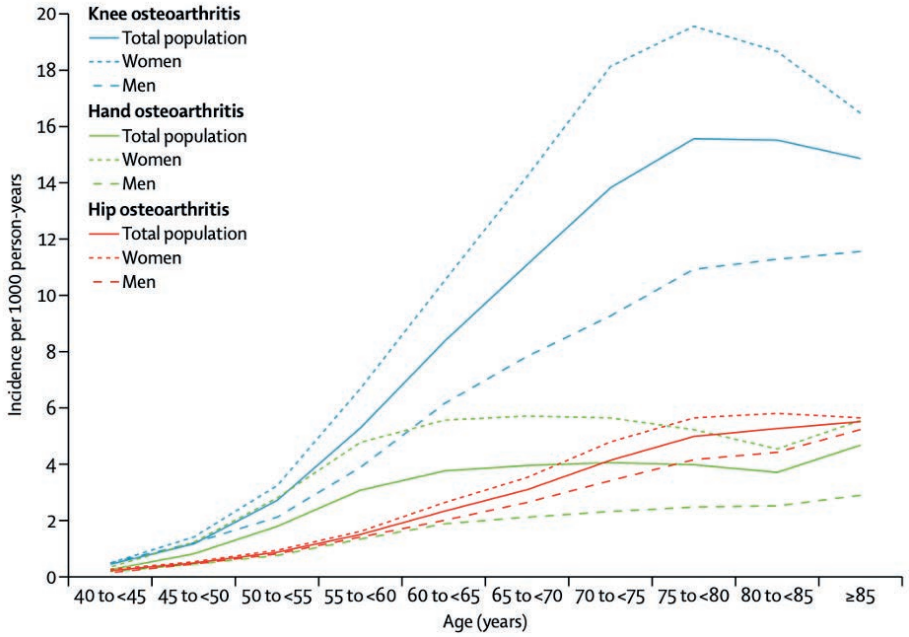


Figure 1. Age and sex-specific incidence rates (per 1,000 person-years) of knee osteoarthritis (OA) (blue), hip OA (red), and hand OA (green). Reproduced with written permission.[8, 9]

A further increase in OA's burden is also expected. Hip and knee OA are among the leading causes of chronic disability in older adults worldwide, ranking in the top 10 contributors to years lived with disability (YLD).[9] In 2017, hip and knee OA accounted for 9.6 million YLDs globally, underscoring its significant impact on quality of life

(QoL). With an aging population and the rising prevalence of OA, this burden is projected to increase in most countries, especially among women.[6, 10]

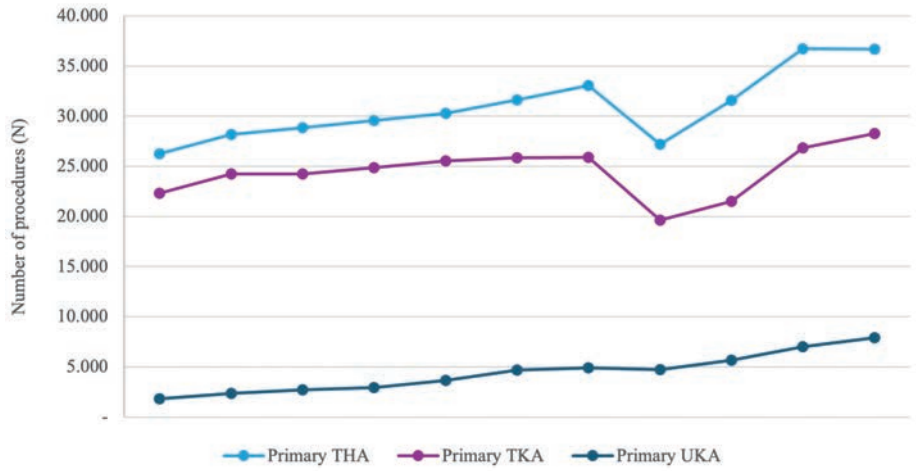
1.2 Total joint replacement of the hip and knee

Treatment of OA is rather difficult, and options are limited, as there is currently no cure or disease-modifying therapy available. For patients with symptomatic, end-stage OA of the hip or knee that is unresponsive to conservative therapies (e.g., lifestyle modifications, physical therapy, bracing, oral COX-2 inhibitors, intra-articular corticosteroids), total joint arthroplasty (TJA) may be considered.[11, 12] Total hip arthroplasty (THA) and total knee arthroplasty (TKA) are among the most common and most effective surgical procedures globally, with satisfaction rates of 94–96% and 82–89%, respectively.[13-16] Studies report excellent pain relief, significant functional improvement, and enhanced QoL following TJA, with low complication rates and high implant longevity.[17-22] Due to this success, combined with the growing demand for improved mobility and QoL at older ages and our enhanced ability to manage comorbidities perioperatively, the number of patients requiring knee or hip joint replacement is steadily increasing.[20, 23, 24] According to data from the Dutch Arthroplasty Register (LROI), the numbers of THAs, TKAs, and unicompartmental knee arthroplasties (UKAs) performed in the Netherlands has increased annually, with the exception of 2020 due to the COVID-19 pandemic (Figure 2).[20]

According to several international studies on TJA projections, demand is expected to grow continuously over the coming decades, although estimated growth rates vary significantly between countries.[24-32] This demographic shift toward an aging population, coupled with the rising demand for TJA, will place significant strain on healthcare systems and budgets worldwide, creating challenges in surgical planning, resource management, and hospital capacity.[25]

2. CARE PATHWAYS

Care pathways (CPs), also referred to as clinical pathways, critical pathways, or integrated care pathways, are basically clinical algorithms that outline a structured, evidence-based sequence and timing of key interventions for managing a specific group of patients with a particular diagnosis or undergoing a particular procedure (e.g., patients with hip OA requiring THA).[33, 34] CPs aim to reduce variability in clinical practice, maximize (cost-)efficiency and resource allocation, and improve patient outcomes and safety by minimizing treatment errors and complication rates.[33, 35, 36]



	Year										
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Primary THA	26,261	28,194	28,872	29,571	30,264	31,634	33,080	27,198	31,568	36,718	36,684
Primary TKA	22,301	24,242	24,244	24,884	25,555	25,835	25,885	19,615	21,517	26,837	28,286
Primary UKA	1,805	2,364	2,693	2,947	3,662	4,702	4,888	4,725	5,666	6,995	7,903

Figure 2. Number of primary total hip (THA), total knee (TKA), and unicompartmental knee arthroplasties (UKA) registered in the LROI in the Netherlands from 2013 to 2023. Reproduced with written permission from the LROI.[20]

2.1 Definitions of care pathways

In 2007, Vanhaecht[37], defined a CP as "a complex intervention for the mutual decision making and organization of care processes for a well-defined group of patients during a well-defined period. Defining characteristics of CPs include:

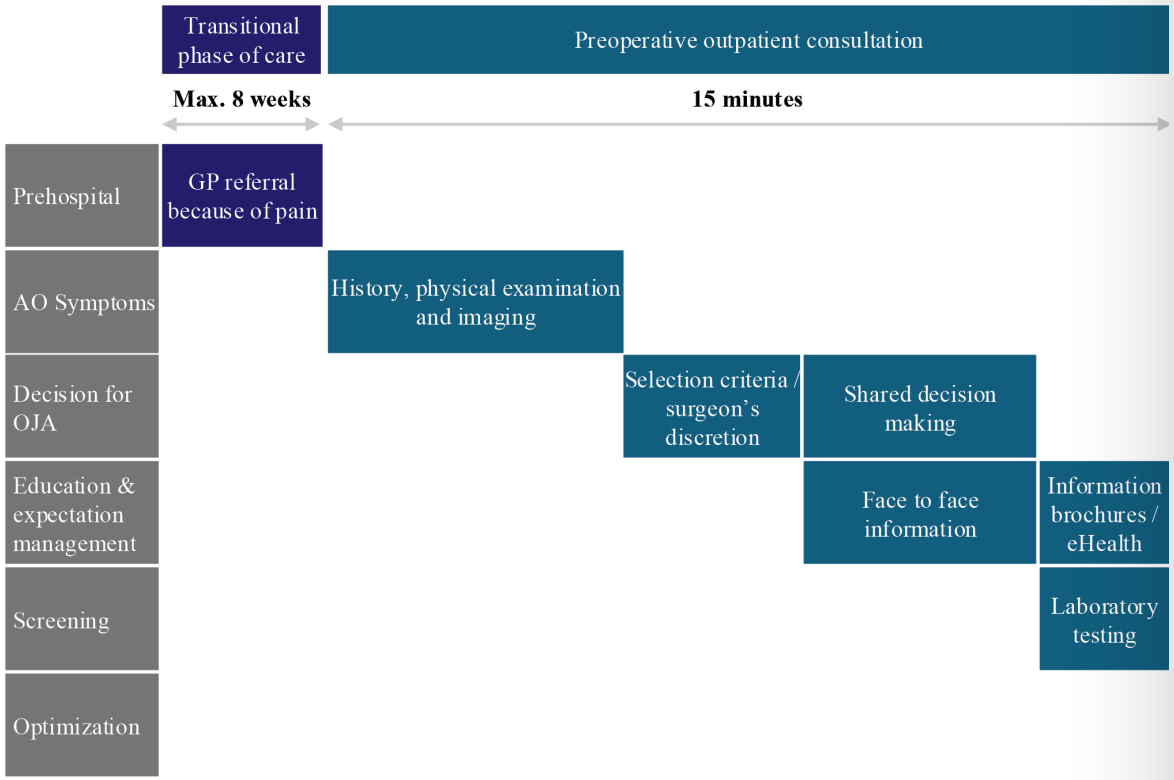
- An explicit statement of the goals and key elements of care based on evidence best practice, and patients' expectations and their characteristics;
- The facilitation of the communication among the team members and with patients and families;
- The coordination of the care process by coordinating the roles and sequencing the activities of the multidisciplinary care team, patients and their relatives;
- The documentation, monitoring, and evaluation of variances and outcomes;
- The identification of the appropriate resources."[37, 38]

2.2 Historical development and implementation of care pathways

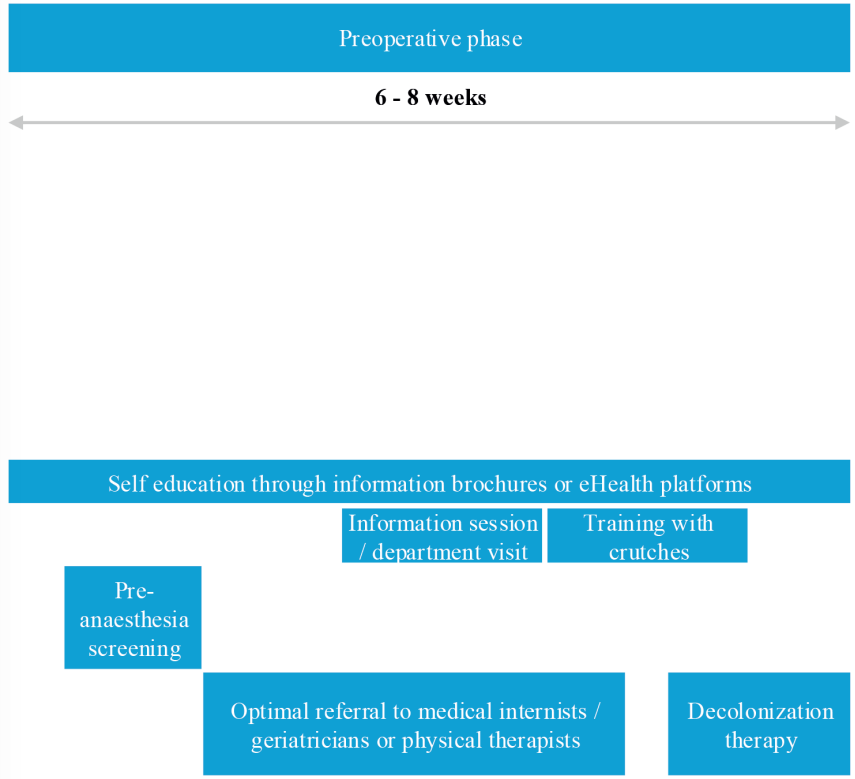
The concept of CPs originated from the Critical Path Method, developed in the 1950s for the construction industry to reduce costs by improving scheduling efficiency. This method involved an algorithm that identified the sequence of essential, interdependent steps needed to complete a project from start to finish.[33, 39-41] Over time, other management theories evolved, such as the Program Evaluation and Review Technique (PERT), Lean Six Sigma, Business Process Redesign, and the Theory of Constraints, further influencing the development of CPs.[33]

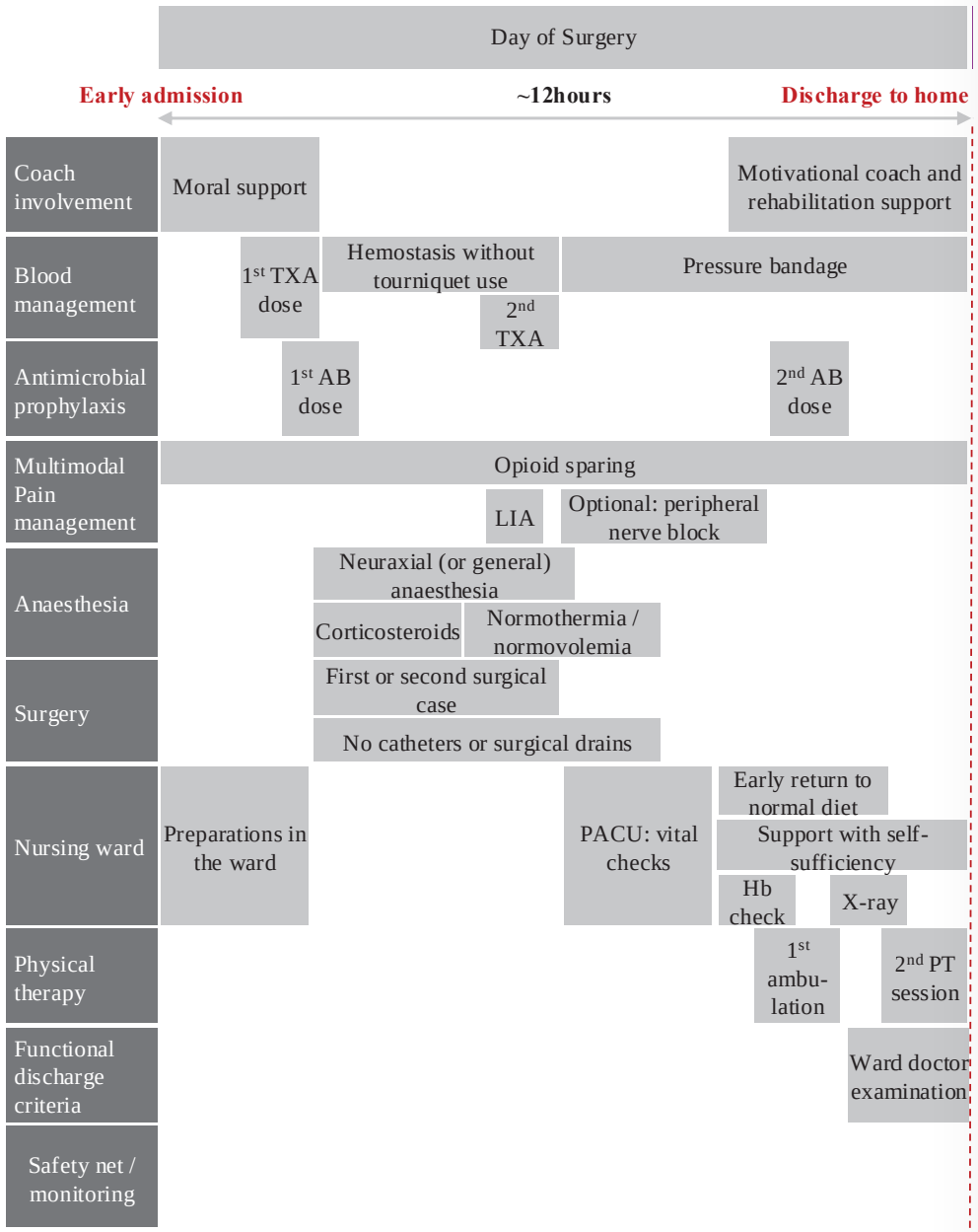
In the 1980s, this method was first applied to healthcare, with the New England Medical Center in Boston (USA) among the initial hospitals to implement and present CPs.[42-44] This shift was in response to the introduction of Diagnosis-Related Groups (DRGs) in 1983, which altered hospital reimbursement from a cost-based, retrospective system to a diagnosis-specific, prospective payment system. Under DRGs, hospitals received a predetermined budget and reference length of stay (LOS) per diagnosis, regardless of the actual resources used or hospital stay.[40, 42, 43] This incentivized efficiency in delivering inpatient services, prompting CPs to focus on managing costs and improving hospital efficiency while maintaining or enhancing care quality.

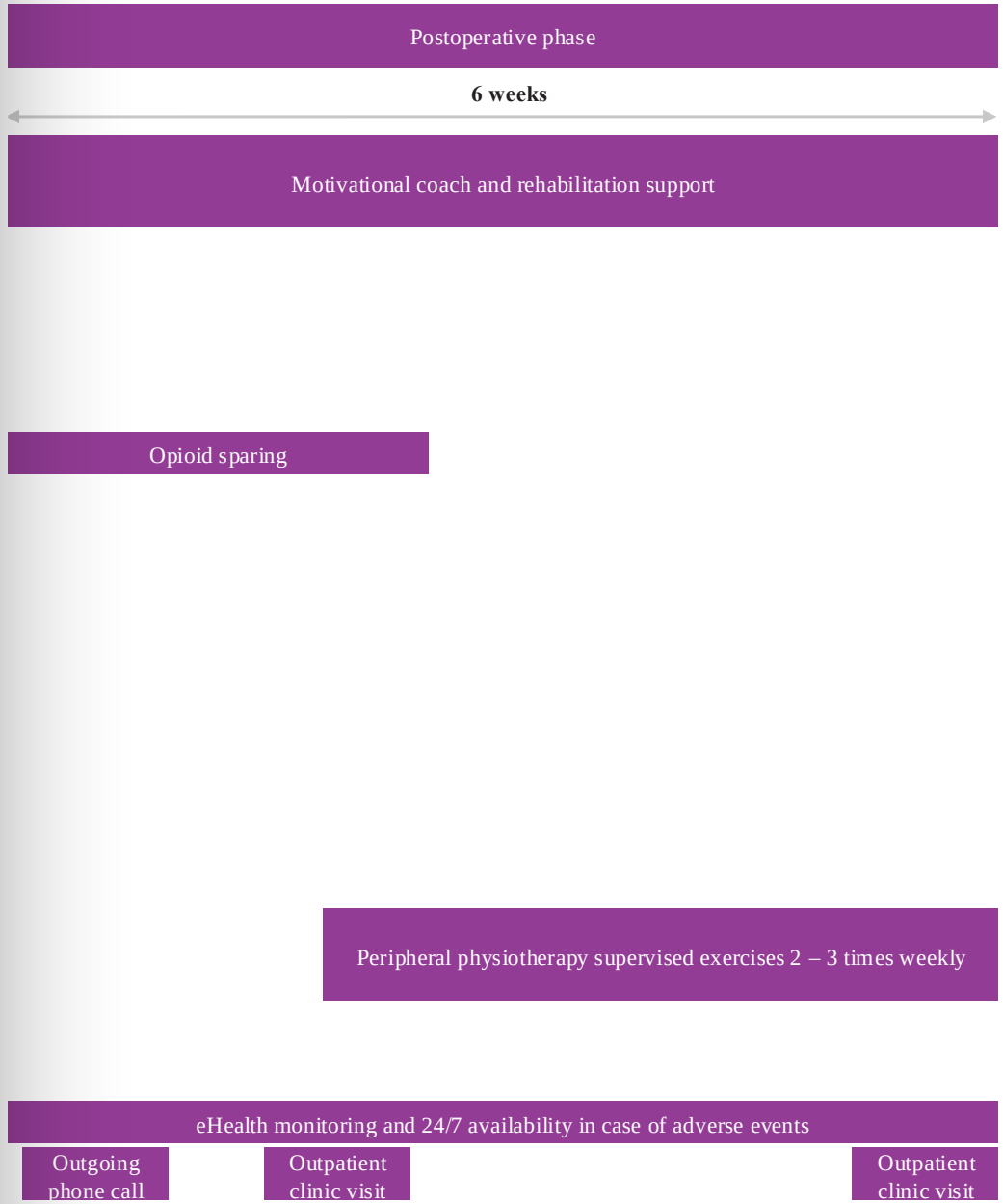
Since the early 1990s, CPs have been widely adopted across various healthcare systems. Pearson reported that by 1999, at least 80% of U.S. hospitals used CPs in some form.[41, 45] From the 1990s onward, CPs spread to the UK, Europe, and beyond.[34, 46, 47] In the Netherlands, the government has promoted healthcare improvements, including CPs, on a national scale.[35] The "Faster Better (Sneller Beter)" initiative launched by the Dutch Ministry of Health in 2003 aimed to improve patient safety and flow in 20% of Dutch hospitals over four years.[48] Additionally, the establishment of multidisciplinary guidelines in the early 21st century accelerated the national adoption of CPs.



A. Phases of the care pathway







B. Phases of the care pathway continued …

Figure 3. An example of a Gantt chart designed to outline the outpatient care pathway for patients undergoing total knee arthroplasty. A: including the transitional phase of care, preoperative consultation and preoperative phase. B: including the day of surgery and postoperative phase. GP = general practitioner; OA = osteoarthritis; OJA = outpatient joint arthroplasty; TXA = tranexamic acid; AB = antibiotic; LIA = local infiltration analgesia; PACU = post-anesthesia care unit; Hb = hemoglobin; PT = physical therapy.

2.3 Care pathways in orthopaedics

CPs are typically developed for high-volume, high-risk, and high-cost patient groups with specific diagnoses that are associated with highly predictable care processes and outcomes.[42, 43] Sermeus and Vanhaecht[49] estimated that approximately 60% of hospital care could be organized through CPs. In orthopaedic surgery, much of the care – such as for patients with hip or knee OA requiring arthroplasty – is well-suited to CPs due to its elective nature, predictable perioperative care, and high alignment among interdisciplinary team members. In these patient groups, chain models with time-task matrices, such as Gantt charts, are often used for coordinating and monitoring pathways. Gantt charts outline the CP timeline and illustrate the individual care processes of the multidisciplinary team (MDT), showing when each event needs to occur within the pathway (Figure 3).[40] Surgical CPs are typically divided into several phases: the preoperative phase (including the consultation in the outpatient clinic), the perioperative phase, the intraoperative phase, and the postoperative or post-discharge.

The first CPs for elective THA and TKA due to OA were introduced in the 1990s, showing success in reducing LOS and costs without compromising patient outcomes.[50-54] Since then, there has been a significant but gradual reduction in the average LOS following THA and TKA – from approximately three weeks in 1984, down to five days by the 2000s, and now to 2-3 days in the Netherlands.[55-58] Although healthcare systems and providers primarily drove CP implementation, commercial medical technology companies may have also played a role by offering consulting services and a CP blueprint to help hospitals adopt fast-track pathways.

By 2003, Berger and colleagues even described the feasibility of outpatient TJA, safely discharging patients on the same day as surgery.[59-65] A recent Danish study by Jenssen et al[66] noted a similar trend of decreasing LOS, and also demonstrated an increase in the proportion of outpatient joint arthroplasties (OJAs) performed from 2010 to 2020 (Figure 4a and 4b).

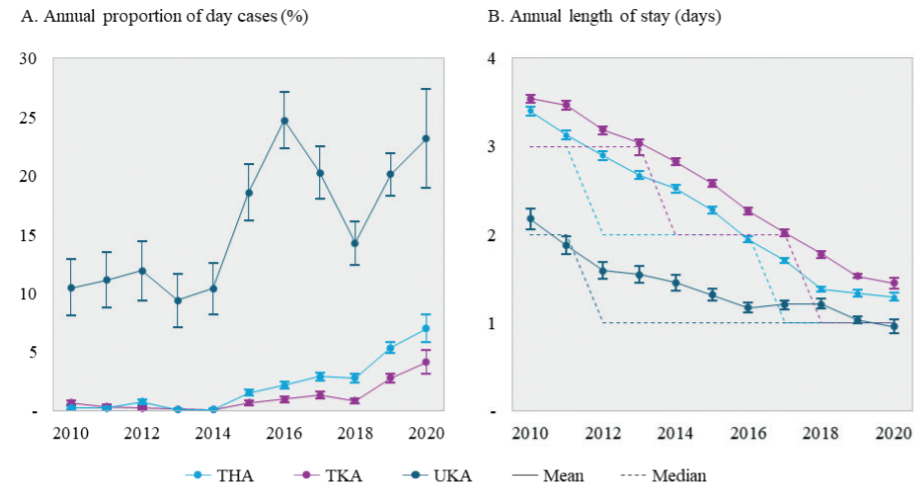


Figure 4. A: The use of day-case surgery sorted for total hip (THA), total knee (TKA), and unicompartmental knee arthroplasty (TKA) as a percentage of total number of performed procedures each year. B: The mean (solid lines) and median (dotted line) length of stay of THA, TKA, and UKA each year. Reproduced with written permission from Jenssen et al[66]

3. ENHANCED RECOVERY AFTER SURGERY

The concept of "enhanced recovery after surgery (ERAS)" was introduced by Kehlet[67] in 1997 and became integral to organizing CPs for major surgeries to improve outcomes and reduce postoperative morbidity and complications. This approach emphasized that the surgically induced stress response (which will be discussed in chapter 3.1) is a key pathogenic factor in postoperative morbidity, potentially leading to organ dysfunction.

Despite new innovations in perioperative techniques (e.g., neural blocks with local anesthetics, minimally invasive surgical methods), therapeutic strategies at the time were largely unimodal and often ineffective at reducing morbidity and complications, especially in high-risk patients.[68, 69] This approach suggested that orthopaedic surgeons often focused primarily on surgery-related complications, while anesthesiologists may have overlooked anesthesiology-related comorbidities due to limited postoperative follow-up. Kehlet[67] emphasized that adverse sequelae – such as cardiovascular or gastrointestinal complications – were rarely the result of surgical or anesthetic imperfections alone. He hypothesized that a multimodal, multidisciplinary approach targeting both the surgical stress response and perioperative risk factors would be more effective in minimizing adverse postoperative outcomes.

Initially, Kehlet applied the ERAS concept to patients undergoing colonic resection for neoplastic disease, as described in his key paper in 1995.[70] However, the concept was soon widely, albeit gradually, adopted for perioperative care in other major surgical procedures, including TJA, due to its demonstrated benefits for both patients and healthcare systems.[71-76] In TJA, these pathways are often referred to as "enhanced recovery," "rapid recovery," or "fast-track" arthroplasty pathways in the literature.

3.1 Surgical stress response

The surgical stress response is the body's physiological reaction to surgical trauma, encompassing neuroendocrine-metabolic and inflammatory-immune processes that promote tissue healing and body adaptation.[77-81]

The neuroendocrine-metabolic response is triggered by afferent nociceptive signals from the surgical site to the central nervous system, activating both the sympathetic nervous system (SNS) and the hypothalamic-pituitary-adrenal (HPA) axis. The SNS initiates the immediate "fight-or-flight" response, releasing catecholamines like adrenaline and noradrenaline, which increase heart rate, blood pressure, and mobilize energy. Simultaneously, the HPA axis is activated, leading to the release of cortisol, which helps sustain the body's metabolic demands over a longer period by promoting tissue catabolism, breaking down substrates such as carbohydrates, proteins, and fats. Other adaptive mechanisms include the release of antidiuretic hormone (ADH) and activation of the renin-angiotensin-aldosterone system (RAAS), which help retain water and salt to maintain fluid volume and cardiovascular homeostasis.[77-80] Perioperative strategies to help control these hormonal and metabolic changes, support recovery, and minimize complications include (1) multimodal analgesia and regional anesthesia (such as neuraxial anesthesia or peripheral nerve blocks); (2) maintaining normovolemia; (3) early oral feeding; (4) preventing hypothermia; (5) encouraging early ambulation; and thus (6) revision of traditional surgical care principles (e.g., avoiding nasogastric tubes, drains, and catheters).[67, 78-80]

The inflammatory-immune response to surgical stress begins immediately after tissue injury, aiming to control damage, initiate repair, and prevent infection. At the injury site, local cells such as leukocytes, fibroblasts, and endothelial cells release proinflammatory cytokines, including interleukin-1 (IL-1), tumor necrosis factor-alpha (TNF-α), and IL-6. These cytokines trigger an inflammatory cascade that attracts immune cells to the injury site, activating both innate and adaptive immune responses. Locally, neutrophils, lymphocytes, and monocytes migrate into inflamed areas due to increased endothelial permeability, adhesion molecules, and chemokines like IL-8. Systemic changes, known as the acute phase response, include

fever, neutrophilia, HPA axis activation (leading to cortisol release, which exerts a negative feedback effect on cytokine production), and liver synthesis of acute-phase proteins (e.g., C-reactive protein) essential for immunity and tissue repair.[78-81]

The innate immune response, as the first line of defense, involves neutrophils and macrophages containing pathogens and clearing damaged cells, while releasing cytokines and chemokines that intensify inflammation and recruit adaptive immune cells. The adaptive immune response follows, activating T-cells and B-cells that recognize antigens, produce targeted antibodies (humoral immunity), or trigger cell-mediated immunity. This precise immune activation helps clear pathogens and regulate tissue repair.[78-81]

The magnitude of the inflammatory-immune response varies with the extent and duration of surgery. Watt et al[82], showed that the response in TJA is substantial and comparable to major open abdominal (e.g., colorectal cancer) or vascular surgeries (e.g., abdominal aorta aneurysm repair). Minimizing this response may involve (1) minimally invasive surgical techniques, and (2) preoperative high-dose steroids to reduce the IL-6 and acute-phase response.[67, 78-82]

While these responses are essential for tissue healing, excessive or prolonged inflammation can disrupt balance, causing complications like immune suppression, infection, and delayed recovery.

3.2 Facets of enhanced recovery after surgery

3.2.1 Multidisciplinary team

Kehlet[67] emphasized the need for a paradigm shift to a multimodal approach led by multidisciplinary teams (MDTs) focused on accelerating perioperative recovery, improving overall quality of care (i.e., achieving better functional outcomes and reducing complication rates), and increasing patient satisfaction. Although the composition of these MDTs may vary across specialties and depend on the specific care required, the importance of a standardized approach cannot be overstated, as it aims to provide better patient care. An MDT should include professionals from various disciplines across the continuum of care (Figure 5), all fully committed to addressing patients' needs, preferences, and values.[83, 84] Actively involving patients and their informal caregivers – as designated coaches – in the recovery process is also key for improving treatment effectiveness, and both groups are often considered integral members of the MDT.[83, 85, 86]

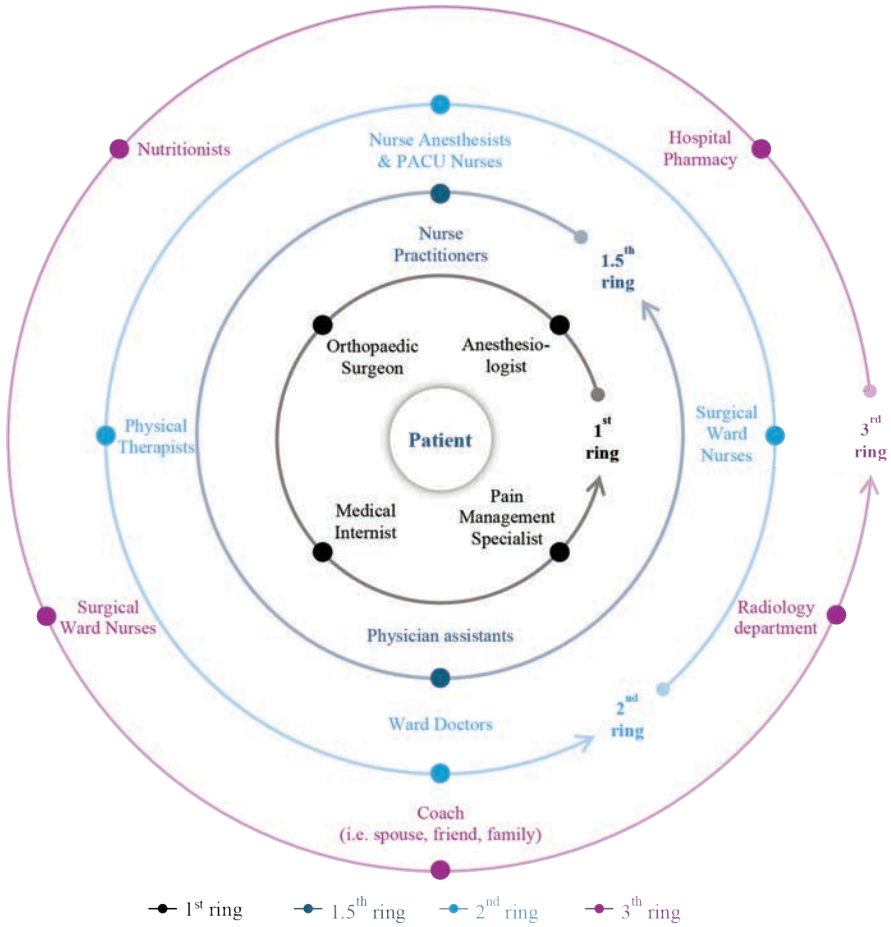


Figure 5. Composition of a multidisciplinary team for outpatient joint arthroplasty, with the patient at the centre. The first ring represents the medical specialists who design the clinical pathway (CP). Surrounding them are physician assistants (PAs) and nurse practitioners (NPs), who serve as key links between the first and second rings. The second ring consists of healthcare professionals responsible for executing the CP at the patient's bedside, while the third ring includes supporting professionals who provide essential auxiliary services to ensure the CP's success.

3.2.2 Pathway components

ERAS-powered CPs re-examine traditional practices and replace them with evidence-based best practices. Since key interventions for CPs may vary across different procedures (e.g., colonic resections versus TJA), the ERAS® Society – a multidisciplinary, multi-professional, non-profit medical organization –

has published several consensus statements to assist MDTs in designing their pathways.[87-89]

In 2020, Wainwright et al[90] published recommendations for the perioperative care of patients undergoing THA and TKA. Key elements included a multimodal, opioid-sparing pain management regimen; the use of local infiltration anesthesia (LIA) (for TKA); preoperative identification and correction of anemia and the prevention of perioperative blood loss through administration of tranexamic acid; and avoidance of perioperative drains and urinary catheters. Early ambulation with functional discharge criteria was also emphasized. These findings are summarized in Table 1.[90]

Table 1. Summary of recommended interventions for the perioperative care of hip and knee replacement. Reproduced from Wainwright et al[90]

Item	Recommendation	Evidence level *	Recommendation grade *
Pre-operative phase			
1. Preoperative information, education and counseling	Patients should routinely receive preoperative education	Low	Strong
2. Preoperative optimization	• 4 weeks or more smoking cessation is recommended prior to surgery. • Alcohol cessation programs are recommended for alcohol abusers. • Anemia should be actively identified, investigated, and corrected preoperatively • Current evidence does not support preoperative physiotherapy (PT)	Smoking: high Alcohol: low Anemia: high PT: moderate	Strong
3. Preoperative fasting	Clear fluids should be allowed up to 2h and solids up to 6h hours prior to induction of anesthesia	Moderate	Strong

Table 1. Summary of recommended interventions for the perioperative care of hip and knee replacement. Reproduced from Wainwright et al[90] (*continued*).

Item	Recommendation	Evidence level *	Recommendation grade *
4. Preoperative carbohydrate treatment	Carbohydrate loading may improve patient well-being and metabolism, but it has not been shown to accelerate the achievement of discharge criteria or reduce complications, and so it is not currently recommended	Moderate	Strong
5. Pre-anesthetic medication	The routine administration of sedatives to reduce anxiety preoperatively is not recommended	Low	Strong
Intra-operative phase			
6. Standard anesthetic protocol	• Modern general anesthesia (GA) and neuraxial (NA) techniques may both be used as part of multimodal anesthetic regimes • Spinal opioids are not recommended for routine use • Epidural analgesia is not recommended for routine use in hip and knee replacement because of the potential for adverse effects which delay recovery	GA: moderate NA: moderate Spinal opioids: moderate Epidurals: moderate to high	Strong

Table 1. Summary of recommended interventions for the perioperative care of hip and knee replacement. Reproduced from Wainwright et al[90] (*continued*).

Item	Recommendation	Evidence level *	Recommendation grade *
7. Use of local anesthetics for infiltration analgesia and nerve blocks	• Within a multimodal opioid-sparing analgesic regimen, the routine use of local infiltration analgesia (LIA) is recommended for knee replacement but not for hip replacement • Nerve block techniques have not shown clinical superiority over LIA (and prolonged motor blockade may limit early and safe mobilization) and are not recommended	LIA in TKA: high	Strong
8. Postoperative nausea and vomiting (PONV)	Patients should be screened for PONV and provided with multimodal prophylaxis and treatment	Moderate	Strong
9. Prevention of perioperative blood loss	Tranexamic acid is recommended to reduce perioperative blood loss and the requirement for postoperative allogenic blood transfusion	High	Strong
10. Perioperative oral analgesia	• The routine use of paracetamol (PCM) and NSAIDs is recommended for patients without contraindications. • Gabapentinoids are not currently recommended as an adjunct in a multimodal analgesia regime although further studies are indicated • A multimodal opioid-sparing approach to analgesia should be adopted	PCM: moderate NSAIDs: high Gabapentinoids: moderate Opioid sparing: high	Strong

Table 1. Summary of recommended interventions for the perioperative care of hip and knee replacement. Reproduced from Wainwright et al[90] (*continued*).

Item	Recommendation	Evidence level *	Recommendation grade *
11. Maintaining normothermia	Normal body temperature should be maintained peri- and postoperatively	High	Strong
12. Antimicrobial prophylaxis	Patients should receive systemic antimicrobial prophylaxis in accordance with local policy and availability	Moderate	Strong
13. Antithrombotic prophylaxis treatment	Patients are at increased risk of venous thromboembolism (VTE) and should undergo pharmacologic and mechanical prophylaxis in line with local policy. Patients should be mobilized as soon as possible post-surgery.	Moderate	Strong
14. Perioperative surgical factors	• There is no conclusive evidence that choice of surgical approach (in THA) accelerates the achievement of discharge criteria. • The routine use of a tourniquet is not recommended • The routine use of surgical drains is not recommended • The routine use of urinary catheters is not recommended and when used they should be removed as soon as the patient is able to void, ideally within 24 hours after completion of surgery. A catheterization threshold of 800 mL should be used to reduce the need for postoperative urinary catheterization	Approach: High Tourniquet: moderate Drains: moderate Urinary catheter: moderate	Strong

Table 1. Summary of recommended interventions for the perioperative care of hip and knee replacement. Reproduced from Wainwright et al[90] (*continued*).

Item	Recommendation	Evidence level *	Recommendation grade *
15. Perioperative fluid management	Fluid balance should be maintained to avoid over- and under-hydration (IV fluids should be used judiciously and postoperative intravenous fluids discouraged in favor of early oral intake)	Moderate	Strong
Post-operative phase			
16. Postoperative nutritional care	An early return to normal diet should be promoted	Low	Strong
17. Early mobilization	Patients should be mobilized as early as they are able in order to facilitate early achievement of discharge criteria	High	Strong
18. Criteria-based discharge	Objective discharge criteria should be used to facilitate patient discharge directly to their home	Low	Strong

* The GRADE system for rating quality of evidence was used to evaluate the quality of evidence (high, moderate, low or very low) and recommendation (strong or low)[87, 91] The strength of the recommendation was based on the balance between desirable and undesirable effects.

3.2.3 Logistics

The involvement of MDTs and the incorporation of multimodal interventions in ERAS-driven CPs required ward reorganization and logistical optimization to ensure continuity of care – from preoperative assessment and surgical indication through to discharge and postoperative rehabilitation. In many healthcare institutions, this shift led to the creation of specialized care units for TJA within orthopaedic wards, optimizing logistics and standardizing care processes.[92, 93] This reorganization fostered a patient community within the ward, encouraging peer support, as patients could share concerns and learn from those at similar stages in recovery, which positively impacted rehabilitation outcomes.[94]

The continuous optimization of perioperative care, including improved management of comorbidities and more efficient resource allocation, has led to a gradual reduction in LOS following TJA. Although reduced LOS is not the primary aim of ERAS (following the principle "better first, then faster"), it is a beneficial outcome of enhanced care quality and improved functional results in a strained healthcare system. A shorter LOS can contribute to cost-effectiveness, reduced waiting times, and improved capacity planning.[95, 96]

3.2.4 Continuous auditing and pathway optimization

It's important to note that ERAS is a concept focused on the continuous improving of perioperative care processes. These ERAS-driven pathways are dynamic, evolving as new evidence emerges and outcomes are evaluated. Therefore, the MDT should routinely audit and update the pathway to incorporate the latest evidence-based interventions and optimize the patient outcomes and journey.[37, 67, 87]

According to Kehlet, a key question to ask each postoperative day is: "Why is the patient in the hospital today?" [67, 97, 98] If the same reason keeps recurring, it is important to also ask: "Is there an alternative approach that could support a better recovery while maintaining safety and achieving the desired outcomes?"

4. OUTPATIENT JOINT ARTHROPLASTY

In his 1997 paper, Kehlet[67] posed the question: "If surgical sequelae are controlled, one may ask if patients could undergo major surgery on an ambulatory or semi-ambulatory basis?". Now, two decades later, the literature on OJA of the hip and knee has expanded significantly, and its CPs are being increasingly implemented worldwide (Figure 4a).[66, 99-101] Berger and colleagues were the first to describe same-day discharge (SDD) following THA in 2003,[59, 60] and TKA in 2005.[61] In the Netherlands, the first results of OJA pathways were published more than 10 years later.[102-106]

4.1 Reduced in-hospital time

OJA, time is a crucial factor distinguishing it from traditional inpatient pathways (rapid recovery pathways), as the hospital stay is shortened, with patients typically discharged within about 12 hours compared to the traditional 48-72 hours in many Dutch hospitals. Patients and their caregivers must be medically and mentally prepared for SDD, ensuring they receive the same quality of care without compromising safety or placing unforeseen burdens on other healthcare providers after discharge.

Although perioperative care and outcomes in hip and knee arthroplasty are generally predictable, with most patients experiencing a similar postoperative course – including symptoms like swelling, pain, anxiety, wound discharge, nausea, fatigue, weakness, and dizziness – the short hospital stay limits time for (1) patient-healthcare provider interaction, (2) monitoring postoperative recovery, and (3) educating patients and addressing concerns. As a result, patients discharged on the day of surgery are expected to have greater self-management capabilities – including pain control, self-administering medication, managing daily self-care tasks and physical therapy exercises (Figure 6).[107, 108] This makes preoperative education and expectation management even more important than in traditional inpatient pathways. Additionally, it seems crucial to select patients who are not only physically fit for this approach but also intrinsically motivated to go home on the day of surgery, resilient, and possess effective coping strategies.[109-111]

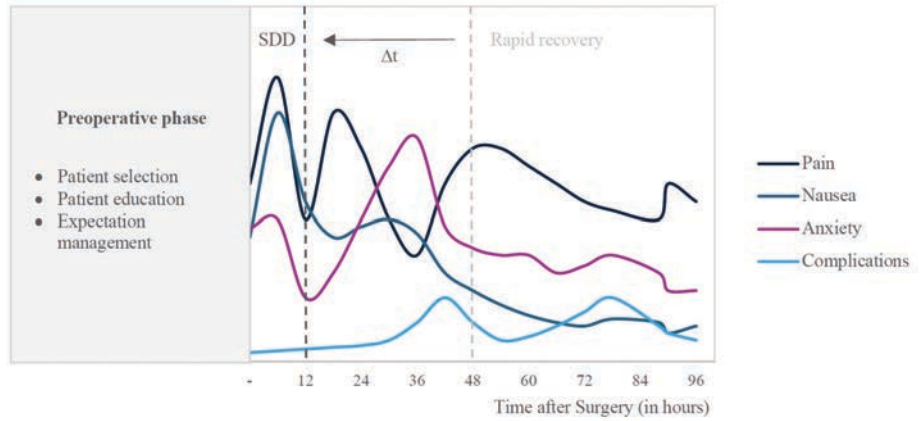


Figure 6. The potential effect of reduced in-hospital time (Δt) in outpatient joint arthroplasty compared to traditional rapid recovery pathways. While patients may experience symptoms such as pain, nausea, and anxiety – or face potential complications – shorter hospital stays limit patient-provider interaction, postoperative monitoring, and education, underscoring the need for stricter patient selection, enhanced preoperative education, and effective expectation management.

The development of OJA pathways relies on the continuous optimization of perioperative care and logistics within the framework of established rapid recovery pathways.[112-114] Although advancements in perioperative care have significantly reduced complications after TJA, these procedures remain high-risk, particularly as more patients present with preexisting multiorgan comorbidities and as the elderly surgical population grows. While some evidence suggests OJA can be safe for unselected patient populations,[115-117] most often, strict selection criteria are applied to

ensure patients are medically fit and have a low risk of complications, distinguishing OJA from most rapid recovery pathways.[118] As most serious complications requiring intervention typically peak within the first four days after surgery, it can be hypothesized that patients who are discharged on the day of surgery are at risk during the period when they are no longer under continuous monitoring, potentially also increasing the likelihood of readmissions.[67, 115, 119, 120]

5. AIMS AND OUTLINE OF THIS THESIS

We aimed to assess the implementation of OJA of the hip and knee from the perspectives of (1) the healthcare institution, (2) the orthopaedic surgeon, and (3) the patient.

5.1 Healthcare institutions' perspective

5.1.1 What is the current evidence on outpatient joint arthroplasty?

From a healthcare institutional perspective, implementing OJA could be beneficial if it is proven to be feasible, efficacious, safe, and capable of delivering non-inferior clinical outcomes, despite the reduced in-hospital time for patients, thereby promoting cost-effectiveness. While some literature presented conflicting outcomes, growing evidence now appears to support the feasibility and advantages of OJA.[115, 121-125] However, it is essential to distinguish and accurately interpret the varying definitions of OJA within this evidence, as some authors define OJA as a LOS under 24 hours with an overnight stay,[116, 122] while others strictly require SDD.[102, 104-106, 112, 126, 127] Bovonratwet et al[128] highlighted this ambiguity, finding that only 12% of outpatients in the 'National Surgical Quality Improvement Program' (NSQIP) database – a nationally validated outcome-based program of the American College of Surgeons, frequently used for comparing outcomes in TJA – were actually discharged on the same day as surgery.[127, 129-131]

Due to these inconsistencies, a systematic review and meta-analysis on outpatient pathways' efficacy, safety, and cost benefits for hip and knee arthroplasty was conducted in Chapter 2. The included studies were grouped based on the OJA definition as either (1) outpatient surgery: "patients discharged to their own home on the day of surgery without an overnight stay at the hospital or another non-home facility"[113]; or (2) semi-outpatient surgery: "LOS under 24 hours or studies with unclear outpatient definitions".

5.1.2 Clinical outcomes from an outpatient joint arthroplasty cohort

Based on Berger et al's[59, 60] pioneering work, three key factors for successful OJA implementation were initially identified: (1) strict patient selection, (2) scheduling surgery as the first (or second) case of the day to optimize planning and recovery, and (3) minimally invasive surgical techniques. These strategies have since evolved to include elements like preoperative education on SDD, multimodal opioid-sparing analgesia with intraoperative local infiltration LIA, TXA administration, et cetera.[90, 112] Over time, various OJA pathways – including our own – have emerged across healthcare institutions, maintaining general similarities but with some variations, such as in patient selection criteria.[111, 118, 125, 132-135]

As outlined in Section 3.2.4, periodically evaluating outcomes is essential for continuous improvement of these pathways. Chapters 3 to 5 of this thesis present experiences from the first 5.5 years with the OJA pathway at a local teaching hospital, based on a database of selected patients planned for outpatient THA, TKA, or unicompartmental knee arthroplasty (UKA) according to predefined selection criteria and surgeon discretion.[118] Inspired by Kehlet's question, "Why is the patient in the hospital today?", Chapter 4 investigates reasons for unsuccessful SDD in this preselected patient group. Chapter 5 builds on this by identifying patient-related risk factors for unsuccessful SDD, attempting to further refine the selection process. Given the potential risks and likelihood of readmission in the initial days after surgery, as outlined in Section 4.1, Chapter 6 examines complications and readmissions among these patients planned for OJA.

5.1.3 Research questions from the healthcare institutions' perspective

In Chapter 2 to 5 of this thesis the following research questions will be addressed:

- Are OJA pathways as safe and effective as traditional inpatient pathways?
- Do OJA pathways reduce hospital costs compared to traditional inpatient pathways, and if so, to what extent?
- What are the main reasons of unsuccessful SDD?
- What patient-related risk factors contribute to unsuccessful SDD?
- What are the 30- and 90-day complication and readmission rates, and what risk factors are associated with them?
- What are the medical and surgical causes of complications and readmissions?

5.2 Surgeons' perspective

5.2.1 The surgeons' perspective on outpatient joint arthroplasty

Recent registry studies from the USA and Denmark examined the 10-year trend (2010 to 2020) in outpatient hip and knee arthroplasties, both showing a gradual increase in use.[66, 100, 101] In Denmark, however, this growth was concentrated in a few centers, suggesting OJA may be underutilized on a national level.[66, 112] Successful implementation of OJA is complex and requires careful attention to the factors that facilitate or hinder provider behavior change, which can vary across healthcare systems and may be specific to each country.[136, 137]

In the Netherlands, some research groups have shared their experiences with OJA implementation.[102-106, 138] However, the national utilization of OJA and the facilitators and barriers to its adoption remain unknown, likely due to its relatively recent introduction and the absence of LOS data in the Dutch national arthroplasty register (LROI).[20] Chapter 6 addresses this knowledge gap by presenting results from a nationwide survey on OJA usage among Dutch orthopaedic surgeons affiliated with the Dutch Hip Society and the Dutch Knee Society.

5.2.2 Differences between inpatient and outpatient pathways

To adapt OJA pathways, it is important for both healthcare institutions and healthcare professionals to recognize what would be needed for a successful transition. As described in Section 4.1, the OJA pathway is often distinguished by key features, including optimal planning of surgical cases, emphasis on patient education and expectation management, and well-defined patient selection criteria. Rather than solely focusing on optimizing logistical aspects of the pathway, it can be hypothesized that perioperative protocols within OJA pathways may be even more refined and innovative than those used in traditional inpatient (rapid recovery) pathways to achieve successful SDD.[112, 113] This was examined in Chapter 7 through a survey conducted among the same population of orthopaedic surgeons described in Chapter 6.

5.2.3 Research questions from the surgeons' perspective

In Chapter 6 and 7 of this thesis the following research questions will be addressed:

- What proportion of Dutch orthopaedic surgeons currently perform OJA of the hip and/or knee, and how many are willing to implement OJA in the future?
- What are the facilitators and barriers to OJA adoption in the Netherlands?
- What are surgeons' perspectives on the implementation of OJA in the Netherlands?

- What are preoperative, intra-operative and postoperative differences between outpatient and traditional inpatient pathways following hip and knee arthroplasty in The Netherlands?

5.3 Patients' perspective

The shortened hospital stay in the OJA pathway, compared to the traditional inpatient approach, as discussed in Section 4.1, may impact patients' experiences with recovery following hip or knee arthroplasty by limiting opportunities for patient-healthcare provider interaction and guidance. This reduced contact time could heighten patient uncertainty, potentially leaving patients and caregivers unsure about managing recovery tasks or recognizing critical symptoms, which may, in turn, affect their perceived safety and satisfaction with care. However, existing evidence indicates that, with appropriate patient selection, OJA can yield high satisfaction levels, as patients often appreciate the autonomy and privacy of recovering at home.[111, 139, 140]

To explore this perspective in greater depth, Chapter 8 presents a qualitative study using semi-structured interviews with patients who were planned for outpatient THA or TKA. This study aims to capture their experiences throughout the entire OJA pathway – from preoperative selection and preparation to postoperative recovery at home – providing insights into satisfaction, the overall recovery process, associated challenges, and perceptions of safety. Given the limited understanding of caregiver burden following OJA, caregivers were also encouraged to participate in the interviews.

5.3.1 Research questions from the patients' perspective

In Chapter 8 of this thesis the following research questions will be addressed:

- What are the patient's experiences and challenges during the preoperative phase, day of surgery, and postoperative phases of the OJA pathway?
- Are patients satisfied with the OJA pathway?

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PART II

Outpatient joint arthroplasty

What is the current evidence?

CHAPTER 2

SAFETY AND EFFICACY OF OUTPATIENT HIP AND KNEE ARTHROPLASTY

A systematic review with meta–analysis

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ABSTRACT

Introduction

This systematic review aimed to assess the safety and efficacy of outpatient joint arthroplasty (OJA) pathways compared to inpatient pathways.

Materials and methods

An electronic literature search was conducted to identify eligible studies. Studies comparing OJA with inpatient pathways—following hip and/or (partial) knee arthroplasty—were included. Included studies were assigned—based on OJA definition—to one of the following two groups: (1) outpatient surgery (OS); outpatient defined as discharge on the same day as surgery; and (2) semi-outpatient surgery (SOS); outpatient defined as discharge within 24 h after surgery with or without an overnight stay. Methodological quality was assessed. Outcomes included (serious) adverse events ((S)AEs), readmissions, successful same-day discharge rates, patient-reported outcome measures (PROMs) and costs. Meta-analyses and subgroup analyses by type of arthroplasty were performed when deemed appropriate.

Results

A total of 41 studies (OS = 26, SOS = 15) met the inclusion criteria. One RCT and 40 observational studies were included, with an overall risk-of-bias of moderate to high. Forty studies were included in the meta-analysis. Outpatients (both OS and SOS) were younger and had a lower BMI and ASA class compared to inpatients. Overall, no significant differences between outpatients and inpatients were found for overall complications and readmission rates, and improvement in PROMs. By type of arthroplasty, only THAs in OS pathways were associated with fewer AEs (OR = 0.55 [0.41–0.74]) compared to inpatient pathways. 92% of OS patients were discharged on the day of surgery. OJA resulted in an average cost reduction of $6,797.02.

Conclusion

OJA pathways are as safe and effective as inpatient pathways in selected populations, with a potential reduction of costs. Considerable risk of bias in the majority of studies emphasizes the need for further research.

1. INTRODUCTION

1.1 Background

As a result of successful fast-track surgery pathways and its continuous optimisation, hip and knee arthroplasty are increasingly performed on an outpatient basis. These day-care surgery pathways are being designed to discharge patients home without an overnight stay in the hospital.[1] This might benefit patients in terms of possible reduced risk for hospital-acquired infections, starting early rehabilitation in their own home environment, and the possibility of enhanced patient participation and improved satisfaction. Besides, there is potential to reduce the economic burden on the healthcare systems, as the demand for hip and knee arthroplasties is increasing internationally.[2-6] When implementing a new treatment (e.g., an outpatient joint arthroplasty (OJA) pathway following hip and knee arthroplasty), it is paramount to ensure the quality of the provided care and safety of patients. Acceptable clinical outcomes, in terms of complications and readmission rates, were found for both hip and (partial) knee arthroplasty in previous systematic reviews.[7-10] These systematic reviews mainly consisted of observational case series, which included a selected group of patients. Patients selected for OJA are generally expected to be healthier compared with the average population undergoing hip or knee arthroplasty. However, even in an unselected group of patients, similar results were found.[11, 12]

When comparing outcomes on OJA, variation in used definitions in the literature has to be accounted for. Some authors defined outpatient as a length of stay (LOS) less than 24 h, whereas others defined outpatient as hospital discharge on the day of surgery. Also, large national registry databases (e.g., the NSQIP) which are frequently used in OJA research, use a controversial outpatient definition. A study by Bovonratwet et al[4] reported that only 11–12% of patients who were registered as outpatients were actually discharged on the day of surgery, because regulations in the USA allow these patients to stay more than 1 night in hospital under observation status. Off all studies reporting on the NSQIP data, different variables are used to indicate OJA: (1) the “outpatient status variable”; and (2) the “LOS (= 0) variable” (which appears to be more accurate). To ensure clarity and uniformity, we agree with Vehmeyer et al[13] to reserve the term “outpatient joint arthroplasty” solely for patients who are discharged to their own home on the day of surgery and who do not have an overnight stay at either the hospital or another non-home facility.

1.2 Aims

The purpose of this systematic review was to study the safety and efficacy of outpatient pathways compared with standard inpatient recovery pathways following

hip and (partial) knee arthroplasty, accounting for the abovementioned definitional differences in OJA. We primarily aimed to assess whether there were significant differences in (1) the number of (serious) adverse events ([S]AEs) and readmission rates; (2) postoperative improvement in patient-reported outcome measures (PROMs) and (3) total hospital costs.

2. MATERIALS AND METHODS

A review protocol was developed according to the Preferred Items for Reporting Systematic Reviews and Meta-Analysis (PRISMA-P) statement and registered in PROSPERO (under review: no 161688), the International Prospective Register of Systematic Reviews.[14]

2.1 Search strategy

A comprehensive electronic literature search was conducted to identify eligible studies on outpatient pathways following primary hip and (partial) knee arthroplasty. Five databases (Embase, PubMed, Wiley/Cochrane Library, Clarivate Analytics/ Web of Science and EBSCO/CINAHL) and three trial registers (World Health Organization portal, ClinicalTrials.gov, and PROSPERO) were searched in December 2019 for published and ongoing trials. Reference lists of included studies were also searched by two independent reviewers to identify eligible studies that were missed by the search. The full search strategies are presented in the supplementary data.

2.2 Eligibility of studies

Both randomized controlled trials (RCTs) and (prospective or retrospective) observational studies were included in this systematic review. Only studies that compared safety and/or efficacy outcomes (e.g., (S)AEs, readmission rates, PROMs, costs) between OJA pathways and standard inpatient pathways – following hip and/ or (partial) knee arthroplasty – were included. Results needed to be published as a full report and there were no restrictions on the date of study publication. Only studies published in English were selected. Studies were excluded if they reported on patients undergoing revision surgery, bilateral arthroplasty or arthroplasty due to traumatic conditions. Strictly descriptive studies (e.g., historical and/or editorial studies) were also excluded.

2.3 Selection and data collection process

Two reviewers independently extracted the search results of the different databases with the RefWorks tool (ProQuest LLC ©, 2020). The aforementioned two reviewers independently screened titles and abstracts of all studies retrieved by the literature

search. Then the full texts of all potentially eligible studies were retrieved and independently reviewed. The decision regarding study selection was based on the inclusion criteria. Discrepancies between reviewers were discussed and, if necessary, an agreement was reached by the adjudication of a third reviewer.

2.4 Data extraction and outcomes

Two reviewers independently extracted the data for each included study using a predefined standardized data extraction form. The data extraction form contained information on study characteristics (e.g., author, year, country, setting, study design, type of arthroplasty and number of selected patients), patient demographics (e.g., age, gender, body mass index (BMI), American Society of Anesthesiologists (ASA) classification and type of anesthesia) and outcomes (e.g., complication rates, readmission rates, success rates of same-day discharge [SDD], PROMs and/or costs).

To account for differences in "outpatient" definitions, studies were assigned to one of the following two categories: (1) outpatient surgery (OS); outpatient defined as discharge to their own home on the day of surgery; and (2) semi-outpatient surgery (SOS); outpatient defined as discharge within 24 h after surgery with or without an overnight stay. Studies that did not specify the "outpatient" definition were also included in the SOS group.

Complications were defined as adverse events (AEs), including wound dehiscence, wound leakage, urinary retention/infection, pneumonia, renal disorder, and blood transfusion; or serious adverse events (SAEs), including death, sepsis, coma, (prolonged) intubation, stroke, thromboembolic event (deep vein thrombosis/ pulmonary embolism), infection of the prosthesis, myocardial infarction, cardiac arrest, arrhythmia, acute renal failure, perioperative fracture, failure of prothesis, hip dislocation and/or peripheral nerve injury, and return to the operating room (all re-operations). A minimal follow-up period of 30 days was required.

Patient demographics were described as means with standard deviations (SD) for continuous variables (age and BMI) and frequencies with percentages for categorical variables (gender, ASA score > II, and type of anesthesia). (S)AEs, readmission rates, and successful SDD rates were described as frequencies with percentages. PROMs and costs were reported descriptively. The two reviewers had to reach a consensus on data extraction. Any discrepancies between reviewers were discussed and, if necessary, an agreement was reached by the adjudication of a third author.

2.5 Risk of bias in individual studies

Two reviewers independently assessed the risk of bias of each of the included studies. The Cochrane Risk of Bias tool (version 2 of the Cochrane risk-of-bias tool for randomized trials) was used to assess the risk of bias in randomized trials.[15] The risk of bias for non-randomized studies was assessed with use of the ROBINS-I tool.[16] Any discrepancies between reviewers were discussed and, if necessary, an agreement was reached by the adjudication of a third author.

2.6 Data synthesis

All outcome measures were analysed using RevMan 5.[17] Continuous data were described as mean differences with 95% confidence intervals (CI) or standardized mean differences. Dichotomous data were described as odds ratios (OR). Where possible, the data were pooled in a meta-analysis. To quantify statistical heterogeneity, the Cochran's Q test and I^2 statistic (the proportion of the total variance explained by heterogeneity) were conducted. I^2 values of > 75% were interpreted as high heterogeneity.[18] Subanalyses were performed for the two defined outpatient groups (experimental): (1) OS versus (2) SOS, compared with inpatient pathways (control) to account for differences in "outpatient" definitions as described above. Subanalyses were also performed for THA, TKA and UKA to account for fundamental differences between the three types of arthroplasties. In case meta-analysis was eligible, forest and funnel plots were presented.

2.7 Ethical considerations

This review is a non-Medical Research Involving Human Subjects Act study.

3. RESULTS

3.1 Study selection and characteristics

This systematic electronic search identified 8,718 references. No additional records were identified by cross-checking reference lists. The search and selection process are shown in the PRISMA flow diagram (Figure 1). After removal of duplicates, 4,538 references remained for screening on title and abstract. In total, 52 full texts were assessed for eligibility. After review, 41 studies met the inclusion criteria and were included in the systematic review. Twenty-six studies were allocated to the OS group,[2-6, 12, 19-38] and 15 to the SOS group for subanalyses.[39-53]

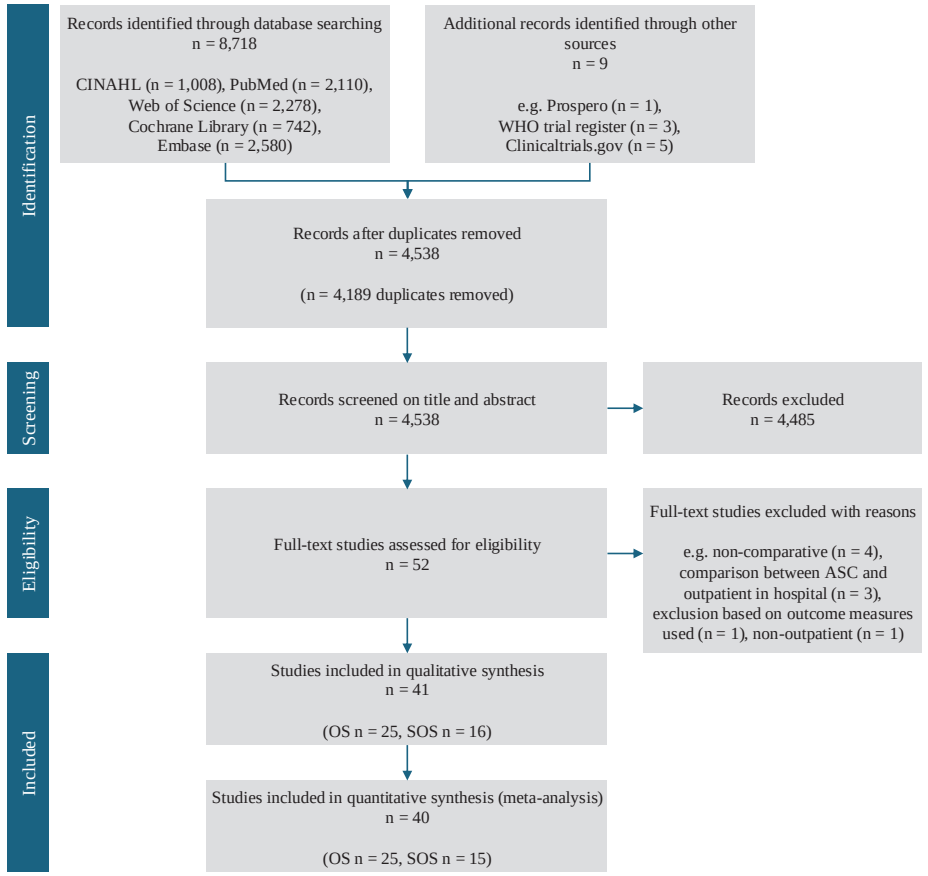

Figure 1. Preferred reporting items for systematic reviews and meta-analyses (PRISMA) flow diagram of the literature search. CINAHL = Cumulative Index to Nursing and Allied Health Literature database; WHO = World Health Organization; OS = outpatient surgery; SOS = semi outpatient surgery.

Thirty-one studies were conducted in the United States,[2-5, 19, 21-24, 26-28, 30, 31, 33, 35, 38-43, 45-53] four in the Netherlands,[25, 29, 36, 37], three in Canada,[6, 32, 34] two in France,[20, 44] and one in Denmark (Figure 1).[12] All studies were published between 2005 and 2019. Of the included studies, there was one RCT,[24] five prospective observational studies,[5, 6, 29, 37, 52] one prospective observational study with a matched inpatient cohort,[48] 16 retrospective observational studies,[20, 21, 27, 30, 35, 36, 38-41, 43, 44, 47, 49, 51, 53] 16 retrospective observational studies with a matched inpatient cohort,[2-4, 12, 19, 22, 23, 28, 31-34, 42, 45, 46, 50] and two qualitative studies.[25, 26] Of the included studies, 18 used large national databases (e.g., national private insurance databases or national registry databases).[2-4, 19, 21, 28, 31-33, 39, 40, 42, 43, 46, 47, 49-51] The setting of the outpatient pathways varied

from ambulatory surgical centers,[22, 26, 41, 45] or hip/knee centers,[5, 38] secondary and tertiary care hospitals,[6, 12, 20, 23-25, 27, 29, 30, 34, 36, 37, 44, 48, 52, 53] or a combination of settings.[35] Ten studies described OJA following total hip arthroplasty (THA),[5, 24, 27, 31, 34, 40, 41, 44, 51, 53] 13 following total knee arthroplasty (TKA),[3, 6, 20, 21, 28, 30, 32, 37, 39, 47-49, 52] six following unicompartmental knee arthroplasty (UKA),[2, 22, 25, 29, 35, 46] and 11 studies presented results on both hip and (partial) knee arthroplasty.[4, 12, 19, 23, 26, 33, 36, 38, 42, 43, 45, 50] In total, the complete sample of studied patients consisted of 40,758 outpatients (OS = 8,358; SOS = 32,400) and 1,212,370 inpatients. A summary of the study characteristics and patient demographics is presented in Table 1.

3.2 Risk of bias

For all observational studies, more than 75% of the studies had a moderate or high risk of bias (Figure 2). The included RCT was of high-quality regarding the low risk-of-bias judgment (Figure 3). Blinding of participants, to prevent performance bias, was not possible because of the nature of the studied objective.

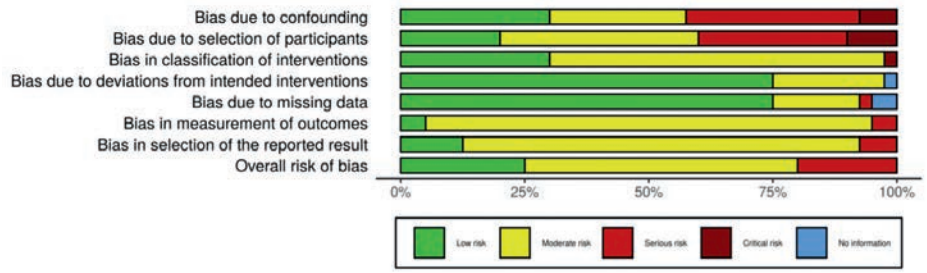

Figure 2. Overall risk of bias for non-randomized trials, with use of the ROBINS-I tool.

3.3 Heterogeneity

The methodological structure, measured outcomes, and description of data types varied between studies. Only studies that used comparable outcomes with a similar description of data were included in a meta-analysis. Data were pooled for total complication rates, SAEs, AEs, and readmissions.

In OS studies, demographics on the distribution of gender, BMI, and type of anesthesia were homogeneous, whereas data on age and ASA class were highly heterogeneous. All data on primary outcomes (e.g., total complication rate, (S) AEs and readmission rates) were homogeneous. In SOS studies, all data on total complication rate, SAEs, readmission rates and demographics (age, gender, BMI, ASA, and type of anesthesia) showed heterogeneity. Subanalysis on AEs for THA showed homogeneity. Data on PROMs and costs were analysed in a qualitative method.

Figure 3. Risk-of-bias assessment for randomized studies, with use of the Cochrane risk-of-bias tool.

3.4 Demographic data

Demographics were pooled and presented in the supplementary data. Within the OS studies, patients were significantly younger ($p = 0.009$), had a lower BMI ($p < 0.001$), and had a lower ASA class ($p = 0.002$) compared to patients in the inpatient pathways.

Patients in the SOS studies were significantly younger ($p = 0.002$) and were significantly more likely to be female ($p = 0.03$) compared to patients in the inpatient pathways. The amount of ASA score > II patients, between the SOS pathways and inpatient pathways was not statistically significant different ($p = 0.13$).

Table 1. Summary of included study characteristics and demographics.

Author	Year	Type of arthroplasty	Country	Setting	Design of study		Definition of outpatient	Allocation based on definition	Inpatient (n)	Outpatient (n)	Baseline characteristics presented	Outcomes used for review
Arshi et al[39]	2017	TKA	USA	HS-PDPR database (2007-2015)	Retrospective observational study		Discharge from hospital or ASC without inpatient hospital admission and absolute LOS of <24hrs	SOS	128,951	4,391	Age, gender	(S)AE's
Arshi et al[40]	2019	THA	USA	HS-PDPR database (2007-2016)	Retrospective observational study		Discharge from hospital or ASC without inpatient hospital admission and absolute LOS of <24hrs	SOS	73,596	2,184	Age, gender	(S)AE's
Aynardi et al[41]	2014	THA	USA	ASC allied to tertiary care hospital	Retrospective observational study		Discharged home or transferred from the hospital at 23h postoperatively	SOS	78	119	Age, gender, BMI	SDD success rate, (S) AE's, readmissions, costs
Basques et al[19]	2014	THA, TKA and UKA	USA	ACS-NSQIP database (2005-2014)	Retrospective observational study (matched cohorts)		Discharge the day of the surgical procedure	OS	1,236	1,236	Age, gender, BMI, ASA, type of anaesthesia	(S)AE's
Bertin[5]	2005	THA	USA	Hip and knee center	Prospective observational study		Surgery and discharge <12hrs	OS	10	10	Age, gender, BMI	SDD success rate, (S) AE's, costs
Bovonratwet et al[2]	2017	UKA	USA	ACS-NSQIP database (2005-2015)	Retrospective observational study (matched cohorts)		Patients with a LOS of 0 days and discharged on the same day of surgery	OS	1,704	568	Age, gender, BMI, ASA	(S)AE's, readmissions
Bovonratwet et al[3]	2017	TKA	USA	ACS-NSQIP database (2005-2014)	Retrospective observational study (matched cohorts)		Patients with a LOS of 0 days and discharged on the same day of surgery	OS	112,280	642	Age, gender, BMI, ASA	(S)AE's, readmissions
Bovonratwet et al[4]	2017	THA and TKA	USA	ACS-NSQIP database (2005-2014)	Retrospective observational study (matched cohorts)		Patients with a LOS of 0 days and discharged home on the same day of surgery without overnight stay in the hospital	OS	189,006	1,099	Age, gender, BMI	(S)AE's
Carey et al[42]	2019	THA and TKA	USA	THAMCR database	Retrospective observational study (matched cohorts)		Not specified in methods and materials	SOS	4,443	1,481	NA	(S)AE's, readmissions, costs
Cassard et al[20]	2018	TKA	FR	Secondary care hospital	Retrospective observational study		SDD (excluded patients who were alone at home on the evening of the procedure)	OS	513	61	Age, gender, ASA	SDD success rate, (S) AE's, readmissions
Courtney et al[43]	2017	THA and TKA	USA	ACS-NSQIP database (2011-2014)	Retrospective observational study		Hospital definition of outpatient and inpatient, according to database	SOS	168,186	1,220	Age, gender, BMI, ASA	(S)AE's, readmissions
Courtney et al[21]	2018	TKA	USA	ACS-NSQIP database (2014-2015)	Retrospective observational study		LOS of 0 days (same day discharge)	OS	48,771	365	Age, gender, BMI, ASA, type of anaesthesia	(S)AE's, readmissions
Crampet et al[44]	2019	THA	FR	Tertiary care hospital	Retrospective observational study		Discharge on the day of surgery with admission the night before surgery	SOS	77	50	Age, gender, BMI, ASA	SDD success rate, (S) AE's, readmissions

Table 1. Summary of included study characteristics and demographics. *(continued).*

Author	Year	Type of arthroplasty	Country	Setting	Design of study	Definition of outpatient	Allocation based on definition	Inpatient (n)	Outpatient (n)	Baseline characteristics presented	Outcomes used for review
Darrith et al[45]	2019	THA, RHA, TKA and UKA	USA	ASC allied to university hospital	Retrospective observational study (matched cohorts)	Discharged home <23hrs without overnight stay	SOS	243	243	Age, gender, BMI, ASA	SDD success rate, (S) AE's, readmissions
Ford et al[22]	2019	UKA	USA	ASC allied to university hospital	Retrospective observational study (matched cohorts)	Discharge on the day of surgery	OS	48	48	Age, gender, BMI, ASA	SDD success rate, (S) AE's, readmissions
Gogineni et al[23]	2019	THA and TKA	USA	Tertiary care hospital	Retrospective observational study (matched cohorts)	SDD	OS	105	136	Age, gender, BMI, ASA, type of anaesthesia	SDD success rate, (S) AE's, readmissions
Goyal et al[24]	2019	THA and TKA	DK	Tertiary care hospital	Retrospective observational study (matched cohorts)	SDD	OS	116	339	Age, gender, BMI, type of anaesthesia	Readmissions
Gromov et al[12]	2016	THA	USA	Tertiary care hospital	Randomized controlled trial	Less than 12hrs of hospital stay	OS	108	112	Age, gender, BMI, type of anaesthesia	SDD success rate, (S) AE's, readmissions
Gruskay et al[46]	2019	UKA	USA	National private insurance database	Retrospective observational study (matched cohorts)	Based on service location codes (outpatient hospital or ASC) according to database	SOS	5,084	2,600	Age, gender	(S)AE's, readmissions
Hoorntje et al[25]	2017	UKA	NL	Secondary care hospital	Qualitative study	SDD	OS	18	18	Age, gender, BMI, ASA, type of anaesthesia	SDD success rate, (S) AE's, readmissions, PROMs
Huang et al[6]	2017	TKA	CA	Tertiary care hospital	Prospective observational study	SDD	OS	20	20	Age, gender, BMI	SDD success rate, (S) AE's, readmissions, costs
Johnson et al[47]	2019	TKA	USA	ACS-NSQIP database (2011-2016)	Retrospective cohort study	Less than 24hrs of hospital stay after surgery	SOS	191,941	18,134	Age, gender, BMI, ASA, type of anaesthesia	(S)AE's
Kelly et al[26]	2018	THA, RHA, TKA and UKA	USA	ASC allied to university hospital	Qualitative study	SDD	OS	102	64	Age, gender, BMI, type of anaesthesia	PROMs
Kim et al[27]	2018	THA	USA	Tertiary care hospital	Retrospective cohort study	SDD	OS	164	168	Age, gender, BMI, ASA, type of anaesthesia	SDD success rate, readmissions
Kimball et al[28]	2019	TKA	USA	THAMCR database	Retrospective observational study (matched cohorts)	SDD	OS	863	863	Age, gender	(S)AE's, readmissions, costs
Kolisek et al[48]	2009	TKA	USA	Secondary care hospital	Prospective observational study (matched cohorts)	<23hrs discharge after surgery	SOS	64	64	Age, gender, BMI	SDD success rate, (S) AE's, PROMs
Kort et al[29]	2017	UKA	NL	Secondary care hospital	Prospective observational study	SDD	OS	20	20	Age, gender, BMI, ASA, type of anaesthesia	SDD success rate, (S) AE's, readmissions, PROMs
Lovald et al[49]	2014	TKA	USA	Medicare database (1997-2009)	Retrospective observational study	Outpatient coded as location of service and discharged to home	SOS	102,230	454	Age	(S)AE's, readmissions

Table 1. Summary of included study characteristics and demographics. *(continued).*

Author	Year	Type of arthroplasty	Country	Setting	Design of study		Definition of outpatient	Allocation based on definition	Inpatient (n)	Outpatient (n)	Baseline characteristics presented	Outcomes used for review
Lovecchio et al[50]	2016	THA and TKA	USA	ACS-NSQIP database (2011-2013)	Retrospective observational study (matched cohorts)		LOS <1 day	SOS	1,476	492	Age, gender, BMI, ASA, type of anaesthesia	(S)AE's, readmissions
Malahias et al[51]	2019	THA	USA	HS-PDPR database (2007-2017)	Retrospective cohort study		Discharged within a day; LOS <24hrs	SOS	39,284	754	Age, gender	(S)AE's, readmissions
Moore et al[30]	2019	TKA	USA	Secondary and tertiary care hospitals	Retrospective observational study		SDD	OS	293	32	Age, gender, BMI, ASA	NA
Nelson et al[31]	2017	THA	USA	ACS-NSQIP database (2005-2014)	Retrospective observational study (matched cohorts)		LOS=0 days, discharge before spending a night in the hospital	OS	63,424	420	Age, gender, BMI, ASA	(S)AE's
Nowak et al[32]	2019	TKA	CA	ACS-NSQIP database (2005-2016)	Retrospective observational study (matched cohorts)		SDD, LOS=0 days	OS	75,260	986	Age, gender, BMI, ASA, type of anaesthesia	(S)AE's
Otero et al[33]	2016	THA, TKA and UKA	USA	ACS-NSQIP database (2011-2013)	Retrospective observational study (matched cohorts)		SDD, LOS=0 days	OS	762	762	Age, gender, BMI, ASA	(S)AE's, readmissions
Richards et al[34]	2018	THA	CA	Secondary and tertiary care hospital	Retrospective observational study (matched cohorts)		SDD (to home)	OS	136	136	Age, gender, BMI, ASA	SDD success rate, (S) AE's, readmissions
Richter et al[35]	2017	UKA	USA	Tertiary care hospital and ASC	Retrospective observational study		SDD (to home)	OS	10	12	Age, gender, BMI, ASA	SDD success rate, (S) AE's, readmissions, costs
Schoifet et al[52]	2011	TKA	USA	Secondary care hospital	Quasi experimental design (prospective treatment arm and retrospective control arm)		Not specified in methods and materials	SOS	50	50	Type of anaesthesia	SDD success rate, (S) AE's, readmissions, costs
Schotanus et al[36]	2017	TKA and UKA	NL	Secondary care hospital	Retrospective observational study		SDD (to home)	OS	267	94	Age, gender, BMI, ASA	SDD success rate, PROMs
Schotanus et al[37]	2017	TKA	NL	Secondary care hospital	Prospective observational study		SDD (to home)	OS	10	10	Age, gender, BMI, ASA	SDD success rate, PROMs
Springer et al[38]	2017	THA and TKA	USA	Hip and knee center	Retrospective observational study		SDD (to home)	OS	106	137	Age, gender, BMI	SDD success rate, (S) AE's, readmissions, PROMs
Weiser et al[53]	2018	THA	USA	Tertiary care hospital	Retrospective observational study		SDD	SOS	1,315	164	Age, gender, BMI	SDD success rate, readmissions

THA = total hip arthroplasty; RHA = resurfacing hip arthroplasty; TKA = total knee arthroplasty; UKA = unicompartmental knee arthroplasty; USA = United States of America; FR = France; DK = Denmark; NL = Netherlands; CA = Canada; HS-PDPR = Humana Subset PearlDiver Patient Record; ASC = ambulatory surgical center; ACS-NSQIP = American College of Surgeons National Surgical Quality Improvement Program; THAMCR = Truven Health Analytics Marketscan Commercial Research; LOS = length of stay; hr(s) = hours; SOS = semi outpatient surgery; OS = outpatient surgery; BMI = body-mass index; ASA = American society of anesthesiologists score; NA = not applicable; (s)AE's = (serious) adverse events; SDD = same day discharge.

3.5 Complications

Overall complication rates were described in 33 studies (OS = 19; SOS = 14).[2-6, 19-25, 28, 29, 31, 32, 34, 35, 38-52] No significant differences were found for overall complication rates in OJA pathways (OS, p = 0.24; SOS, p = 0.71) compared to inpatient pathways (Figure 4).

Adverse events (AEs) were described in 27 studies (OS = 17, SOS = 10).[2-6, 19, 21, 22, 24, 25, 28, 29, 31, 32, 34, 35, 38-41, 44-49, 52] For OS studies, only THAs showed statistically significant fewer AEs in outpatient pathways (OR = 0.55 [0.41– 0.74]; I^2 = 0%) compared to inpatient pathways (Figure 5). For SOS studies, no statistically significant differences (by type of arthroplasty) were found for AEs between the two pathways.

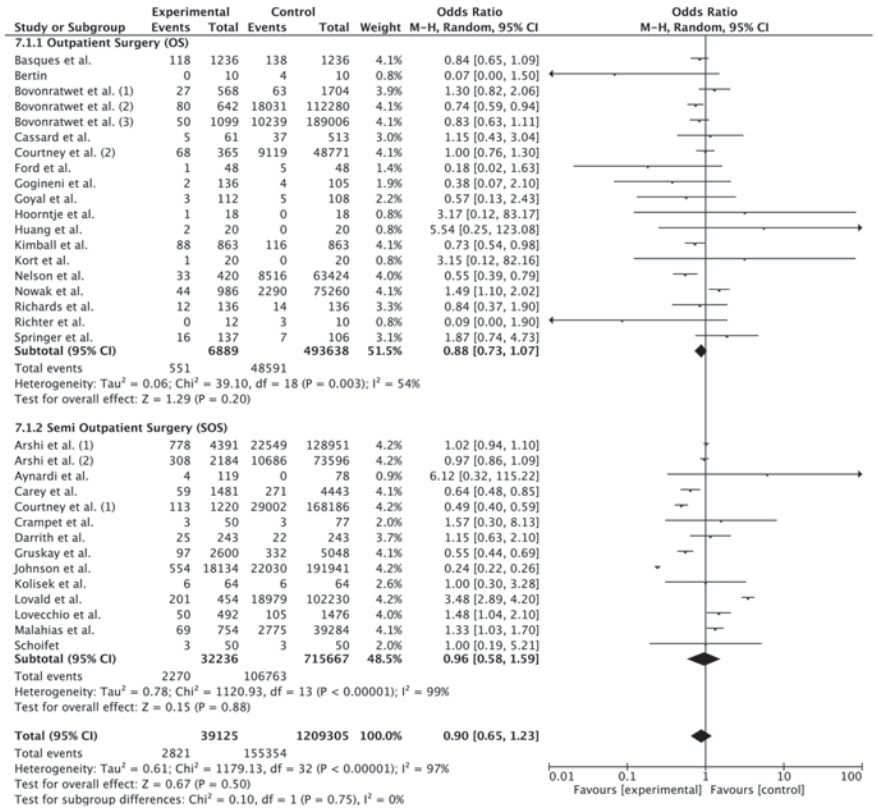

Figure 4. Forest plot for overall complication rate, presented as numbers (n). Experimental = outpatient joint arthroplasty pathway; control = inpatient pathway.

Serious adverse events (SAEs) were described in 29 studies (OS = 17, SOS = 12).[2-6, 19, 21, 22, 24, 25, 28, 29, 38-42, 44-49, 51, 52] For both OS and SOS studies, no statistically significant differences (by type of arthroplasty) were found for SAEs compared to inpatients (Figure 6).

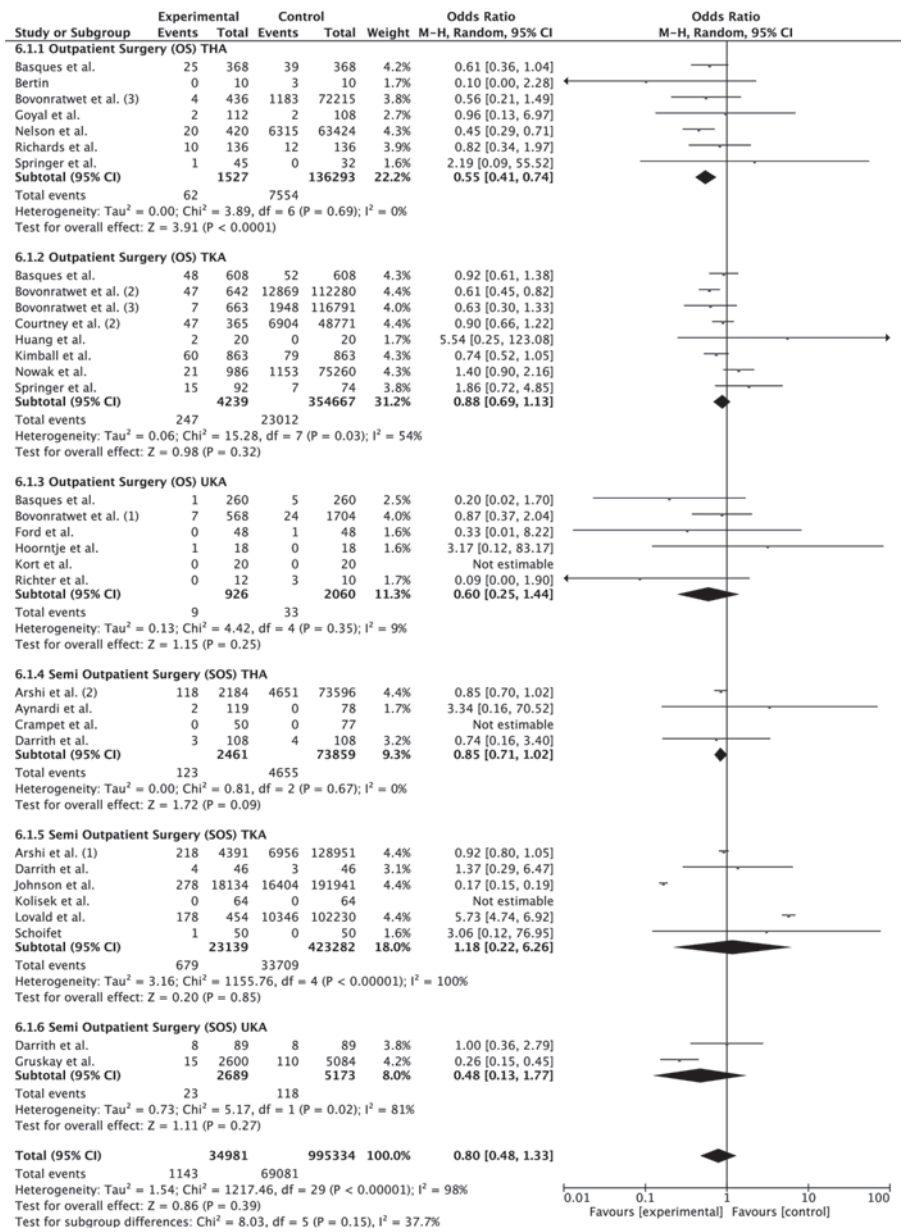

Figure 5. Forest plot for adverse events with subgroup analysis for total hip arthroplasty (THA), total knee arthroplasty (TKA) and unicompartmental knee arthroplasty (UKA), presented as numbers (n). Experimental = outpatient joint arthroplasty pathway; control = inpatient pathway.

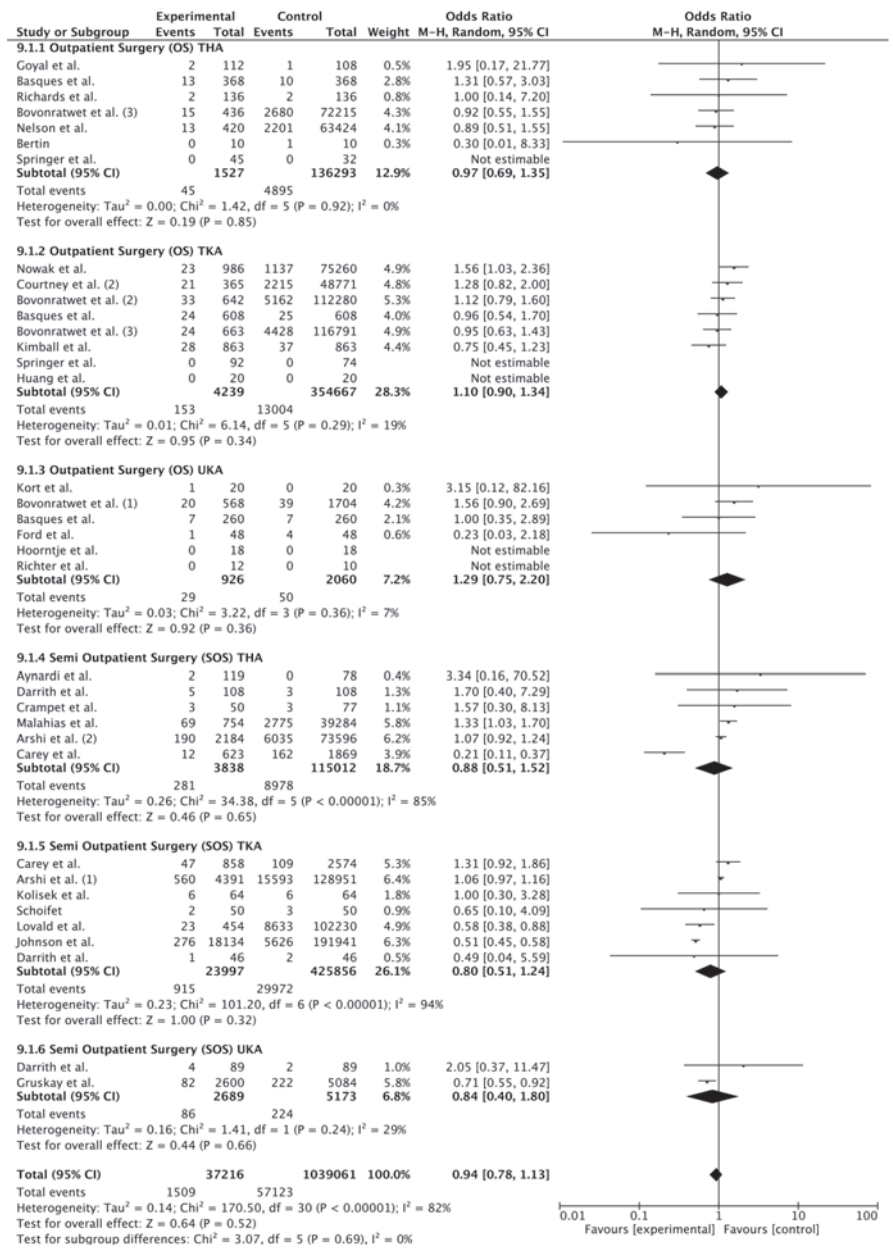

Figure 6. Forest plot for serious adverse events with subgroup analysis for total hip arthroplasty (THA), total knee arthroplasty (TKA) and unicompartmental knee arthroplasty (UKA), presented as numbers (n). Experimental = outpatient joint arthroplasty pathway; control = inpatient pathway.

3.6 Readmission rates

No statistically significant differences (by type of arthroplasty) were found for readmission rates in both outpatient pathways (OS and SOS) compared to inpatient pathways (Figure 7). The follow-up period ranged from 4 weeks to 1 year.

3.7 SDD success rate

Success rates of SDD following an OJA pathway was presented in 14 studies.[5, 6, 20, 22-25, 27, 29, 34-38] Overall, we found that 941 of 1,077 outpatients of the OS studies (average success rate of 92%, ranging from 61 to 100%) were successfully discharged on the day of surgery. TKAs and UKAs had an average SDD success rate of 95%, whereas 86% of THAs were successfully discharged on the day of surgery.

3.8 PROMs

Seven studies reported a comparison of postoperative improvements in PROMs between outpatient and inpatient pathways.[25, 26, 29, 36-38, 48] Used PROMs varied and included the Knee Injury and Osteoarthritis Outcome Score (KOOS), Oxford Knee Score (OKS), Knee Society Score (KSS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), EuroQol-5D (EQ-5D), Visual Analogue Scale (VAS) for pain, and patient satisfaction questionnaires. The postoperative improvement was similar between outpatient pathways and inpatient pathways for all PROMs. The follow-up period ranged from 30 days to 1 year. High patient satisfaction was reported in three studies for OJA and inpatient pathways.[26, 38, 48] Two studies (one in an ambulatory surgical center and one in a hip/ knee center) reported favorable outcomes on patient satisfaction.[26, 38] Patient satisfaction was either measured with a numerical scale,[48] or with the use of a survey by telephone.[26, 35, 38]

3.9 Costs

Seven observational studies reported on costs.[5, 6, 28, 35, 41, 42, 52] Evaluation and description of costs varied highly across studies. Six of seven studies (86%) reporting on costs were conducted in the United States. Only total costs were compared between outpatient and inpatient pathways. A mean (SD) cost reduction of $6,797.02 ($5,394.81) was found in favor of outpatient pathways, but with a large range ($2,468.62 to $20,573.00). Overall, usage of surgery (e.g., surgery facility fee, operation room supplies) and hospital facility (e.g., nursing, room charges, laboratory tests, medication, perioperative physiotherapy) contributed the most in the cost reduction.

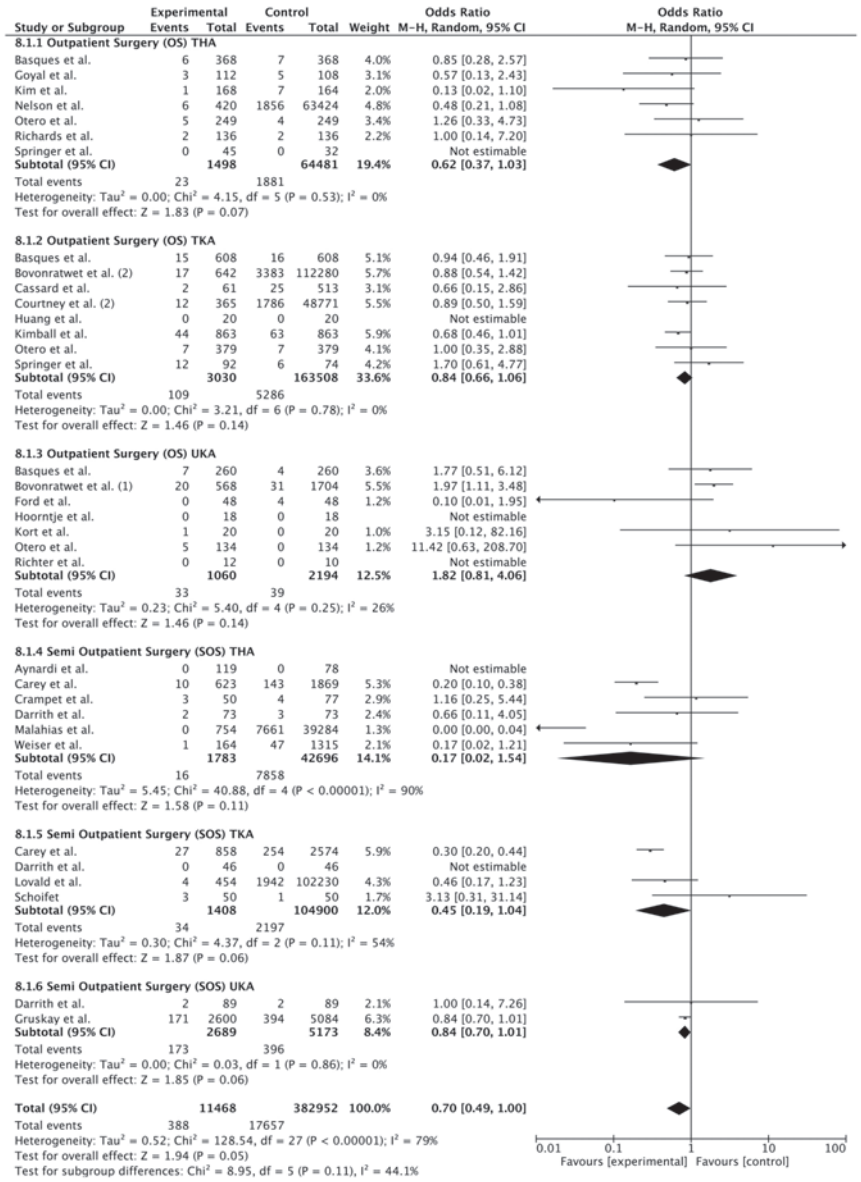

Figure 7. Forest plot for readmissions with subgroup analysis for total hip arthroplasty (THA), total knee arthroplasty (TKA) and unicompartmental knee arthroplasty (UKA), presented as numbers (n). Experimental = outpatient joint arthroplasty pathway; control = inpatient pathway.

4. DISCUSSION

Current literature is divided on the safety (in terms of complications and readmissions) of OJA pathways. Several studies reported an increased risk for (S)AEs if patients were discharged on the same day of surgery,[32, 39, 50] while others stated that there were no safety issues.[9, 24, 29, 34, 53] The most important finding of this study was that the implementation of OJA pathways in a selective group of patients resulted in acceptable clinical outcomes regarding complications and readmission rates while reducing costs and preserving the patient-reported outcome compared to standard inpatient pathways. Subanalyses by type of arthroplasty (e.g., THA, TKA, UKA) found that THAs in OS pathways were associated with fewer AEs compared to inpatient pathways. For SAEs and readmissions, subanalyses found no significant differences between outpatient and inpatient pathways, suggesting that OJA following hip or knee arthroplasty is most likely safe in a selected patient population.

The current literature on OJA, however, consists of low to moderate quality with moderate to high risk of selection bias. Only one RCT was included in the present systematic review. Most included studies, however, had a retrospective and observational design, with high risk of selection bias.[5, 6, 20, 21, 25-27, 29, 30, 35-41, 43, 44, 47, 51-53] Many studies on OJA used large (national claims and administrative) databases.[2-4, 19, 21, 28, 31-33, 39, 40, 42, 43, 46, 47, 49-51] These databases provide high power to outcome measures and although results can provide a raw estimate of certain relationships, heterogeneity in the sample (as variations in practice patterns are not accounted for can lead to potential recording bias and/or confounding) may worsen the accuracy that comes with interpreting the results. Bonvonratwet et al[4] also found that definitional differences in "outpatient" status were present in the American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP®) – a national (USA) database which is used in many studies on OJA. The same study also described the possible influence of definitional differences on outcomes. An explanation for this could be a more stringent patient selection for patients discharged on the day of surgery compared to patients discharged within 24 h (i.e., the first postoperative day). Besides, there is substantial potential of confounding by selection bias in these database and observational studies, as OJA is often reserved for the more "active" and "healthy" patients. As expected, we found that patients included in the OJA pathways were overall younger and less infirm (in terms of ASA class), and had a lower BMI compared to patients in the inpatient pathways.[20, 24, 28, 34, 43, 45, 48] This should be taken into account while interpreting the current results and emphasizes the need for large randomized controlled clinical trials comparing outpatient with inpatients pathways following hip and knee arthroplasty.

Another factor that might impede the interpretation of the results is a lack of consistent use of the same definitions for complications/adverse events.[54] Some studies described (S)AEs in terms of surgical versus medical complications,[50] whereas others described minor versus major complications.[32] Scoring of complications was based on the authors' interpretation or the availability of data in databases. Furthermore, the majority of (S)AEs occur within 4 days postoperatively.[54] Most inpatient pathways (consisting of fast-track recovery pathways) discharge patients within 2–3 days after surgery. This might explain why the current meta-analysis did not find differences in terms of overall complications and readmission rates, since both outpatients and inpatients are discharged within this timeframe. Another potential limitation could be the fact that the follow-up period for reporting complications and readmission rates varied between studies.

Patients in the outpatient pathways improved equally postoperatively in terms of PROMs compared to patients in the inpatient pathways. Previous research did not find differences in the long-term (1 year) outcomes between these pathways.[36] PROMs are used to transform qualitative symptoms and limitations into quantitative data that can be compared over time, across patients, and benchmarked against different populations.[55] In the literature, the utilization of PROM tools varies strongly in and between measured domains following hip and knee arthroplasty, making it difficult to compare and interpret outcomes. The possible implementation of Patient-Reported Outcomes Measurement Information System (PROMIS®) – a systematic measurement system applying a standardized metric that is based on the normative data of the general population – is increasingly being researched in the orthopaedic literature,[55, 56] and might allow for a better comparison of PROMs (also between different domains and populations) if adopted internationally in research.

All studies on costs (and made a comparison between outpatient and inpatient pathways) included in this systematic review showed a total cost reduction in favor of outpatient pathways. All these studies, however, treated costs differently which led to a wide range of outcome and made comparison difficult. One study assessed total charges to a patient's insurance carrier (including surgical facility fees, OR supplies, hospital room facility, et cetera) and negotiated reimbursement.[35] Another study assessed total hospital charges because they found it impossible to assign actual costs to items such as nursing or therapist care and used fixed facility costs.[5] Two studies assessed direct costs (charges to the patient including costs for medical supplies, implants, nursing and medication et cetera), indirect costs (overhead expenses that were not directly related to patient care including administration, housekeeping et cetera), and total costs.[6, 52] Two studies assessed payment for the index hospitalization

or index outpatient encounter, with a correction of payments for all post-acute care to 90-day follow-up.[28, 42] Almost all studies reporting on costs were conducted in the United States. Since healthcare systems and reimbursement models differ between countries, these results lack external validity. This implicates that there is a need for cost-efficiency analysis in different settings to assess the potential benefits of OJA internationally.[5, 6, 28, 35, 41, 42, 52]

5. CONCLUSIONS

The present systematic review and meta-analysis suggests that OJA pathways are as safe and effective as inpatient pathways following hip and knee arthroplasty in selected populations, with a potential reduction of costs. Considerable risk of bias in the majority of studies, however, emphasizes the need for large randomized controlled clinical trials comparing outpatient with inpatients pathways.

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7. APPENDICES

The full appendices are available online and can be accessed via DOI: 10.1007/s00402-021-03811-5.

PART III

Outpatient joint arthroplasty

Clinical outcomes from a cohort

CHAPTER 3

REASONS FOR UNSUCCESSFUL SAME–DAY DISCHARGE FOLLOWING OUTPATIENT HIP AND KNEE ARTHROPLASTY

5½ years' experience from a single institution

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ABSTRACT

Background
Outpatient joint arthroplasty (OJA) is considered safe and feasible in selected patients but should be further optimized to improve success rates. The purposes of this study are to (1) identify the main reasons of unsuccessful same-day discharge (SDD) following hip and knee arthroplasty; (2) determine the hospital length of stay (LOS) following unsuccessful SDD; and (3) assess which independent variables are related to specific reasons for unsuccessful SDD.

Methods
Five hundred twenty-five patients undergoing total hip arthroplasty (THA), total knee arthroplasty (TKA), and unicompartmental knee arthroplasty (UKA) between 2013 and 2019 were retrospectively identified. SDD to home was planned in all patients. Specific reasons for unsuccessful SDD and LOS were assessed. Bivariate analysis was performed to find differences in independent variables between patients experiencing a specific reason for unsuccessful SDD and control patients.

Results
One hundred ten patients (21%) underwent unsuccessful SDD. The main reason was postoperative reduced motor function and sensory disturbances (33%). The mean LOS in the unsuccessful SDD group was 1.7 days (standard deviation ± 1.0 days). Postoperative transient reduced motor function and sensory disturbances occurred more often in patients undergoing TKA ($p < 0.001$).

Conclusion
An option for overnight stay should be available when performing outpatient hip and knee arthroplasty. The main reason for unsuccessful SDD in this study was transient postoperative reduced motor function and sensory disturbance, most likely due to intraoperative local infiltration analgesia in TKA. No other studies have found local infiltration analgesia to be an issue preventing SDD.

1. INTRODUCTION

1.1 Background
Total hip and knee arthroplasty has proven to be one of the most successful elective surgical procedures. An abundance of literature exists on the beneficial effects of pain reduction, functional improvement, and health-related quality of life.[1, 2] Traditionally, these types of surgeries were performed as an inpatient procedure with varying lengths of hospital stays (LOS), even exceeding several weeks.[3] Over the years, clinical pathways were developed incorporating multimodal strategies to manage pain, reduce post-operative nausea and vomiting (PONV), and promote early post-operative mobilization and nutritional supplementation. This led to the successful introduction of "fast-track" pathways for elective total hip (THA), total knee (TKA), and unicompartmental knee arthroplasty (UKA). These pathways have proved to reduce the hospital LOS and total rehabilitation period and lower the number of complications and readmissions following these procedures.[4-6] As a response to the increasing demand and economic burden, currently outpatient joint arthroplasty (OJA) pathways have been implemented throughout the world. Several studies have shown that the vast majority of patients undergoing an OJA pathway are successfully discharged on the same day and that complications and readmission rates are acceptably low.[7, 8]

Although the most common reasons for a prolonged hospital stay are well known in patients undergoing hip or knee arthroplasty in a fast-track pathway,[9, 10] there are only a few studies that assess reasons for unsuccessful same-day discharge (SDD) following an OJA pathway.[11-13] As perioperative protocols might vary internationally and previous study populations are relatively small, we present our 5½ years' experience with the OJA pathway for patients undergoing THA, TKA, and UKA.

1.2 Aims
The purposes of this study are to (1) identify the main reasons of unsuccessful SDD following hip and knee arthroplasty in patients following an OJA pathway; (2) determine the hospital LOS following unsuccessful SDD; (3) assess which independent variables are related to specific reasons for unsuccessful SDD.

2. METHODS

2.1 Settings and subjects
This retrospective study with study number 20190064 was approved by the local institutional review board. The OJA pathway was implemented at the orthopaedics

department of the local hospital – a secondary care nonacademic teaching hospital – in 2013. All patients undergoing OJA from December 2013 until April 2019 were retrospectively identified (N = 525). Patients who matched the profile to participate in an OJA pathway were preoperatively included by 5 different orthopaedic surgeons. Strict selection criteria for OJA included (1) unilateral joint arthroplasty of the hip (THA) or knee (TKA or UKA); (2) patients who were highly motivated and able to be discharged home on the day of surgery (consent was given before planning of surgery); and (3) postoperative availability of a coach (i.e., partner) and adequate social support in the home environment. Relative exclusion criteria were described in Table 1 and aided the surgeon's discretion in selecting appropriate patients.[14]

Table 1. Inclusion and exclusion criteria for outpatient joint arthroplasty

Inclusion criteria	
General	Preoperative consent to be discharged to home on the same day of surgery; Patients' understanding of the OJA program; Care and social support must be provided during the first postoperative days.
Surgical	Primary elective THA, TKA or UKA; Unilateral procedure.
Exclusion criteria	
Cardiology	Coumadin-derivative usage, bridging anticoagulation and NYHA classification III/IV.
Pulmonary	Poorly controlled lung fibrosis, emphysema or pulmonary hypertension, recent embolism or carcinoma.
Internal medicine	Extensive oedema, chronic usage of prednisolone, severe renal function disorders, and insulin dependent diabetes mellitus.
Geriatric	History of (frequent) falling in the past three months, cognitive function disorders (e.g. history of delirium, dementia, memory difficulties), requiring additional inpatient rehabilitation and polypharmacy.
Urology	Pre-existing voiding difficulties and preoperative use of urologic medication (e.g. long-acting alpha 1 blockers).
Neurology	Severe mobility disorders (e.g. cerebrovascular accident with residual deficits, Parkinson's disease, peripheral neurologic function disorders).
Psychiatry	Substance or drug abuse.

OJA = outpatient joint arthroplasty; THA = total hip arthroplasty; TKA = total knee arthroplasty; UKA = unicompartmental knee arthroplasty; NYHA = New York Heart Association;

The OJA pathway has optimized multimodal logistics and evidence-based clinical features. To set proper patient expectations, all patients received multidisciplinary preoperative education about the outpatient process and home-based rehabilitation, followed by exercise training to become familiar with transfers and walking (stairs) with crutches.[15] All patients were admitted to the hospital early on the day of surgery and surgery was scheduled first or second in the operating room so discharge criteria could be achieved by the end of the day. Patients were operated under general or spinal anesthesia based on the anesthesiologic consultation and patient's preference.[16] The local anesthetic (LA) used in spinal anesthesia changed over time and was used interchangeably (mepivacaine until 2017; bupivacaine since 2015; prilocaine since 2017; and articaine since 2018).[17] Choice and dosing of the spinal anesthetic was up to the discretion of the anesthesiologist. Patients undergoing THA (Trident Cementless Acetabular Shell System and Accolade II Cementless Hip Stem System; Stryker, Mahwah, NJ) were operated with a posterolateral approach (N = 78) or direct anterior approach (implemented since 2017 by 2 of 5 surgeons) (N = 12) based on the surgeons' preference.[18] The open medial parapatellar or minimally invasive technique was used for patients undergoing cemented TKA (Vanguard Complete Knee System; Biomet, Warsaw, IN) or cementless medial UKA (Oxford Partial Knee Microplasty System; Biomet, Bridgend, UK), respectively. A pneumatic tourniquet (positioned on the thigh before surgery) was only used in UKA during the full duration of surgery. A standardized perioperative regimen was followed for fluid administration consisting of 0.9% saline (5 mL/kg/h) and Ringer's lactate or Sterofundin only if indicated. Single high-dose glucocorticoid was administered intravenously (dexamethasone 8 mg; during the initiation of the operation) to reduce the surgical stress response.[19] Antibiotics were administered intravenously (cefazolin 2 gram 30 minutes before surgical incision and 1 gram before hospital discharge).[20] Tranexamic acid (TXA) was administered (1 gram oral dose 2 hours preoperatively and 1 gram intravenously at wound closure) and no drains were used.[21] No urinary catheters were used and nurses were instructed to follow a nurse-led bladder scan protocol as described in a previous study.[22] Patients who underwent TKA or medial UKA had an LA intraoperatively infiltrated into the soft tissues (local infiltration analgesia; LIA). For TKA, a maximum of 150 mL ropivacaine 0.2% (300 mg) was administered with the use of a technique according to Kerr and Kohan.[23] For UKA, a maximum of 100 mL ropivacaine 0.2% (200 mg) was administered only on the medial side. The LA was not diluted and was not mixed with other agents (e.g., ketorolac, epinephrine, morphine, or clonidine).[24] Dosing was standard for all patients and was not based on patient characteristics (body mass index [BMI], age, or American Society of Anesthesiologists [ASA] class). No wound catheters were left behind for intermittent or continuous wound infiltration. No LIA was used in THA.[25] Wound closure was standardized for

all procedures and was done in layers with continuous barbed sutures (V-Loc Wound Closure Device; Covidien, Mansfield, MA). No staples were used.

After surgery, patients were monitored at the postanesthesia care unit for an average time of 1 to 2 hours before they were discharged to the outpatient ward. Upon arrival on the ward, early ambulation was encouraged by a physical therapist (PT) within 4 hours postoperatively.[26, 27] Two exercise sessions of mobilization with crutches under supervision of the PT had to be completed before hospital discharge. A patient's relative was appointed as a personal coach to support the patient in the first postoperative hours as well as in the home environment. Postoperative cooling and compression therapy were used to relieve pain and swelling. Multimodal oral opioid-sparing analgesia was given to all patients: paracetamol (4 gram/24 hourly), COX-2 inhibitor (meloxicam; 15 mg/24 hourly), gabapentin (300 mg morning and 600 mg evening dose) (in 2018 gabapentin was omitted from the multimodal analgesia protocol),[28] and opioids (OxyNorm Instant 5 mg) with a maximum of 4 times a day as needed (rescue medication only upon patients' request). For thromboprophylaxis, parenteral low-molecular-weight heparin (Fragmin 5,000 international units) was administered once a day during 42 days, starting 6-8 h postoperatively.[29] An X-ray was done before discharge, and lab results were only carried out if indicated (i.e., intraoperative blood loss >750 mL or early medical complications). SDD to home was planned for all patients and discharge criteria were listed in Table 2.

Table 2. Discharge criteria following outpatient joint arthroplasty

Discharge criteria
Patients' general well-being and acceptable pain control (VAS < 5);
Dry wound;
Ability to safely make independent postoperative transfers;
Ability to safely mobilize with crutches and (if required at home) climb the stairs;
Patients' express acceptance of discharge;
Understanding of the living rules during the first 3 months (for THA).

VAS = Visual analogous scale; THA = total hip arthroplasty.

2.2 Data collection and outcome measures

For the purpose of this study, the primary outcome measure was the main reason for unsuccessful SDD following elective unilateral THA, TKA, and UKA in an OJA pathway. Reasons for unsuccessful SDD were categorized as (1) postoperative reduced motor function and sensory disturbances; (2) pain and/or fear; (3) dizziness and/or orthostatic hypotension; (4) PONV; (5) excessive wound discharge; and (6) other

reason. Postoperative reduced motor function and sensory disturbances were defined as any degree of motor or sensory dysfunction, not due to pain or swelling, that was objectified by a medical doctor. This was considered to be a risk for falling. Therefore, when present, mobilization was postponed due to safety concerns. Wound discharge was considered excessive if at least one of the following was present: (1) leakage beyond the hydrocolloid exterior layer of the AQUACEL surgical dressing and/or (2) more than 50% saturation of the hydrofiber inner layer of the AQUACEL surgical dressing. In order to reduce interpretation bias, data were retrospectively retrieved from the patient's electronic health records by 2 independent authors (M.K. and S.A.). Discrepancies were discussed and agreement reached by the adjudication of a third author (B.B.). The secondary outcome measure was LOS.

Baseline and clinical characteristics included patient and surgical characteristics: age at the time of surgery; gender; BMI; ASA physical function class[30]; Charnley class – indicating the severity of osteoarthritis – where Charnley A indicates one single hip or knee joint affected, B1 bilateral joints affected, B2 a contralateral joint with a successful joint arthroplasty, and C multiple joints affected; preoperative use of an anticoagulant; the preoperative visual analog scale (VAS) for pain scaled from 0 to 10, where a lower score indicates less pain[31]; type of arthroplasty; intraoperative blood loss; surgical duration; type of anesthesia; and the LA used for spinal anesthesia.

2.3 Statistical analysis

All analyses were performed with SPSS (IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp.). Descriptive statistics were used to present the data. Demographic and clinical baseline characteristics of study participants were described as means with standard deviations (SD) for continuous variables and frequencies with percentages for categorical variables. Reasons for unsuccessful SDD were categorized in the 5 most common and "other reason" category. Subjects were appointed to one category and were censored after to ensure that subjects with multiple reasons did not excessively weight the results. Bivariate analysis was performed to find differences in independent variables for each reason of unsuccessful SDD. If the specific reason for unsuccessful SDD was not present in the patient, the patient was included in the control group. A chi-square or (in case of cells with expected value < 5) Fisher exact test was conducted for categorical variables and an unpaired t-test or one-way ANOVA was conducted for continuous variables. Two-sided P values were reported with a p value < 0.05 indicating statistical significance. Additional descriptive statistics were performed to find differences in characteristics between types of arthroplasties (e.g., blood loss and duration of surgery) (Appendix 1).

3. RESULTS

3.1 Study population

The mean age in this study population was 63 years (SD ± 7.6 years; range, 29-83 years). Four hundred three patients (77%) underwent surgery under spinal anesthesia and most patients (N = 277; 53%) underwent TKA (Table 3). The overall mean duration of surgery was 55 minutes (SD ± 15 minutes; range, 26-135 minutes) and was the longest in TKA (59 ± 15 minutes). The overall mean blood loss was 198 mL (SD ± 178 mL, range, 0-1100 mL) and was higher in THA (405 ± 192 mL) and TKA (239 ± 111 mL). Patient and surgical characteristics (e.g., age, BMI, type of anesthesia, ASA class) among the types of arthroplasties were described in Appendix 1.

3.2 Length of stay

Four hundred fifteen patients achieved successful SDD (LOS = 0). A total of 110 patients (21%) failed to be discharged on the day of surgery and had to be admitted to the inpatient orthopaedic ward. The mean LOS in this group was 1.7 days (SD ± 1.0 days; range, 1-7 days; Table 3).

Table 3. Demographics and clinical characteristics

Patient characteristics	Overall (N = 525)	SDD (N = 415)	Unsuccessful SDD (N = 110)	p value
Age (years)	63 ± 7.6 (29 - 83)	63 ± 7.7 (29-83)	64 ± 7.5 (45-80)	0.19
< 50	22 (4.2%)	18 (4.3%)	4 (3.6%)	
50 - 64	281 (54%)	224 (54%)	57 (52%)	
65 - 79	216 (41%)	169 (41%)	47 (43%)	
≥ 80	6 (1.1%)	4 (0.96%)	2 (1.8%)	
BMI (kg/m^2)	28 ± 4.1 (17 - 42)	28 ± 4.0 (17-40)	28 ± 4.5 (19-42)	0.87
< 25	114 (22%)	85 (20%)	29 (26%)	
25 - 29.9	255 (49%)	209 (50%)	46 (42%)	
30 - 34.9	120 (23%)	92 (22%)	28 (25%)	
35 - 39.9	34 (6.5%)	28 (6.7%)	6 (5.5%)	
≥ 40	2 (0.38%)	1 (0.24%)	1 (0.9%)	
Female	259 (49%)	196 (47%)	63 (57%)	0.061
Charnley class				0.096
A	187 (36%)	141 (34%)	46 (42%)	
B1	215 (41%)	171 (41%)	44 (40%)	
B2	104 (20%)	90 (22%)	14 (13%)	
C	19 (3.6%)	13 (3.1%)	6 (5.4%)	

Table 3. Demographics and clinical characteristics (*continued*).

Patient characteristics	Overall (N = 525)	SDD (N = 415)	Unsuccessful SDD (N = 110)	p value
ASA class				**0.001**
I	292 (56%)	246 (59%)	46 (42%)	
II	217 (41%)	160 (39%)	57 (52%)	
III	16 (3.0%)	9 (2.2%)	7 (6.4%)	
Preoperative anticoagulant use	56 (11%)	48 (12%)	8 (7.3%)	0.20
Preoperative VAS pain *	6.6 ± 1.8 (0 - 10)	6.5 ± 1.8 (0-10)	6.9 ± 1.5 (3-10)	**0.029**
Surgical characteristics				
Type of arthroplasty				0.098
THA	90 (17%)	134 (32%)	24 (22%)	
TKA	277 (53%)	211 (51%)	66 (60%)	
UKA	158 (30%)	70 (17%)	20 (18%)	
Blood loss (mL) *	198 ± 178 (0 - 1100)	188 ± 169 (0-1000)	234 ± 204 (0-1100)	**0.017**
Surgery duration (min) *	55 ± 15 (26 - 135)	55 ± 15 (26-135)	57 ± 14 (28-96)	0.28
Anesthesia type				**0.004**
Spinal	403 (77%)	330 (80%)	73 (66%)	
General	122 (23%)	85 (20%)	37 (34%)	
LA (used for spinal anesthesia, N = 403)				**0.034**
Mepivacaine	275 (68%)	232 (70%)	43 (59%)	
Bupivacaine	101 (25%)	73 (22%)	28 (38%)	
Articaine	6 (1.5%)	6 (1.8%)	0	
Prilocaine	14 (3.5%)	12 (3.6%)	2 (2.7%)	
Unknown	7 (1.7%)	7 (2.1%)	0	
LOS (days)	0.35 ± 0.83 (0 - 7)	0	1.7 ± 1.0 (1-7)	**< 0.001**

SDD = same-day discharge; BMI = body mass index; ASA = American Society of Anesthesiologists physical function score; VAS pain = visual analogous scale for pain; THA = total hip arthroplasty; TKA = total knee arthroplasty; UKA = unicompartmental knee arthroplasty; LA = local anesthetic; LOS = length of stay.

Discrete variables as frequency (percentage); continuous variables as mean ± standard deviation (range); **Bold** values indicate statistical significance ($p < 0.05$).

3.3 Causes and characteristics of unsuccessful SDD

Patients undergoing TKA had the highest rate of being admitted to the hospital (24%), whereas patients undergoing UKA had the lowest rate (15%; p = 0.098). The main reason for unsuccessful SDD was postoperative reduced motor function and sensory disturbances (N = 36 of 110 unsuccessful SDD, 33%; Table 4).

Table 4. Reasons for unsuccessful SDD

	UKA (N = 158)	TKA (N = 277)	THA (N = 90)	Total (N = 525)
Postoperative reduced motor function and sensory disturbances	5 (3.2%)	30 (11%)	1 (1.1%)	**36 (6.9%)**
Pain / fear	8 (5.1%)	4 (1.4%)	4 (4.4%)	**16 (3.0%)**
Dizziness / orthostatic hypotension	0	11 (4.0%)	8 (8.9%)	**19 (3.6%)**
PONV	2 (1.3%)	5 (1.8%)	5 (5.6%)	**12 (2.3%)**
Wound discharge	6 (3.8%)	10 (3.6%)	1 (1.1%)	**17 (3.2%)**
Other *	3 (1.9%)	6 (2.2%)	1 (1.1%)	**10 (1.9%)**
Total	**24 (15%)**	**66 (24%)**	**20 (22%)**	**110 (21%)**

SDD = same-day discharge; UKA = unicompartmental knee arthroplasty; TKA = total knee arthroplasty; THA = total hip arthroplasty; PONV = postoperative nausea and vomiting.

* UKA: unsafe gate (1), exacerbation COPD (1), surgery postponed until the afternoon (1); TKA: unsafe gate (2), direct postoperative ICU-admission (1), traumatic disrupted extensor mechanism (1), uncontrolled hyperglycemia (1), unknown reason (1); THA: urinary retention.

Postoperative reduced motor function and sensory disturbances occurred significantly more in patients undergoing TKA (11%) compared to THA (1.1%) and UKA (3.2%; p < 0.001). Unsuccessful SDD because of postoperative dizziness/orthostatic hypotension occurred more often in patients undergoing THA (8.9%) or TKA (4.0%) compared to UKA (0%; p = 0.001) and in patients who had more intraoperative blood loss (mean of 405 mL vs 190 mL; p = 0.004). Patients who experienced excessive postoperative pain and/or fear had a higher preoperative VAS pain score (mean of 7.5 vs 6.5; p = 0.03). PONV occurred more often in patients undergoing general anesthesia (7.8% vs 0.74%; p < 0.001). Early postoperative wound discharge occurred more often in patients with an ASA class of II (4.1%) or III (13%; p = 0.044; Table 5).

Table 5. Differences in demographics and clinical characteristics for all reasons of unsuccessful SDD *

Variable	Postoperative reduced motor function and sensory disturbances (N = 36)	Control (N = 489)	p value
Type of arthroplasty			**0.001**
THA	1 (3.3)	89 (18%)	
TKA	30 (83%)	247 (51%)	
UKA	5 (14%)	135 (28%)	
Preoperative anticoagulant use	0	56 (11%)	**0.032**
	Dizziness/orthostatic hypotension (N = 19)	**Control (N = 506)**	
Type of arthroplasty			**0.001**
THA	8 (42%)	82 (16%)	
TKA	11 (58%)	266 (53%)	
UKA	0	158 (31%)	
Blood loss (mL)	405 ± 279 (150 - 1100)	190 ± 168 (0 - 1000)	**0.004**
	Pain/fear (N = 16)	**Control (N = 509)**	
ASA			**0.02**
I	4 (25%)	288 (57%)	
II	12 (75%)	205 (40%)	
III	0	16 (3.1%)	
VAS preoperative	7.5 ± 1.1 (6 - 10)	6.5 ± 1.8 (0 - 10)	**0.03**
	PONV (N = 12)	**Control (N = 513)**	
Anesthesia type			**< 0.001**
Spinal	3 (25%)	400 (78%)	
General	9 (75%)	113 (22%)	
Surgery duration (min)	51 ± 6.3 (41 - 65)	55 ± 15 (26 - 135)	**0.028**
	Wound discharge (N = 17)	**Control (N = 508)**	
ASA			**0.44**
I	6 (35%)	286 (56%)	
II	9 (53%)	208 (41%)	
III	2 (12%)	14 (2.8%)	
	Other reason (N = 10)	**Control (N = 515)**	
ASA			**< 0.001**
I	4 (40%)	288 (56%)	
II	3 (30%)	214 (42%)	

Table 5. Differences in demographics and clinical characteristics for all reasons of unsuccessful SDD * *(continued).*

	Other reason (N = 10)	Control (N = 515)	
lII	3 (30%)	13 (2.5%)	
Anesthesia type			**0.005**
Spinal	4 (40%)	399 (77%)	
General	6 (60%)	116 (23%)	

SDD = same-day discharge; THA = total hip arthroplasty; TKA = total knee arthroplasty; UKA = unicompartmental knee arthroplasty; ASA = American Society of Anesthesiologists physical function score; VAS pain = Visual analogous Scale for pain; PONV = postoperative nausea and vomiting.

Discrete variables as frequency (percentage); continuous variables as mean ± standard deviation (range).
* Only statistically significant data ($p < 0.05$) were presented.

4. DISCUSSION

OJA is considered the "ultimate" optimized pathway for lower limb arthroplasty. Improvements in perioperative and rehabilitation protocols were crucial to this optimization process.[4, 5] In order to keep optimizing the pathway, it is important to understand the causes of unsuccessful SDD. The success rate of SDD following the OJA pathway in this study was 79% – with transient postoperative reduced motor function and sensory disturbances being the main reason for unsuccessful SDD.

The strengths and limitations of this study should be taken into account while interpreting these results. The main strength of this study was the large study population (N = 525) in a single secondary care nonacademic teaching hospital. A standardized OJA protocol was used, which was implemented by several orthopaedic surgeons within our clinic. The main limitation of this study was the retrospective design. It was impossible to retrospectively retrieve consistent detailed information from the patients' electronic files on the specific reason and grade of motor/sensory disturbances, severity of pain (VAS) or orthostatic hypotension, et cetera. Secondly, new insights led to a couple of protocol changes – and thus heterogenicity – over time, as described in the Methods section. These changes only had limited effect on the overall success of the protocol because an additional analysis did not show a statistically significant difference between year-to-year success rates of SDD

($p = 0.13$). Thirdly, it was our intention to identify factors that were related to specific reasons for unsuccessful SDD. Because the number of patients with a specific reason for unsuccessful SDD was relatively small, only bivariate analysis was performed to describe the groups. These small sample sizes might have led to more random statistically significant findings and can therefore only be interpreted as descriptive rather than conclusive. External validity is limited by the fact that we analyzed a preselected group of patients based on the protocol (e.g., most patients with severe systemic comorbidities were excluded).[14] OJA is feasible in our clinic because of logistic efforts, staffing levels, multidisciplinary agreements, and our long-term experience with clinical pathways. These findings may not generalize well to lower-volume practice settings and orthopaedic surgeons with less experience with clinical pathways.

The success rate of our past 5½ years' experience with the OJA pathway (79%) was substantially lower than reported by a recent systematic review by Hoffman et al[32] (overall success rate of 94.5%) and a study by Berger et al[7] The main difference with our study design, however, was the setting in which OJA was performed. The vast majority of these studies were conducted at ambulatory surgery centers (ASCs) or orthopaedic specialty hospitals in the United States.[33, 34] We present data from a large secondary care nonacademic teaching hospital, and as our operating room is in the same building as both our inpatient and outpatient orthopaedic wards, the threshold for inpatient admission may be lower at our setting. At times we experienced difficulty to come to a good practical agreement with other (para) medics, propagating the same vision toward our patients (i.e., physical therapists and nurses might have primed the patients toward an inpatient admission instead of following the initiated outpatient pathway). This emphasizes the importance that every specialty involved is on the same page in order for an OJA pathway to succeed. Secondly, the definition of OJA is interpreted differently in the present literature. Some authors might consider patients who stay for less than 24 hours (with overnight stay) or discharge to an inpatient extended care facility to be OJA, while others, like this study, defined outpatient surgery as being discharged to home on the same day of surgery.[13, 35, 36]

Many studies report upon data from administrative claims or national databases. A study by Bovonratwet et al[37], however, found that the "outpatient" status as defined by large national databases such as the National Surgical Quality Improvement Program is not consistent and does not necessarily correlate with an actual LOS of 0 days. We did find equivalent results in 3 other recent studies, reporting success rates from 74% to 84%.[11-13] These studies were conducted in similar settings to ours.

Transient postoperative reduced motor function and sensory disturbance was the main reason for unsuccessful SDD and admission to the inpatient orthopaedic ward. These neurologic symptoms could be the result of either spinal anesthesia or the use of LIA. Spinal anesthesia gained popularity in outpatient surgery because of the availability of many short-acting LAs and modernization of regional anesthetic techniques. The optimal LA for spinal anesthesia in a fast-track pathway for TJA, however, is still subject of debate. In our clinic, mepivacaine was omitted from the protocol in 2017 because off-label use was not supported by the Dutch National Association of Anesthesiologists – mainly based on a lack of supportive evidence.[17] More recent studies, however, showed that mepivacaine was superior to bupivacaine in terms of faster return of motor and sensory function, episodes of urinary retention, time to urination, time to discharge, and did not show worse pain control or transient neurologic symptoms.[38, 39] The present study also found that mepivacaine was superior to bupivacaine in terms of successful SDD (Table 3). Short-acting LAs, such as articaine, also gained popularity in outpatient surgery, and previous studies suggested more beneficial effects of articaine over bupivacaine or prilocaine in an outpatient setting.[40, 41] In the present study, no statistically significant differences were found between patients in the general and spinal anesthesia group in terms of the occurrence of transient postoperative reduced motor and sensory function ($p = 0.10$). Also, the use of different LAs for spinal anesthesia was not related to postoperative reduced motor and sensory function ($p = 0.10$).

As postoperative reduced motor and sensory function occurred significantly more often in patients undergoing TKA (Table 5) and the type of anesthesia was evenly distributed over the different types of arthroplasties ($p = 0.31$; Appendix 1), we hypothesized that the use of our LIA regimen impacted the results. The efficacy of LIA in improving short-term postoperative pain relief and reducing total narcotic consumption has been confirmed in TKA and UKA.[25, 42] Pain control is crucial in early ambulation following joint arthroplasty, which is part of successful fast-track recovery pathways.[43] The present results, however, suggest that LIA might compromise this early ambulatory effect in an OJA pathway. In this study setting, LIA was administered only on the medial side of the knee in the UKA group and no LIA was administered in the THA group. In the TKA group, LIA was administered in 3 stages as described by Kerr and Kohan, infiltrating the tissues around the posterior joint capsule on both medial and lateral sides of the knee in the first stage.[23] Although complications of LIA are rare, injury to the neurovascular bundle in the posterior knee and the peroneal nerve located laterally can occur.[44] We believe that transient common peroneal nerve palsy can be a "side effect" of injecting a high volume of a long-acting LA (e.g., ropivacaine) in close proximity to the common peroneal nerve,

which runs down to the posterolateral side of the knee joint. Interestingly, Kerr and Kohan and other studies assessing the effect of LIA in TKA never described this motor blockade and propagated the possibility of early mobilization after LIA.[23, 45] A similar phenomenon, however, has been observed with the intraoperative injection of bupivacaine in close proximity to the sciatic nerve during THA.[46] A possible explanation may be that this effect remains unperceived in study settings with a longer LOS because of its early onset and relatively fast transient nature.[23, 46, 47] We believe these neurologic symptoms are also easily missed in retrospective observational studies if early mobilization and early hospital discharge are not the main objectives of the intervention. The fact that all patients in the present cohort recovered within the first postoperative day makes this hypothesis more likely. In other studies, only 2 of 33 patients (6.1%) were admitted to the hospital because of foot drop, and 2 of 33 (6.1%) because of bilateral leg weakness.[12, 13] Other studies that assessed reasons for unsuccessful SDD in an OJA pathway found that pain, patient preference, dizziness/orthostatic hypotension, and nausea were the main reasons for hospital admission and corresponds with the other findings in this study.[11-13, 32]

The LIA mixture used in the present study differed from most others.[33, 45] Adrenaline was not added because a double-blind prospective clinical trial by our research group could not confirm the benefit of adding adrenaline to ropivacaine in patients undergoing TKA following a fast-track recovery protocol.[24] Ketorolac was not added because clinical and animal studies suggested that nonsteroidal anti-inflammatory drugs may inhibit bony ingrowth and have an adverse effect on endoprosthetic fixation.[48, 49] Another reason was the possible renal and stomach toxicity of NSAIDs, and the fact that we already incorporated meloxicam (orally) in our multimodal analgesia protocol. Clonidine was not added because of little scientific data regarding the benefit in LIA mixtures. In the initial study on LIA by Kerr and Kohan, the total dose of ropivacaine was based on weight, age, and infirmity (ASA class) of the patient.[23] However, in most LIA regimen – including our own – the dosing of ropivacaine is standardized rather than patient-tailored. The dose of ropivacaine in the present study (a maximum of 300 mg) was similar or even lower compared to other studies.[23, 45, 47] Overall, we did not find statistically significant higher rates of postoperative reduced motor function and sensory disturbance in patients with a lower BMI, older or infirm patients (Table 5). When analyzing the occurrence in the TKA subgroup, also no significant differences in patient characteristics were found. We believe the maximum dose is more important when regarding toxicity of the drug rather than the occurrence of its therapeutic effect (while duration of the effect may vary, a slightly lower dose should also lead to motor disturbances if the injection technique is the same). We do believe that the method and location where LIA is

injected is more important regarding the occurrence of these neurologic symptoms and therefore suggest extra cautiousness when injecting LIA in the posterolateral joint capsule.

Patients who were admitted to the hospital because of unsuccessful SDD had a short LOS and were often discharged after 1 to 2 in-hospital days (Table 3). This is still faster than most regular fast-track recovery pathways, including our own.[5, 8, 50, 51] Although an in-hospital backup plan is necessary for patients failing SDD, this suggests that most early "side effects" that cause hospital admission are mild and resolve quickly.

Bleeding management and wound closure are also important facets of a successful clinical pathway for hip and knee joint arthroplasty. In this study, postoperative dizziness or orthostatic intolerance occurred more often in patients undergoing THA or TKA, which by themselves also seemed to correlate with higher intraoperative blood loss (Appendix 1). Postoperative dizziness or orthostatic intolerance represents a major problem in early mobilization after joint arthroplasty.[52] Restriction of opioid use, intraoperative correction of fluids, and preventive measures for anemia are generally targeted to reduce these symptoms. In this study setting, oral TXA was given preoperatively and intravenous TXA at wound closure to reduce blood loss. Further research is needed to assess the effects of topical TXA on early postoperative symptoms (i.e., dizziness, hypotension, and wound discharge) in an OJA setting. This study also showed that a higher ASA class correlated with early postoperative wound discharge. We hypothesize that polypharmacy or systemic diseases affecting wound healing (e.g., diabetes mellitus, rheumatoid diseases, morbid obesity) might have been present in these specific patient populations; however, this was not in the scope of the present study. The effect of topical adhesive materials (e.g., Dermabond) might provide additional protection against wound discharge, but such wound closure techniques need to be further investigated within a clinical pathway for joint arthroplasty.[53]

Consistent with a study by Liu et al[54], we found that increased severity of preoperative pain was correlated with higher pain and/ or fear on the first postoperative day. This result might help orthopaedic surgeons with the preoperative stratification of patients for more intensive pain management including education and nursing staffing. These results also supported the fact that general anesthesia is associated with higher rates of PONV. More recent studies demonstrated that spinal anesthesia was associated with fewer complications and reduced LOS and would, therefore, be more beneficial than general anesthesia.[55, 56] Although the choice between

general anesthesia or regional anesthesia for OJA is controversial and both may be acceptable,[16] our study results also showed that spinal anesthesia was superior to general anesthesia in terms of successful SDD (Table 3). Large randomized studies are needed to find the best anesthetic method in an OJA pathway.

5. CONCLUSIONS

In conclusion, the results of this study suggest the importance of a short-stay backup plan for patients who were unsuccessfully discharged on the same day of surgery in an OJA pathway for hip and knee arthroplasty. The main reason for inpatient hospital admission in this cohort was transient postoperative reduced motor function and sensory disturbance, most likely due to intra-operative LIA in TKA. As most studies are using a standardized LIA regimen, improvements of the LIA technique (e.g., optimal placement of LA and use of patient-tailored infiltration doses) are needed in an OJA pathway.

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7. APPENDICES

Appendix 1. Differences in demographics and clinical characteristics by type of arthroplasty

	UKA (N = 158)	TKA (N = 277)	THA (N = 90)	p value
Patient characteristics				
Age (years)	62 ± 7.0 (45 – 80)	64 ± 7.2 (35 – 83)	61 ± 9.1 (29 – 80)	< **0.001**
BMI (kg/m2)	29 ± 3.7 (19 - 40)	28 ± 4.1 (19 - 42)	27 ± 4.2 (17 - 40)	< **0.001**
Female	80 (51%)	135 (49%)	44 (49%)	0.93
Charnley class				0.094
A	*64 (41%)*	89 (32%)	34 (38%)	
B1	66 (42%)	115 (42%)	34 (38%)	
B2	22 (14%)	66 (24%)	16 (18%)	
C	*6 (3.8%)*	7 (2.5%)	6 (6.7%)	
ASA class				0.21
I	98 (62%)	147 (53%)	47 (52%)	
II	56 (35%)	119 (43%)	42 (47%)	
III	*4 (2.5%)*	11 (4.0%)	1 (1.1%)	
Preoperative anticoagulant use	13 (8.2%)	30 (11%)	13 (14%)	0.31
Preoperative VAS pain	6.8 ± 1.6 (1 - 10)	6.4 ± 1.9 (0 - 10)	6.8 ± 1.7 (1 - 10)	.060
Surgical characteristics				
Blood loss (mL)	12 ± 25 (0 - 150)	239 ± 111 (50 - 1000)	405 ± 192 (150 - 1100)	< **0.001**
Surgery duration (min)	52 ± 15 (26 - 132)	59 ± 15 (28 - 135)	52 ± 12 (31 - 80)	< **0.001**
Anesthesia type				0.31
Spinal	117 (74%)	220 (79%)	66 (73%)	
General	41 (26%)	57 (21%)	24 (27%)	

Appendix 1. Differences in demographics and clinical characteristics by type of arthroplasty *(continued)*.

	UKA (N = 158)	TKA (N = 277)	THA (N = 90)	p value
LA (used for spinal anesthesia, N = 403)				< **0.001**
Mepivacaine	88 (75%)	172 (78%)	15 (23%)	
Bupivacaine	17 (15%)	40 (18%)	44 (67%)	
Articaine	4 (3.4%)	2 (0.91%)	0	
Prilocaine	5 (4.3%)	3 (1.4%)	6 (9.1%)	
Unknown	3 (2.6%)	3 (1.4%)	1 (1.5%)	

UKA = unicompartmental knee arthroplasty; TKA = total knee arthroplasty; THA = total hip arthroplasty; BMI = body mass index; ASA = American Society of Anesthesiologists physical function score; VAS pain = visual analogous scale for pain; LA = local anesthetic.

Discrete variables as frequency (percentage); continuous variables as mean ± standard deviation (range);
Bold values indicate statistical significance (p < .05).

CHAPTER 4

PREDICTORS OF (UN)SUCCESSFUL SAME-DAY DISCHARGE IN SELECTED PATIENTS FOLLOWING OUTPATIENT HIP AND KNEE ARTHROPLASTY

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ABSTRACT

Background
It is generally accepted that only selected patients are suitable for outpatient joint arthroplasty (OJA); however, no consensus exists on the optimal selection criteria. We believe patients undergoing OJA should undergo risk stratification and mitigation in an attempt to optimize quality and minimize costs.

Methods
Patient factors of 525 patients who were selected to have primary elective unicompartmental knee arthroplasty (N = 158), total knee arthroplasty (N = 277), or total hip arthroplasty (N = 90) in an outpatient setting were retrospectively reviewed. A complete case multivariable logistic regression analysis of 440 patients was conducted to identify factors that were independently associated with (un) successful same-day discharge (SDD).

Results
One hundred ten patients (21%) were not able to be discharged on the day of surgery. Charnley class B2 was associated with a higher chance of successful SDD (odds ratio [OR], 0.29; 95% confidence interval [CI], 0.12-0.72), whereas female gender (OR, 1.7; 95% CI, 1.0-2.8), total knee arthroplasty (OR, 1.9; 95% CI, 1.1-3.4), and a higher American Society of Anesthesiologists (ASA) physical function score (ASA II: OR, 1.9; 95% CI, 1.1-3.3; ASA III: OR, 3.9; 95% CI, 1.1-13) were associated with a higher risk of unsuccessful SDD.

Conclusion
These results in a preselected population suggest the need for further specifying and improving selection criteria for patients undergoing OJA and emphasize the importance of an in-hospital backup plan for patients at risk of unsuccessful SDD. Previous contralateral joint arthroplasty is a protective factor for successful SDD.

1. INTRODUCTION

1.1 Background
Osteoarthritis (OA) is one of the most disabling diseases in Western countries. The high prevalence of OA, the growing demand for increased mobility and quality of life at an older age, the success of joint arthroplasty, and the increased longevity of a prosthesis over the recent decades have resulted in an estimated 7 million individuals living with artificial hips and knees in the United States.[1] Because of the aging population worldwide and our ability to more effectively manage comorbidities in the perioperative period, the number of patients who require joint arthroplasty of the knee or the hip is still on the rise. As a result, healthcare systems are facing significant challenges to meet the needs of this increasing surgical load and its associated economic burden.[2-4]

A majority of research in the last decades has focused on optimizing clinical protocols (fast-track) to reduce the length of stay (LOS) and improve treatment quality. The success of these fast-track clinical pathways for joint arthroplasty lies in improved anesthetic techniques, multimodal pain relief with less utilization of opioids, and early postoperative mobilization.[5] Perioperative developments including modern surgical techniques, the use of tranexamic acid to decrease blood loss, and avoiding the use of bladder catheters have further decreased the need for prolonged hospital stay after joint arthroplasty.[6-8]

Nowadays, there is a growing clinical and financial interest in outpatient joint arthroplasty (OJA). As more patients undergo joint arthroplasty at a younger age and patients stay more active at an older age, many patients can be considered disabled rather than diseased.[8] Previous studies have already shown the feasibility, safety, and cost-effectiveness of OJA in appropriately selected patients.[9-16]

1.2 Rationale
It is generally accepted that OJA should only be performed in a selected group of patients.[11, 17-19] The selection criteria for enrolling patients in a same-day discharge (SDD) program, however, seem to be variable in different literature,[11, 20, 21] and some researchers even reported the feasibility of OJA in unselected populations.[22, 23]. The purpose of this study is to identify (1) differences between patients undergoing successful SDD and unsuccessful SDD; (2) patient-related risk factors for successful SDD; and (3) patient-related risk factors for unsuccessful SDD in selected patients undergoing outpatient hip or knee arthroplasty.

2. MATERIALS AND METHODS

This retrospective study with study number 20190064 was approved by the local institutional review board.

2.1 Setting and subjects

This study retrospectively identified 525 patients who underwent primary elective total hip (THA), total knee (TKA) or unicompartmental knee arthroplasty (UKA) in an outpatient setting between December 2013 and April 2019. Strict selection criteria for OJA included (1) unilateral joint arthroplasty; (2) patients who were able and willing to be discharged to home on the day of surgery (consent was given before planning the surgery); and (3) postoperative availability of a coach and adequate social support (i.e., partner) in the home environment. Relative exclusion criteria were described in Table 1 and aided the surgeon's discretion in selecting appropriate patients.[11] All patients underwent surgery at a single high-volume secondary-referral teaching hospital for hip and knee arthroplasty (annual estimated > 1,600 cases), and pre-operative selection and surgery was performed by 1 of 5 trained orthopaedic surgeons.

Table 1. Inclusion and exclusion criteria for OJA

Inclusion criteria	
General	Preoperative consent to be discharged to home on the same day of surgery; Patients' understanding of the OJA program; Care and social support must be provided during the first postoperative days.
Surgical	Primary elective THA, TKA or UKA; Unilateral procedure.
Exclusion criteria	
Cardiology	Coumarin-derivative usage, bridging anticoagulation and NYHA classification III/IV.
Pulmonary	Poorly controlled lung fibrosis, emphysema or pulmonary hypertension, recent embolism or carcinoma.
Internal medicine	Extensive oedema, chronic usage of prednisolone, severe renal function disorders, and insulin dependent diabetes mellitus.
Geriatric	History of (frequent) falling in the past three months, cognitive function disorders (e.g. history of delirium, dementia, memory difficulties), requiring additional inpatient rehabilitation and polypharmacy.
Urology	Pre-existing voiding difficulties and preoperative use of urologic medication.

Table 1. Inclusion and exclusion criteria for OJA (*continued).*

Exclusion criteria	
Neurology	Severe mobility disorders (e.g. cerebrovascular accident with residual deficits, Parkinson's disease, peripheral neurologic function disorders).
Psychiatry	Substance or drug abuse.

OJA = outpatient joint arthroplasty; THA = total hip arthroplasty; TKA = total knee arthroplasty; UKA = unicompartmental knee arthroplasty; NYHA = New York Heart Association.

The utilized OJA protocol was previously described for UKA.[12] All patients undergoing outpatient hip or knee arthroplasty were admitted to the hospital on the day of surgery. Hospital discharge was also planned on the same day of surgery. Patients were scheduled first or second in the operating room so discharge criteria could be achieved by the end of the day. The discharge criteria consisted of patient general well-being and acceptable pain control (visual analog scale [VAS] < 5), a dry wound, ability to safely make independent postoperative transfers (i.e., supine to sit, sit to stand, and bed to chair positions), ability to safely mobilize with crutches (or other aid), ability to safely climb the stairs (if required in the home situation), patients' understanding of the living rules during the first 3 months (for THA), and patients express acceptance of discharge.

Intraoperative local infiltration anesthesia (ropivacaine [2%]) was only administered in TKA and UKA without epinephrine.[24] The perioperative medication was used as described in Table 2. No drains or urinary catheters were used. Postoperatively, urinary retention was tested with the use of a bladder scan.[25]

Postoperative pain was managed by following a multimodal opioid-sparing pain protocol. The first mobilization was attempted within 4 hours postoperatively and patients were obligated to mobilize at least 2 times under the supervision of a physical therapist before discharge. A patients' relative was appointed as a personal coach to support the patient in the first postoperative hours and in their home environment.

Table 2. Characteristics of the OJA pathway

Preoperative characteristics	
Education and exercise training Appointing a patients' relative/ spouse as coach	
Hospital Admission	07:00 AM on the day of surgery
Time of surgery	First or second on the surgical schedule
Planned discharge	On the day of surgery (home)
Perioperative	
Anesthetic method	General or spinal
Tranexamic acid	Oral administration 2 hours prior to surgery IV administration at wound closure
Prophylactic antibiotics	IV administration prior to surgical incision and prior to discharge
Dexamethasone	IV (single) high-dose administration
LIA	Only in TKA and UKA
Drains or urinary catheters	None
Postoperative	
Multimodal pain protocol	Acetaminophen, selective COX-2 inhibitor, gabapentin, and opioids (only upon patients' request)
Urinary retention analysis	Using a bladder scan
Compression bandage	First 8 hours; removed prior to discharge
Cooling by ice packs	First 24 hours
First mobilization	<4 Hours, with the guidance of a physical therapist
Thrombosis prophylaxis	Self-administration instructions for subcutaneous LMWHs; continued for 6 weeks
Physical therapy at home	Starting in the first week (THA) and in the second week (TKA/UKA)
Discharge criteria	
Patients' general well-being and acceptable pain control (VAS < 5);	
Dry wound;	
Ability to safely make independent postoperative transfers;	
Ability to safely mobilize with crutches and climb the stairs;	
Patients' express acceptance of discharge;	
Understanding of the living rules during the first 3 months (for THA).	

OJA = outpatient joint arthroplasty; IV = intravenous; LIA = local infiltration anesthesia; TKA = total knee arthroplasty; UKA = unicompartmental knee arthroplasty; COX-2 inhibitor = cyclooxygenase-2 inhibitor drugs; LMWH = Low-molecular-weight heparin; THA = total hip arthroplasty.

2.2 Data collection and outcome measures

Data were retrieved from the patient's electronic health records by 2 researchers (M.K. and S.A.). The primary outcome measure was the successfulness of outpatient surgery. Successful OJA was defined as same-day discharge (SDD) to home. Patients discharged to an inpatient rehabilitation clinic were not considered OJA.

Independent variables included patient-related factors and a subset of preoperatively administered patient-reported outcome measures (PROMs) to quantify preoperative physical symptoms. Patient-related factors included age at the time of surgery, gender, ethnicity, body mass index (BMI), type of surgery, affected joint side, history of joint surgery, American Society of Anesthesiologists (ASA) physical function score (where ASA I indicates a healthy person, ASA II mild systemic disease, and ASA III severe systemic disease),[26] Charnley score (indicating the severity of OA, where Charnley score A indicates one single hip or knee joint affected; B1 bilateral joints affected, B2 a contralateral joint with a successful joint arthroplasty, and C multiple joints affected),[27] duration of complaints, preoperative use of anticoagulants (defined as the use of acetylsalicylic acid or other anticoagulants), chronic opioid use (defined as daily or near-daily use of opioids over the course of 90 days or more), and a medical history of a central chronic pain syndrome. Central chronic pain syndromes were defined as chronic pain syndromes that may be characterized by pain centralization / amplification / hypersensitivity (e.g., fibromyalgia, irritable bowel syndrome).[28] Preoperatively administered PROMs consisted of the VAS for pain scaled from 0 to 10, where a lower score indicates less pain[29]; Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scaled from 0 to 100, where a lower score indicates less pain, stiffness, and functional limitations in patients with hip and/or knee OA[30]; Oxford Hip Score or Oxford Knee Score both scaled from 12 to 60, where a higher score indicates worse functionality and more pain in the hip or knee joint, respectively.[31, 32]

2.3 Statistical analysis

All analyses were performed with SPSS (IBM Corp. Released 2019. IBM SPSS Statistics for Windows, version 26. Armonk, NY: IBM Corp.). Demographic and clinical baseline characteristics of study participants were described as means with standard deviations for continuous variables and frequencies with percentages for categorical variables.

The difference in independent variables between patients who underwent successful SDD and those who underwent unsuccessful SDD in an OJA pathway was assessed

using chi-square or (for small sample sizes, with frequencies 5) Fisher exact test for categorical variables. An unpaired t-test was conducted for continuous variables.

Subjects with missing data were omitted (PROMs were not complete in 85 patients [16%]; 70 of 415 patients [17%] in the SDD group and 14 of 110 [13%] in the unsuccessful SDD group, p = 0.29) from further analysis and a complete case analysis (N = 440) was conducted. All variables that yielded a p value ≤ 0.10 from the bivariate analysis (Table 3) were included in a multivariable logistic regression analysis (enter method). Regardless of p value from bivariate analysis, age and BMI were included in the multivariable logistic regression model based on the importance suggested by previous literature.[11, 19, 33] No collinearity was found between variables. We assessed whether risk factors were independently associated with (un)successful SDD. Odds ratios (OR) with 95% confidence intervals (CI) were calculated. A 2-sided p ≤ 0.05 was considered to indicate statistical significance.

2.4 Study population

The mean age in this study population was 63 years (standard deviation ± 7.6 years; range, 29-83 years) and 259 patients (49%) were female. One hundred fifty-six patients (30%) were obese (BMI > 30 kg/m^2) and almost all patients were classified as ASA I (N = 292; 56%) or II (N = 217; 41%). Two hundred seventy-seven patients (53%) underwent TKA (Table 3).

Table 3. Demographic and clinical characteristics for successful versus unsuccessful SDD

Variable	Overall (N = 525)	SDD (N = 415)	Unsuccessful SDD (N = 110)	p value
Age (years)	63 ± 7.6 (29-83)	63 ± 7.7 (29-83)	64 ± 7.5 (45-80)	0.19
< 50	22 (4.2%)	18 (4.3%)	4 (3.6%)	
50 - 64	281 (54%)	224 (54%)	57 (52%)	
65 - 79	216 (41%)	169 (41%)	47 (43%)	
≥ 80	6 (1.1%)	4 (0.96%)	2 (1.8%)	
BMI (kg/m2)	28 ± 4.1 (17-42)	28 ± 4.0 (17-40)	28 ± 4.5 (19-42)	0.87
< 25	114 (22%)	85 (20%)	29 (26%)	
25 - 29.9	255 (49%)	209 (50%)	46 (42%)	
30 - 34.9	120 (23%)	92 (22%)	28 (25%)	
35 - 39.9	34 (6.5%)	28 (6.7%)	6 (5.5%)	
≥ 40	2 (0.38%)	1 (0.24%)	1 (0.9%)	
Female	259 (49%)	196 (47%)	63 (57%)	0.061
White	515 (98%)	408 (98%)	107 (97%)	0.44

Table 3. Demographic and clinical characteristics for successful versus unsuccessful SDD *(continued)*.

Variable	Overall (N = 525)	SDD (N = 415)	Unsuccessful SDD (N = 110)	p value
ASA class				**0.001**
I	292 (56%)	246 (59%)	46 (42%)	
II	217 (41%)	160 (39%)	57 (52%)	
III	16 (3.0%)	9 (2.2%)	7 (6.4%)	
Type of arthroplasty				
UKA	158 (30%)	134 (32%)	24 (22%)	0.098
TKA	277 (53%)	211 (51%)	66 (60%)	
THA	90 (17%)	70 (17%)	20 (18%)	
Surgery side, left	250 (48%)	196 (47%)	54 (49%)	0.73
Charnley class				0.096
A	187 (36%)	141 (34%)	46 (42%)	
B1	215 (41%)	171 (41%)	44 (40%)	
B2	104 (20%)	90 (22%)	14 (13%)	
C	19 (3.6%)	13 (3.1%)	6 (5.5%)	
Duration of complaints (months)				0.65
1 - 3	40 (7.6%)	29 (7.0%)	11 (10%)	
3 - 6	34 (6.5%)	26 (6.3%)	8 (7.3%)	
6 - 12	45 (8.6%)	36 (8.7%)	9 (8.2%)	
12 - 24	59 (11%)	50 (12%)	9 (8.2%)	
> 24	209 (40%)	160 (39%)	49 (45%)	
> 120	117 (22%)	97 (23%)	20 (18%)	
Missing	21 (4.0%)	17 (4.1%)	4 (3.6%)	
Previous surgery *	244 (47%)	225 (54%)	56 (51%)	0.54
Arthroscopic lavage / meniscectomy	227 (43%)			
ACL reconstruction	12 (2.3%)			
Osteotomy	10 (1.9%)			
Fracture repair	7 (1.3%)			
Other	8 (1.5%)			

Table 3. Demographic and clinical characteristics for successful versus unsuccessful SDD *(continued)*.

Variable	Overall (N = 525)	SDD (N = 415)	Unsuccessful SDD (N = 110)	p value
PROMs #				
WOMAC	64 ± 22 (1-100)	66 ± 21 (1-100)	59 ± 25 (14-100)	**0.024**
OKS/OHS	37 ± 8.0 (14-56)	36 ± 8.0 (14-56)	38 ± 7.6 (17-55)	0.072
VAS pain	6.6 ± 1.8 (0-10)	6.5 ± 1.8 (0-10)	6.9 ± 1.5 (3-10)	**0.029**
Preoperative anticoagulant use	56 (11%)	48 (12%)	8 (7.3%)	0.20
Acetylsalicylic acid	42 (8.0%)	36 (8.7%)	6 (5.5%)	
Other	14 (2.7%)	12 (2.9%)	2 (1.8%)	
Preoperative opioid use	18 (3.4%)	14 (3.4%)	4 (3.6%)	0.89
Intrinsic pain syndrome	50 (9.5%)	38 (9.2%)	12 (11%)	0.58

BMI = Body mass index; ASA = American Society of Anesthesiologists physical function score; UKA = unicompartmental knee arthroplasty; TKA = total knee arthroplasty; THA = total hip arthroplasty; ACL = anterior cruciate ligament; PROMs = patients reported outcome measures; WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index; OKS = Oxford Knee Score; OHS = Oxford Hip score; VAS pain = Visual analogous Scale for pain; SDD = same day discharge.

Discrete variables as frequency (percentage); continuous variables as mean ± standard deviation (range); **Bold** indicates statistical significance ($p < 0.05$).
* 12 patients underwent a combination of surgical procedures; # PROMs were not complete in 85 patients.

3. RESULTS

3.1 Bivariate analyses

One hundred ten patients (21%) were not able to be discharged from the hospital on the day of surgery. On bivariate analysis, we found a statistically significant difference in preoperative WOMAC (a mean of 66 ± 21 vs 59 ± 25) and VAS pain score (a mean of 6.5 ± 1.8 vs 6.9 ± 1.5), and ASA classification between the successful SDD group and unsuccessful SDD group (Table 3).

3.2 Multivariable logistic regression analyses

Charnley score B2, indicating a patient with previous successful contralateral joint arthroplasty, was independently associated with a higher chance of successful

SDD after hip or knee arthroplasty in an OJA pathway (OR, 0.30; 95% CI, 0.13-0.68; p = 0.004; Table 4).

Table 4. Multivariable logistic regression analysis

Retained variables	β regression coefficient	SE	p value	OR (95% CI)
Age (years)	– 0.002	0.018	0.91	1.0 (0.96 - 1.0)
BMI (kg/m2)	0.012	0.031	0.69	1.0 (0.95 - 1.1)
Gender				
Male	reference			
Female	0.53	0.25	**0.037**	1.7 (1.0 - 2.8)
ASA class				
I	reference			
II	0.65	0.27	**0.015**	1.9 (1.1 - 3.3)
III	1.3	0.64	**0.034**	3.9 (1.1 - 13)
Type of arthroplasty				
UKA	reference			
TKA	0.64	0.29	**0.028**	1.9 (1.1 - 3.4)
THA	0.46	0.46	0.32	1.6 (0.64 - 3.9)
Charnley class				
A	reference			
B1	– 0.43	0.27	0.11	0.65 (0.38 - 1.1)
B2	– 1.21	0.42	**0.004**	0.30 (0.13 - 0.68)
C	– 0.041	0.58	0.94	0.96 (0.31 - 3.0)
WOMAC	– 0.007	0.006	0.30	0.99 (0.98 - 1.0)
OKS/OHS	0.012	0.020	0.57	1.0 (0.97 - 1.1)
VAS pain	0.069	0.091	0.45	1.1 (0.90 - 1.3)
Nagelkerke pseudo $R^2 = 0.13$				

SE = standard error; OR = odds ratio; CI = confidence interval; BMI = body mass index; ASA = American Society of Anesthesiologists physical function score; UKA = unicompartmental knee arthroplasty; TKA = total knee arthroplasty; THA = total hip arthroplasty; PROMs = patients reported outcome measures; WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index; OKS = Oxford Knee Score; OHS = Oxford Hip score; VAS pain = Visual analogous Scale for pain.

Bold indicates statistical significance ($p < 0.05$).

ASA class II (indicating a patient with known mild systemic disease) and ASA class III (indicating a patient with known severe systemic disease) were independently associated with a higher risk of unsuccessful SDD after hip or knee arthroplasty

in an OJA pathway (OR, 1.9; 95% CI, 1.1-3.3; p = 0.015 and OR, 3.9; 95% CI, 1.1-13; p = 0.034, respectively). Female patients (OR, 1.7; 95% CI, 1.0-2.8; p = 0.037) and patients undergoing TKA (OR, 1.9; 95% CI, 1.1-3.4; p = 0.028) were also independently associated with a higher risk of unsuccessful SDD after hip or knee arthroplasty in an OJA pathway (Table 4).

4. DISCUSSION

Patients should undergo risk stratification and mitigation in an attempt to optimize quality and minimize costs in an OJA setting for hip and knee arthroplasty. Because there is much debate on the exact selection criteria for OJA, it is of great importance that patient-related risk factors for unsuccessful SDD in an OJA pathway are being identified.[2, 9, 11, 20, 21, 33-40] This study identified Charnley class B2 as a protective factor for successful SDD whereas female gender, TKA, and a higher ASA class (II/III) were found risk factors for unsuccessful SDD in a selected patient population.

The strengths and limitations of this study should be taken into account while interpreting these results. Many large studies on risk factors for unsuccessful OJA make use of claims or administrative data, consisting of data from multiple orthopaedic healthcare services with differing OJA protocols, perioperative care, and logistical setup.[14, 17, 18, 41] This may lead to bias. The main strength of this study was the large study population (N = 525) in a single orthopaedic clinic (within a secondary-referral teaching hospital), utilizing a standardized OJA protocol. Second, this study design differs from most other studies assessing risk factors for unsuccessful SDD in an OJA pathway, as only preselected patients were included.[9, 14, 41, 42] We recognize that the retrospective study design is a limitation as the perioperative protocol may change over time and certain data cannot be retrieved from the patient file. Besides slight changes in the multimodal pain protocol throughout the years and the implementation of the direct anterior approach for THA in 2017 by 2 of 5 surgeons, there were no other notable changes. An additional analysis did not show a statistically significant difference between year-to-year success rates of SDD (p = 0.13). A subanalysis also did not show a statistically significant difference between successful SDD after direct anterior approach THA (83%) and the posterolateral THA (77%) (p = 1.0). External validity is limited by the fact that we analyzed a selected group of patients. Patient selection for OJA was based on several criteria (Table 1), as a result of which patients with severe cardiovascular, pulmonary, and/or internal diseases (most ASA ≥ III patients) were excluded.[11] It can be expected that other risk factors were to be found in a group of unselected patients. Secondly, hospital logistics, payment models, perioperative protocols, and selection

criteria may differ in hospitals worldwide. OJA is possible in our clinic because of the multidisciplinary collaboration and logistic efforts in a high-volume secondary-referral teaching hospital.

Patients who had a previous successful contralateral joint arthroplasty (Charnley B2) had a higher chance of successful SDD compared to patients with single-joint OA (Charnley A) in a selected patient population. Previous studies found that having multiple joints in need of arthroplasty (Charnley C) was a predictor of delayed inpatient recovery of function after THA because of physical impairment due to comorbidities.[43, 44] Sibia et al[33] found that patients with prior successful TKA on the contralateral side (Charnley B2) were prone to a longer hospital stay. A possible explanation for these contradictory findings is the differences in study designs. Both their study designs retrospectively assessed patients in an unselected patient group, whereas we only assessed patients who were preselected and found eligible for OJA. We hypothesize that selected patients with prior successful contralateral joint arthroplasty (Charnley B2) benefit from their knowledge and previous experiences with the early rehabilitation process, leading to more effective coping strategies, enhanced resiliency, and better expectation management. We believe that patient expectation is one of the most critical predictors of successful discharge after joint arthroplasty. This is in accordance with study results from Halawi et al.[45] Nowadays, electronic health (eHealth) is taking a prominent role in perioperative care for patients undergoing elective joint arthroplasties, optimizing surgical care journeys, patient expectation management, and patient education.[46] Although this has yet to be investigated, the value of such patient journey apps in an OJA setting sounds promising.

The results of the present study confirmed that patients with a higher ASA class had a higher risk of unsuccessful SDD. Interestingly, ASA I and II are generally accepted for inclusion in an OJA pathway, and previous studies did not find ASA II to be a risk factor for unsuccessful OJA.[2, 22, 23] This study showed that patients with known mild systemic disease (ASA II) had a statistically significant higher risk of failing OJA in a selected population. These findings may be explained by taking a selected population, in which most ASA ≥ III patients were tended to be excluded from OJA due to protocol.[11, 12] We believe that ASA II is nonspecific and we hypothesize that this would not be a clinically relevant risk factor in an unselected group of patients. Nevertheless, this finding suggests scope for improvement and further specifying the selection criteria. It would be of interest to find out which specific comorbidities, within the ASA II category, influence the success of SDD in this selected population undergoing OJA. Although only a small amount of ASA III patients were present

in this case study, the results showed a higher tendency of unsuccessful SDD in an OJA setting (Table 4). This corresponds with results from studies with unselected patient groups.[42, 47] ASA III is generally associated with longer LOS, higher risk of readmissions, and early postoperative complications.[48-51]

Female gender was associated with unsuccessful SDD in an OJA pathway (Table 4). Although the causation of gender disparities remains unclear, many previous studies also found a positive association between the female gender and unsuccessful SDD, increased LOS overall, and the need for discharge to an inpatient extended care facility in varied patient populations undergoing THA or TKA.[23, 42, 47, 49, 50, 52-54] Possible cited explanations are that females (1) have a lower "functional independence score" after surgery compared to males, related to lower limb strength and muscle tone; (2) have greater preoperative dysfunction because they are more likely to present for surgery later in life; (3) verbalize the need for and use of assistance during recovery and rehabilitation more than men do, thereby changing the course of rehabilitation care.[54-56] In the present study, no gender disparities were found in terms of preoperative functional scores (WOMAC, Oxford Hip Score/Oxford Knee Score, and VAS) and the duration of complaints.

Patients undergoing TKA are more likely to undergo unsuccessful SDD in an OJA pathway compared to patients undergoing UKA. In general, the early rehabilitation phase is faster in patients undergoing a UKA and patients have a shorter LOS compared to TKA.[57] Possible explanations include a smaller bony resection, less blood loss, and preservation of normal knee kinematics. However, selection bias favoring healthier patients undergoing UKA may also play a role. In this case study, patients undergoing TKA had a longer onset of symptoms, were slightly but significantly older (a mean of 64 years vs a mean of 62 years), and had a lower BMI (a mean of 28 kg/m^2 vs a mean of 29 kg/m^2). No significant differences between both groups were found in gender, ASA or Charnley classification, and PROMs. These results correspond with findings from Berger et al[9], who describe that UKAs develop fewer perioperative problems that can delay SDD compared to TKAs.

These results also suggested that higher age and BMI were not significant risk factors for unsuccessful SDD in a selected population and are comparable to findings by Berger et al.[9] Interestingly, this is not consistent with a majority of the existing literature. Multiple studies found that increasing age and obesity were risk factors for a prolonged hospital stay after elective THA and TKA.[33, 42, 47, 49, 58, 59] These studies, however, assessed an unselected patient population and differed from the present study design, as older and obese patients were mostly excluded from OJA protocols

(although the exact cutoff points for what is acceptable are highly variable in the literature).[11, 13, 19] Advanced age is associated with multimorbidity, gradual physical decline, cognitive impairment, and lack of direct social support,[60-62] which might negatively affect the early rehabilitation process after joint arthroplasty.[56, 63, 64] Obesity is recognized to be associated with higher postoperative complication (i.e., superficial/deep infection and revision surgery) and readmission rates after joint arthroplasty.[58, 65-68] Total joint arthroplasty can also be technically challenging in obese patients, resulting in prolonged operative duration and increased intraoperative blood loss resulting in postoperative blood transfusion.[69] Additionally, because of limited ambulatory ability, obese patients are in greater need of assistance with post-operative transfers (i.e., supine to sit, sit to stand, and bed to chair positions), making this group of patients less suitable for OJA.[70] We believe no differences were found because the surgeon pre-operatively selected patients based on extensive selection criteria, yielding vital patients with otherwise few comorbidities and sufficient social support. As the possible negative effect of age and BMI on early postoperative discharge may be more pronounced in > 80-year-olds or in the morbidly obese category (BMI > 40 kg/m^2),[71, 72] and these categories were underrepresented in this study population, no definitive conclusions can be drawn.

5. CONCLUSIONS

In conclusion, the results emphasize the importance of adequate preoperative risk stratification and mitigation of patients undergoing OJA, and the importance of an in-hospital backup plan for patients at risk of unsuccessful SDD. Patients who already underwent a successful contralateral joint arthroplasty (Charnley B2) were more likely to succeed SDD, suggesting the importance of patient expectation management and close patient counseling. Further research for OJA within a selected patient population may be directed in finding specific comorbidities (in ASA II patients) that are risk factors for unsuccessful SDD.

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CHAPTER 5

RATES AND CAUSES OF 90–DAY COMPLICATIONS AND READMISSIONS FOLLOWING OUTPATIENT HIP AND KNEE ARTHROPLASTY

A retrospective analysis of 525 patients in a single institution

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ABSTRACT

Background
Outpatient joint arthroplasty (OJA) has gained increasing popularity and success in a well-defined population. Safety concerns, in terms of complications and readmissions, however still exist.

Patients and methods
This retrospective study included 525 patients (90 primary THAs, 277 primary TKAs, and 158 primary UKAs), initially planned for OJA. All complications and readmissions were evaluated for timing and cause (surgical vs medical) within a 90-day follow-up. Complications and readmissions were compared by the length of stay (LOS): same-day discharge (SDD) vs ≥ 1 day. Differences were assessed by the log-rank test. Complications and readmission risk were assessed using multivariable logistic regression analysis.

Results
The complication rate was 9.9% at 30 days and 15% at 90 days. The readmission rate was 2.5% at 30 days and 4.2% at 90 days. The majority of surgical complications and readmissions were the result of wound discharge (43% and 56%, respectively). Overall, we did not observe different rates between SDD and LOS ≥ 1. Following THA, but not TKA or UKA, the 90-day complication rate was significantly lower in patients that underwent SDD compared with LOS ≥ 1. The risk of complications was positively associated with TKA (vs THA and UKA), ASA III (vs ASA I), and Charnley C (vs Charnley A). The risk of readmissions was negatively associated with a BMI ranging from 25-29.9 kg/m^2 (vs BMI < 25 kg/m^2).

Conclusion
SDD following OJA did not result in more complications and hospital readmissions compared to a prolonged hospital stay. The majority of complications and readmissions were due to noninfected wound discharge.

1. INTRODUCTION

1.1 Background
The increasing number of patients in need of a TJA and the success of these procedures is reflected in the increasing rates of total hip (THA) and total knee arthroplasty (TKA) performed worldwide. Subsequently, this leads to significant healthcare budget and health workforce implications.[1]

In recent decades, enhanced clinical recovery ("fast-track") pathways have been composed to further improve quality of care and patient outcomes, and allow cost-effective care. Studies have shown that these pathways with perioperative improvements (e.g., multimodal pain management, early mobilization) successfully reduced the hospital length of stay (LOS) without increasing – and maybe even reducing – the number of complications and hospital readmissions.[2-6]

Through continuous improvement of hospital logistics and perioperative care, nowadays outpatient joint arthroplasty (OJA) is feasible in a selected patient population. It is gaining popularity due to increased focus on value-based healthcare and cost-effectiveness. Although OJA is considered safe in selected patients, the current literature on complications and readmission rates is controversial and largely based on administrative data, national databases or observational cohort studies with relatively small sample sizes.[7-12] Complications and readmission rates are an important indicator of safety and quality of care as it causes a high burden to healthcare and patients.[13] This study presents clinical data on early and late complications of a relatively large study population following OJA in a single center and adds to a growing body of literature. Insights into complications and readmissions can assist in further refining the pathway protocol and the patient selection process.

1.2 Aims
This study primarily aimed to identify the 30- and 90-day complications and readmission rates in patients who were planned to undergo outpatient THA, TKA or unicompartmental knee arthroplasty (UKA) and to assess whether there were differences in rates between patients who were successfully discharged on the same day of surgery and patients with a prolonged hospital stay (LOS ≥1 day). Secondary research purposes were to identify (1) the medical and surgical causes of 90-day complications and readmissions; and (2) risk factors associated with 90-day complications and readmissions.

2. PATIENTS AND METHODS

This retrospective study was approved by the local institutional review board (study number 20190064).

2.1 Setting and subjects

All patients who were planned to undergo OJA between December 2013 and April 2019 (N = 525) were retrospectively identified using the medical records database of the local institution (a secondary care multispecialty non-academic teaching hospital). Patients were preoperatively selected by five orthopaedic surgeons based on the criteria listed in Table 1. Relative exclusion criteria aided the surgeon's discretion.[14]

Table 1. Inclusion and exclusion criteria for OJA

Inclusion criteria	
General	Preoperative consent to be discharged to home on the same day of surgery; Patients' understanding of the OJA program; Care and social support must be provided during the first postoperative days.
Surgical	Primary elective THA, TKA or UKA; Unilateral procedure.
Exclusion criteria	
Cardiology	Coumarin-derivative usage, bridging anticoagulation, and NYHA classification III/IV.
Pulmonary	Poorly controlled lung fibrosis, emphysema or pulmonary hypertension, recent embolism or carcinoma.
Internal medicine	Extensive edema, chronic usage of prednisolone, severe renal function disorders, and insulin-dependent diabetes mellitus.
Geriatric	History of (frequent) falling in the past three months, cognitive function disorders (e.g., history of delirium, dementia, memory difficulties), requiring additional inpatient rehabilitation and polypharmacy.
Urology	Pre-existing voiding difficulties and preoperative use of urologic medication.
Neurology	Severe mobility disorders (e.g., cerebrovascular accident with residual deficits, Parkinson's disease, peripheral neurologic function disorders).
Psychiatry	Substance or drug abuse.

OJA = outpatient joint arthroplasty; THA = total hip arthroplasty; TKA = total knee arthroplasty; UKA = unicompartmental knee arthroplasty; NYHA = New York Heart Association.

All patients were planned to be discharged home on the day of surgery and no patients were discharged to an inpatient skilled nursing or rehabilitation facility. Preoperative multidisciplinary education about the outpatient process and home-based rehabilitation was provided to set proper patient expectations. They were admitted to the hospital early on the day of surgery and surgery was scheduled first or second in the operating room so discharge criteria (Appendix 1) could be achieved by the end of the day. If patients were not medically cleared for SDD by the physician, they were admitted to the inpatient orthopaedic ward. Reasons for a prolonged hospital stay in this population included postoperative pain and/or fear, wound discharge, nausea and vomiting, dizziness and/or orthostatic hypotension, et cetera, and were previously described in a study by our research group.[15]

The utilized OJA protocol was standardized for all patients and was previously described in detail by our research group.[15, 16] All patients underwent the same preoperative routine (in terms of selection, multidisciplinary education and training, and preoperative analgesia, nausea and urinary retention prevention, et cetera) and all relevant protocol characteristics were presented in Table 2 and categorized by type of arthroplasty. Postoperative follow-up visits were standardized for all patients at 2 and 6 weeks and 1 year. Fifty-eight percent of patients also had a follow-up visit at 3 months in compliance with our previous follow-up protocol.[17]

Table 2. Characteristics of the OJA pathway

Pharmacological			
Prophylactic antibiotics	IV administration prior to surgical incision (1st dose) and prior to discharge (2nd dose)		
Dexamethasone	IV (single) high-dose administration		
Tranexamic acid	Oral administration (1st dose) 2 hours prior to surgery and IV administration (2nd dose) at wound closure		
Multimodal pain protocol	Acetaminophen, selective COX-2 inhibitor, gabapentin, and opioids (only upon patients' request)		
Thrombosis prophylaxis	Self-administration instructions for subcutaneous LMWHs; continued for 6 weeks		
Intraoperative	**THA**	**TKA**	**UKA**
Anesthetic method	General or spinal based on the anesthesiologic consultation (with multidisciplinary preference for spinal anesthesia)		
Surgical approach	Posterolateral or direct anterior	Open medial parapatellar	Minimal invasive
Implant type	Trident® Cementless Acetabular Shell System, Stryker Accolade® II Cementless Hip Stem System, Stryker	Vanguard® Complete Knee System, Biomet	Oxford® Partial Knee Microplasty® System, Biomet
Tourniquet use	N/A	N/A	During the full duration of surgery
LIA	N/A	Yes, both medially and laterally	Yes, only medially
Drains or urinary catheters	N/A	N/A	N/A
Wound closure	In layers with continuous barbed sutures: V-Loc™ Wound Closure Device, Covidien		
Postoperative			
Urinary retention analysis	Using a bladder scan protocol[16]		
Compressive and cooling therapy	A compressive bandage for the first 8 hours which is removed prior to discharge. Cooling by ice packs for the first 24 hours		
First mobilization	< 4 Hours, with guidance of a physical therapist		
Physical therapy at home	Start in 1st postoperative week	Start in 2nd postoperative week	Start in 2nd postoperative week

OJA = outpatient joint arthroplasty; IV = intravenous; LIA = local infiltration anesthesia; COX-2 inhibitor = cyclooxygenase-2 inhibitor drugs; LMWH = Low-molecular-weight heparin; THA = total hip arthroplasty; TKA = total knee arthroplasty; UKA = unicompartmental knee arthroplasty.

2.2 Complications and hospital readmissions

Hospital-specific patient identification numbers were used and medical records data were retrospectively reviewed to identify complications and hospital readmissions within 30 and 90 days. All complications and readmissions were evaluated for the timing of occurrence and cause. A complication within the specified time frames (30- and 90-days, counting from the date of the index procedure) was defined as follows: "any undesirable, unintended and direct result of an operation affecting the patient which would not have occurred had the operation (and the outpatient pathway) gone as well as could reasonably be hoped".[18] All unplanned physical hospital contacts of any kind (e.g., for pain) were considered complications. Complications were categorized as a surgical complication (e.g., arthrofibrosis, wound healing problems, pain) or another medical complication (e.g., pneumonia, cardiac arrhythmia). The severity of complications was graded on a scoring system adapted from the Dindo-Clavien classification (Appendix 2).[19] Hospital readmission was defined as any admission to the hospital after discharge from the hospital that occurred within the specified time frames (90 days, counted from the date of discharge of the index admission). Readmission on the same day of discharge was not considered a single continuous admission. All hospital readmissions were recorded and were either planned (e.g., planned revision) or unplanned (e.g., persistent wound discharge, pneumonia). Patients were either readmitted from the emergency department or the outpatient orthopaedic clinic. We did not have a means of determining readmissions to another hospital or health institution.

2.3 Patient and procedural characteristics

Recorded independent variables included patient-related and surgery-related factors. Patient-related factors were age at the time of surgery, Body Mass Index (BMI), gender, American Society of Anesthesiologists (ASA) physical function score (where ASA 1 indicates a healthy person, ASA II mild systemic disease, and ASA III severe systemic disease), Charnley class (indicating the severity of osteoarthritis, where Charnley score A indicates one single hip or knee joint affected; B1 bilateral joints affected, B2 a contralateral joint with a successful joint replacement and C multiple joints affected), a history of prior surgery to the same joint (e.g., arthroscopic meniscectomy, ACL-reconstruction, correction osteotomy, open reduction and internal fixation of a fracture), a history of anticoagulants (e.g., acetylsalicylic acid, clopidogrel and direct oral anticoagulants such as rivaroxaban) or chronic preoperative opioid use (defined as daily or near-daily use of opioids such as tramadol or oxycodone for 90 days or more). Surgery-related factors included the type of arthroplasty, type of anesthesia, duration of surgery, intraoperative blood loss, and LOS (SDD versus ≥1 day).

2.4 Study population

A total of 525 patients were initially planned for OJA. The overall mean age in this study population was 63 years (SD ± 7.6 years). Most patients underwent TKA (N = 277, 53%) and had spinal anesthesia (N = 403, 77%). One hundred ten patients (21%) were not medically cleared for discharge by the medical doctor on the day of surgery and were admitted to the inpatient ward. Differences in demographics across groups are presented in Table 3. Additional baseline analyses (by different type of arthroplasty) are described in Appendix 3a-c.

Table 3. Demographics and clinical characteristics

	Overall (N = 525)	SDD (N = 415)	LOS ≥1 day (N = 110)	p value
Patient factors				
Age (years)	63 ± 7.6 (29-83)	63 ± 7.7 (29-83)	64 ± 7.5 (45-80)	0.19
< 50	22 (4.2%)	18 (4.3%)	4 (3.6%)	
50 - 64	281 (54%)	224 (54%)	57 (52%)	
65 - 79	216 (41%)	169 (41%)	47 (43%)	
≥ 80	6 (1.1%)	4 (0.96%)	2 (1.8%)	
BMI (kg/m2)	28 ± 4.1 (17-42)	28 ± 4.0 (17-40)	28 ± 4.5 (19-42)	0.87
< 25	114 (22%)	85 (20%)	29 (26%)	
25 - 29.9	255 (49%)	209 (50%)	46 (42%)	
30 - 34.9	120 (23%)	92 (22%)	28 (25%)	
≥ 35	36 (6.9%)	29 (7.0%)	7 (6.4%)	
Female	259 (49%)	196 (47%)	63 (57%)	0.061
ASA class				**0.001**
I	292 (56%)	246 (59%)	46 (42%)	
II	217 (41%)	160 (39%)	57 (52%)	
III	16 (3.0%)	9 (2.2%)	7 (6.4%)	
Charnley class				0.096
A	187 (36%)	141 (34%)	46 (42%)	
B1	215 (41%)	171 (41%)	44 (40%)	
B2	104 (20%)	90 (22%)	14 (13%)	
C	19 (3.6%)	13 (3.1%)	6 (5.5%)	
Previous surgery	244 (47%)	225 (54%)	56 (51%)	0.54
Preoperative anticoagulant use	56 (11%)	48 (12%)	8 (7.3%)	0.2
Preoperative opioid use	18 (3.4%)	14 (3.4%)	4 (3.6%)	0.89

Table 3. Demographics and clinical characteristics (*continued*).

	Overall (N = 525)	SDD (N = 415)	LOS ≥1 day (N = 110)	p value
Surgical factors				
Type of arthroplasty				0.098
THA	90 (17%)	70 (17%)	20 (18%)	
TKA	277 (53%)	211 (51%)	66 (60%)	
UKA	158 (30%)	134 (32%)	24 (22%)	
Blood loss (mL)	198 ± 178 (0-1100)	188 ± 169 (0-1000)	234 ± 204 (0-1100)	**0.017**
Surgery duration (min)	55 ± 15 (26-135)	55 ± 15 (26-135)	57 ± 14 (28-96)	0.28
Anesthesia type				**0.004**
Spinal	403 (77%)	330 (80%)	73 (66%)	
General	122 (23%)	85 (20%)	37 (34%)	

SDD = same-day discharge; LOS = length of stay; BMI = body mass index; ASA = American Society of Anesthesiologists; THA = total hip arthroplasty; TKA = total knee arthroplasty; UKA = unicompartmental knee arthroplasty.

Discrete variables as frequency (percentage); continuous variables as mean ± standard deviation (range); **Bold** values indicate statistical significance ($p < 0.05$).

2.5 Statistical analysis

All analyses were performed with SPSS (IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp.). The primary outcome measures were 90-day complications and hospital readmission rates. Secondary outcome measures included 30-day complications and hospital readmission rates, causes of complications and readmissions, and independent risk factors. Demographics of study participants were described as means ± standard deviations (SD) for continuous variables and frequencies with percentages for categorical variables.

Two inverse (one-minus survival) Kaplan-Meier curves were created to estimate the cumulative incidence of 90-day complications and 90-day readmissions. Complications and readmissions were grouped by LOS (SDD versus ≥1 day). Differences in complications and readmissions between the two groups were assessed with the log-rank test. The fact that complicated procedures are often associated with a prolonged hospital stay was accounted for: if a complication occurred on the day of surgery, and the patient subsequently became an inpatient, the complication was scored in the SDD group (N = 3). Subjects were censored after a complication/

readmission occurred to ensure that patients (N = 2) with multiple complications/ readmissions did not excessively weigh the results.

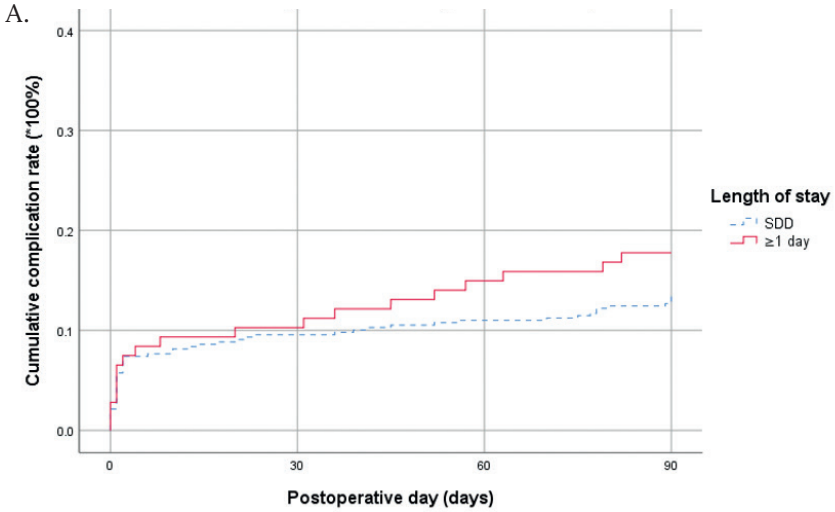
Bivariate statistics were performed to assess differences in characteristics between patients in which a complication occurred and patients in which no complication occurred (Appendix 4). The same was done for readmissions (Appendix 5). Groups were compared using chi-square or (in case of cells with expected value < 5) Fisher's exact test for categorical variables. An unpaired T-test was conducted for continuous variables. To determine which factors were independently associated with risk of complications/hospital readmissions, two multivariable logistic regression models (enter method) were created including all independent variables with a bivariate p value of < 0.20: one for 90-day complications and one for 90-day hospital readmissions. LOS and arthroplasty type were included in the analysis, regardless of p value. No collinearity was found between variables. To assess between-group effects for the different types of arthroplasties the interaction-term arthroplasty type*LOS was included in the regression model. Odds ratios (OR) with 95% confidence intervals (CI) and cases per person-days were calculated. Two-sided p values were reported throughout this paper with a p value ≤ 0.05 indicating statistical significance.

3. RESULTS

3.1 Complication rate

The overall complication rate was 9.9% (N = 52 of 525) at 30 days and 15% (N = 78 of 525) at 90 days. The overall number of patients with one (or more) complication(s) at 30- and 90- days did not show significant differences between patients that were successfully discharged on the day of surgery and patients with a prolonged LOS (p = 0.82 and p = 0.26 respectively) (Figure 1a). By type of arthroplasty, the overall number of patients with one (or more) complication(s) at 90-days following THA was significantly (p = 0.011) lower in patients that were successfully discharged on the day of surgery compared with patients with a prolonged LOS (Figure 1b-1d).

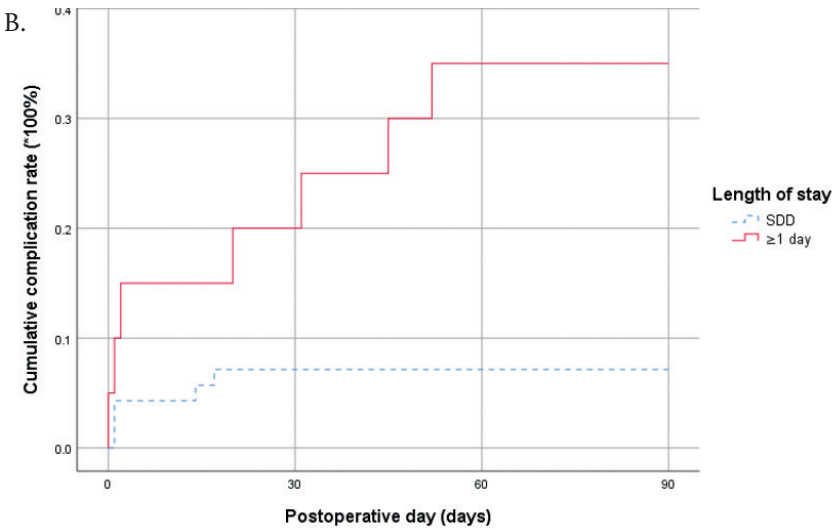
A.



Overall number of patients with one (or more) complication(s)

Postoperative day	30	60	90
SDD	40	46	56
≥1 day	11	16	19
p value	0.82	0.27	0.26

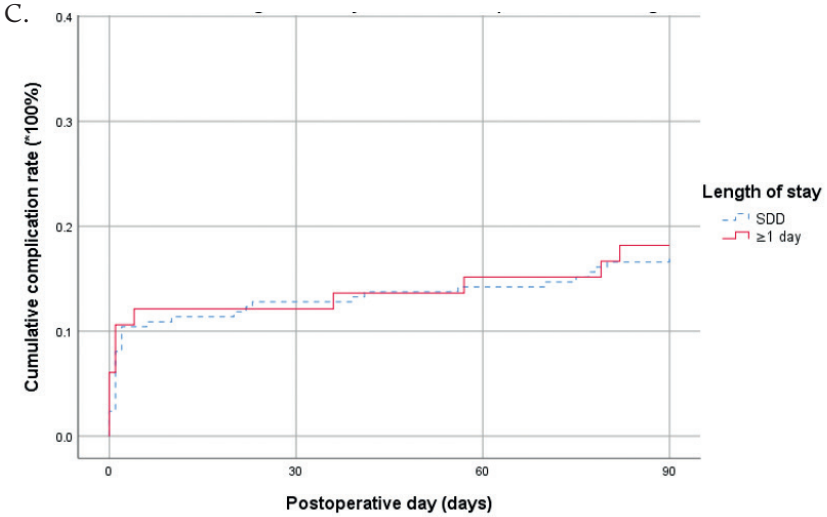
B.



Number of patients with one (or more) complication(s) following THA (*continued*)

Postoperative day	30	60	90
SDD	6	6	6
≥1 day	3	6	6
p value	0.36	**0.011**	**0.011**

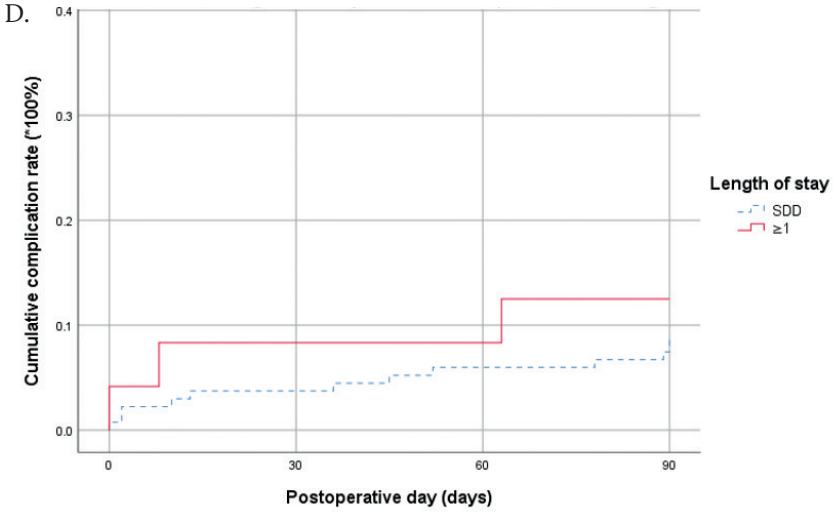
C.



Number of patients with one (or more) complication(s) following TKA

Postoperative day	30	60	90
SDD	29	32	38
≥1 day	6	8	10
p value	0.39	0.61	0.67

D.



Number of patients with one (or more) complication(s) following UKA

Postoperative day	30	60	90
SDD	5	8	12
≥1 day	2	2	3
p value	0.30	0.64	0.56

Figure 1. A. Overall, 90-day cumulative complications. B. 90-day cumulative complications following THA. C. 90-day cumulative complications following TKA. D. 90-day cumulative complications following UKA.

3.2 Causes of complications

Of all complications, surgical complications occurred in 81% of cases (N = 63 of 78). The majority of surgical complications were the result of noninfected wound discharge (43%, N = 27 of 63), excessive pain at the surgery site (13%, N = 8 of 63), and urinary retention (9.5%, N = 6 of 63). Surgical site infection (SSI) occurred in 6.3% of surgical complications (N = 4 of 63). Other medical complications varied and were listed in Table 4.

Noninfective wound discharge occurred more often in patients that were discharged on the day of surgery (6.0%) compared with patients with a prolonged LOS (1.8%) (p = 0.090) (Table 4). Noninfective wound discharge occurred more often in TKA (7.9%) compared with THA (3.3%) and UKA (1.3%) (p = 0.007) (Appendix 6).

Table 4. 90-Day surgical and medical complications (N = 78) #

Surgical complication (N = 63)	Grade of complication*	SDD (N = 415)	LOS ≥1 day (N = 110)	p value
Noninfected wound discharge				
Requiring monitoring	1	24 (5.8%)	2 (1.8%)	0.13
Requiring surgical exploration (suspected fascial defect)	3a	1 (0.24%)	0	1.0
Excessive pain	1	6 (1.4%)	2 (1.8%)	0.68
Urinary retention	1	1 (0.24%)	5 (4.5%)	**0.002**
Symptoms of instability	1	5 (1.2%)	0	0.59
Surgical site infection (SSI)				
Superficial SSI requiring antibiotics	2	1 (0.24%)	2 (1.8%)	0.11
SSI (suture fistula) requiring surgical debridement	3b	0	1 (0.91%)	0.21
Arthrofibrosis requiring manipulation under anesthesia	3b	2 (0.48%)	0	1.0
Allergic reaction to bandage	1	2 (0.48%)	0	1.0
Symptomatic postoperative anemia requiring transfusion	2	0	1 (0.91%)	0.21
Subsidence	1	1 (0.24%)	0	1.0
Insert dislocation (in UKA)	3a	1 (0.24%)	0	1.0
Dislocation (in THA)	3b	0	1 (0.91%)	0.21
Symptomatic ruptured Baker's cyst	3a	1 (0.24%)	0	1.0
Traumatic disrupted extensor mechanism	3a	1 (0.24%)	0	1.0
Postoperative dystrophia	1	1 (0.24%)	0	1.0
Falling without traumatic injury	1	1 (0.24%)	0	1.0
Post-operative hypotension requiring intensive care admission	4	1 (0.24%)	0	1.0
Other medical complication (N = 15)				
Erysipelas	2	0	2 (1.8%)	**0.044**
Pneumonia	2	1 (0.24%)	1 (0.91%)	0.38
Malaise	1	2 (0.48%)	0	1.0
Herpes zoster	1	2 (0.48%)	0	1.0
Biliary pancreatitis requiring surgery	3b	0	1 (0.91%)	0.21
Cholecystitis requiring surgery	3b	1 (0.24%)	0	1.0
Gastroenteritis	1	1 (0.24%)	0	1.0

Table 4. 90-Day surgical and medical complications (N = 78) # *(continued).*

Other medical complication (N = 15)				
Diverticulitis	1	0	1 (0.91%)	0.21
Bell's Palsy	1	0	1 (0.91%)	0.21
Cutaneous sarcoidosis	2	1 (0.24%)	0	1.0
AV nodal reentrant tachycardia	2	1 (0.24%)	0	1.0

SDD = same-day discharge; LOS = length of stay; UKA = unicompartmental knee arthroplasty; THA = total hip arthroplasty; AV = atrioventricular.

Multiple complications occurred in two patients; * Grading was done based on the classification system presented in Appendix 2.

3.3 Risk of complications

Multivariable logistic regression analysis showed that patients undergoing UKA (OR 0.47; p = 0.036) or THA (OR 0.40; p = 0.050) had an overall lower risk of 90-day complications compared to patients undergoing TKA. A near statistically significant interaction was found between the type of arthroplasty and LOS (p = 0.051). Patients in the THA group (OR 5.6; p = 0.028) were more likely to develop a complication following a prolonged LOS (versus SDD) compared with patients in the TKA group (Table 5).

ASA classification III (compared with ASA I; OR 3.9; p = 0.021) and Charnley classification C (compared with Charnley A; OR 3.1; p = 0.050) were associated with a significantly increased risk of complications within 90-days (Table 5).

Table 5. Multivariable logistic regression analysis 90-day complication rate

Retained variables	Cases/person-days	β regression coefficient	SE	p value	OR (95% CI)
Clinical pathway					
SDD	53/33,830	reference	reference	reference	1
LOS ≥1 day	22/8,403	– 0.21	0.4	0.57	0.81 (0.37 - 1.8)
Type of arthroplasty					
TKA	48/21,580	reference	reference	reference	1
UKA	15/13,448	– 0.76	0.36	**0.036**	0.47 (0.23 - 0.95)
THA	12/7,205	– 0.93	0.47	**0.050**	0.40 (0.16 - 1.0)
BMI					
< 25	22/8,744	reference	reference	reference	1
25 - 29.9	30/20,910	– 0.50	0.32	0.12	0.61 (0.32 - 1.1)
30 - 34.9	20/9,505	– 0.16	0.37	0.67	0.85 (0.41 - 1.8)
≥ 35	3/3,074	– 0.94	0.67	0.16	0.39 (0.11 - 1.5)
ASA class					
I	37/24,043	reference	reference	reference	1
II	32/17,283	0.099	0.28	0.72	1.1 (0.64 - 1.9)
III	6/904	1.4	0.58	**0.021**	3.9 (1.2 - 12)
Charnley class					
A	23/15,435	reference	reference	reference	1
B1	33/16,901	0.29	0.30	0.33	1.3 (0.74 - 2.4)
B2	13/8,509	– 0.045	0.39	0.91	0.96 (0.45 - 2.0)
C	6/1,388	1.1	0.58	**0.050**	3.1 (1.0 - 9.5)

Table 5. Multivariable logistic regression analysis 90-day complication rate *(continued)*.

Retained variables	Cases/person-days	β regression coefficient	SE	p value	OR (95% CI)
Arthroplasty type*LOS					
TKA (≥1 day vs SDD)	N/A	reference	reference	reference	1
UKA (≥1 day vs SDD)	N/A	0.31	0.82	0.71	1.4 (0.27 - 6.8)
THA (≥1 day vs SDD)	N/A	1.7	0.78	**0.028**	5.6 (1.2 - 26)

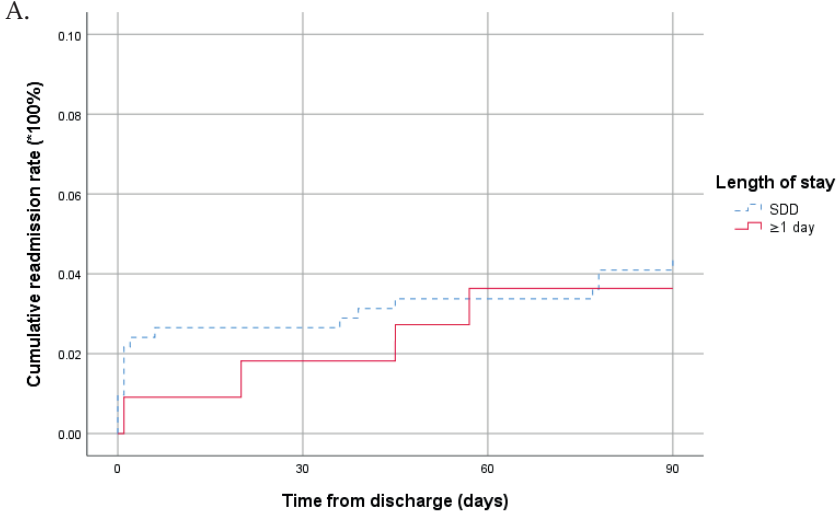
SE = standard error; OR = odds ratio; CI = confidence interval; SDD = same day discharge; LOS = length of stay; TKA = total knee arthroplasty; UKA = unicompartmental knee arthroplasty; THA = total hip arthroplasty; BMI = body mass index; ASA = American Society of Anesthesiologists.

Bold indicates statistical significance, $p < 0.05$.

3.4 Readmission rate

The overall readmission rate was 2.5% (N = 13 of 525) at 30 days and 4.2% (N = 22 of 525) at 90 days. Patients were readmitted from the emergency department (64%, N = 14 of 22) or from the outpatient clinic (36%, N = 8 of 22). The overall 30- and 90-day readmission rates did not show significant differences between patients that were successfully discharged on the day of surgery and patients with a prolonged LOS (p = 0.61 and p = 0.74 respectively) (Figure 2a). No statistically significant differences in readmission rates between SDD and LOS ≥1 was observed by type of arthroplasty (Figure 2b-2d).

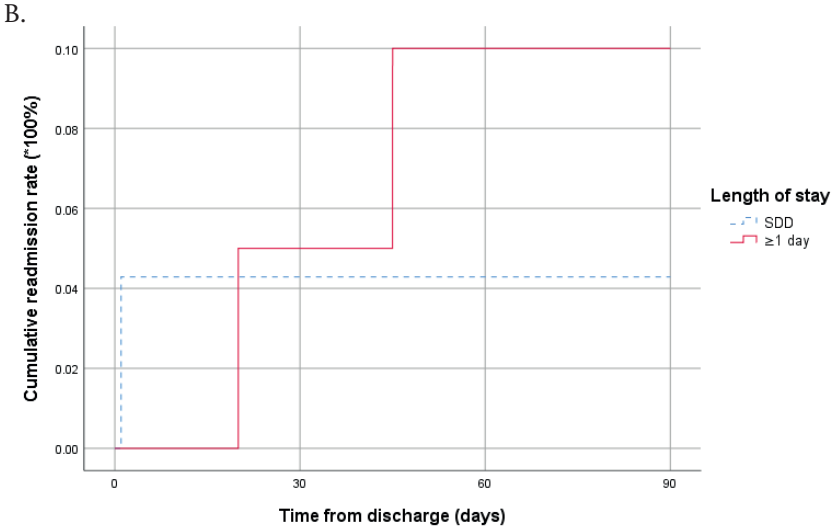
A.



Overall number of patients that were readmitted

Postoperative day	30	60	90
SDD	11	14	18
≥1 day	2	4	4
p value	0.65	0.91	0.79

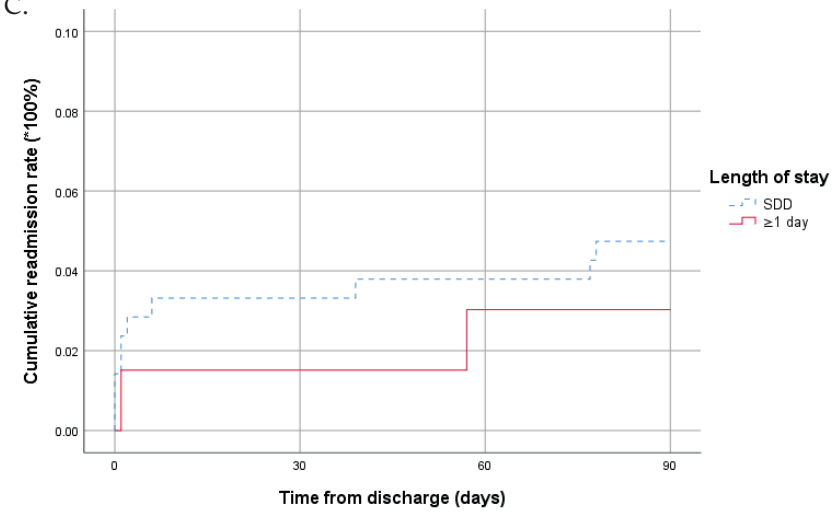
B.



Number of patients that were readmitted following THA

Postoperative day	30	60	90
SDD	3	3	3
≥1 day	1	2	2
p value	0.86	0.34	0.34

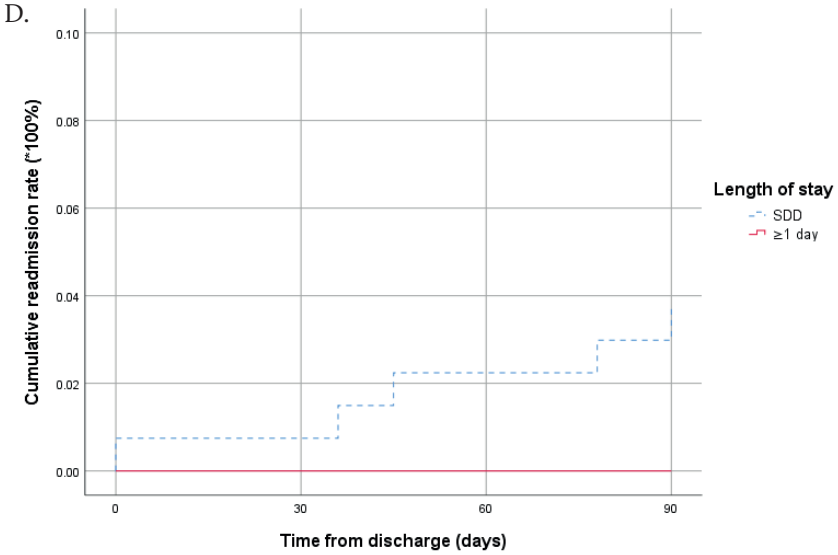
C.



Number of patients that were readmitted following TKA *(continued)*

Postoperative day	30	60	90
SDD	7	8	10
≥1 day	1	2	2
p value	0.45	0.77	0.59

D.



Number of patients that were readmitted following UKA

Postoperative day	30	60	90
SDD	1	3	5
≥1 day	0	0	0
p value	0.67	0.46	0.34

Figure 2. Figure 2. A. Overall, 90-day cumulative readmissions. B. 90-day cumulative readmissions following THA. C. 90-day cumulative readmissions following TKA. D. 90-day cumulative readmissions following UKA.

3.5 Causes of readmissions

The cause of readmission was surgical in 73% (N = 16 of 22) of patients. The majority of readmissions with a surgical cause were the result of noninfected wound discharge (56%, N = 9 of 16) which required in-hospital monitoring. Other surgical and medical causes for hospital readmissions varied and were listed in Table

6. Hospital readmission because of noninfective wound discharge occurred more often in TKA (2.2%) and THA (2.2%) compared to UKA (0.6%) (p = 0.46) (Appendix 7). Readmissions were unplanned in 86% of cases, whereas 14% of readmissions were planned. Readmissions required surgical intervention in 36% of cases.

Table 6. 90-Day hospital readmissions (N = 22)

Surgical reason (N = 16)	SDD (N = 415)	LOS ≥1 day (N = 110)	p value
Noninfected wound discharge			
Requiring monitoring	7 (1.7%)	1 (0.91%)	1.0
Requiring surgical exploration	1 (0.24%)	0	1.0
Excessive pain monitoring	2 (0.48%)	0	1.0
Arthrofibrosis requiring manipulation under anesthesia	2 (0.48%)	0	1.0
SSI requiring surgical debridement	0	1 (0.91%)	0.21
Insert dislocation requiring insert revision (in UKA)	1 (0.24%)	0	1.0
Ruptured Baker's cyst requiring surgical debridement	1 (0.24%)	0	1.0
Other medical reason (N = 6)			
Pneumonia	1 (0.24%)	1 (0.91%)	0.38
Biliary pancreatitis requiring surgery	0	1 (0.91%)	0.21
Cholecystitis requiring surgery	1 (0.24%)	0	1.0
Gastroenteritis	1 (0.24%)	0	1.0
Malaise	1 (0.24%)	0	1.0

SDD = same-day discharge; LOS = length of stay; SSI = surgical site infection; UKA = unicompartmental knee arthroplasty.

3.6 Risk of readmission

Multivariable logistic regression analysis showed that patients who were overweight (BMI 25 - 29.9 kg/m^2), but not obese, were associated with a decreased risk of hospital readmissions within 90 days compared with patients with a BMI < 25 (OR 0.25; p = 0.022) (Table 7).

Table 7. Multivariable logistic regression analysis 90-day readmission rate

Retained variables	Cases/ person-days	β regression coefficient	SE	p value	OR (95% CI)
Clinical pathway					
SDD	18/36,186	reference	reference	reference	1
LOS ≥1 day	4/9,663	– 0.53	0.81	0.52	0.59 (0.12 - 2.9)
Type of arthroplasty					
TKA	12/24,112	reference	reference	reference	1
UKA	5/14,019	– 0.14	0.59	0.81	0.87 (0.28 - 2.7)
THA	5/7,718	– 0.23	0.70	0.74	0.79 (0.20 - 3.1)
BMI					
< 25	8/9,823	reference	reference	reference	1
25 - 29.9	5/22,597	– 1.4	0.61	**0.022**	0.25 (0.075 - 0.82)
30 - 34.9	9/10,189	0.027	0.56	0.96	1.0 (0.34 - 3.1)
≥ 35	0/3,240	– 19	6614	1.0	0
ASA class					
I	9/25,814	reference	reference	reference	1
II	11/18,774	0.44	0.52	0.4	1.6 (0.56 - 4.4)
III	2/1,261	1.3	1	0.21	3.7 (0.49 - 29)
Preoperative anticoagulant use					
No	17/41,255	reference	reference	reference	1
Yes	5/4,594	0.60	0.65	0.36	1.8 (0.51 - 6.5)
Arthroplasty type*LOS					
TKA (≥1 day vs SDD)	N/A	reference	reference	reference	1
UKA (≥1 day vs SDD)	N/A	– 18	7775	1.0	0
THA (≥1 day vs SDD)	N/A	1.1	1.3	0.38	3.1 (0.25 - 39)

SE = standard error; OR = odds ratio; CI = confidence interval; SDD = same-day discharge; LOS = length of stay; TKA = total knee arthroplasty; UKA = unicompartmental knee arthroplasty; THA = total hip arthroplasty; BMI = body mass index; ASA = American Society of Anesthesiologists.

Bold indicates statistical significance, $p < 0.05$.

4. DISCUSSION

Outpatient joint arthroplasty (OJA) is growing in popularity.[14, 20, 21] To assess the effectiveness and safety of the local OJA program for hip and knee arthroplasty, complications and readmission rates were calculated. Causes and risk factors were identified in an attempt to refine the pathway's protocol and selection process. We found a 90-day complication rate of 15% and a readmission rate of 4.3%, and uninfected wound discharge was the most common cause in both. Overall, no statistically significant differences in complications and readmissions were found between patients who were successfully discharged on the day of surgery and patients with a prolonged hospital stay. Patients undergoing THA were more likely to develop a complication if they had a prolonged hospital stay.

The strengths and limitations of this study should be taken into account while interpreting these results. The main strength of this study was the relatively large study group presenting clinical results from one center (a secondary care multidisciplinary non-academic hospital) with a uniform OJA protocol, that was applied by five different surgeons. A complete case analysis of 525 patients was conducted as all patients completed follow-up. Definitions were prespecified and data on complications and readmissions were not relying solely on diagnostic codes but was gathered by a detailed review of the local institution's medical records database. While the number of total patients in this sample is of reasonable size, when broken down into THA, TKA and UKA, each group is fairly small. Other limitations of this study include those inherent to retrospective data. Although selection criteria were defined, results may be subject to the bias of evolving clinical practices by surgeons. External validity is limited because a preselected population was analyzed. As the identification of complications and readmissions was based on hospital-specific patient identification numbers, there is a potential of missing readmissions and complications admitted to other hospitals or primary care. We believe the missing of relevant complications and readmissions is minimal because we encourage patients to contact the department in case of problems and because of the presence of the underlying implant material (and because commitment to implant suppliers varies by hospitals). This study focused on the complications and readmission rates of all patients who were initially planned for OJA and aimed to identify differences in rates between the SDD and LOS ≥1 group. However, baseline characteristics between groups slightly differed and varied by type of arthroplasty (Appendix 3a-c). A previous study on the same cohort also demonstrated that female gender, TKA, ASA II/III were independently associated with unsuccessful SDD and thus prolonged hospital stay.[16] To conclude the safety of SDD, we acknowledge the need for matched cohorts

or randomized controlled trials comparing patients who are initially planned in an outpatient versus inpatient setting. Finally, there was a low post-hoc power of OR calculation, limiting the adjusted risk-factor calculation for complications (N = 78) and readmissions (N = 22).

When enhanced recovery programs were implemented for total joint arthroplasty (TJA), most studies reported similar or even lower complications and readmission rates (compared to care as usual).[3-6, 22] For OJA, however, the literature is divided and lacks consensus on the magnitude of the rates.[4-12, 20, 23-25] A recent study by Nowak and Schemitsch[11] showed that patients discharged on postoperative days one and two had fewer complications compared with SDD. A systematic review by Hoffmann et al[9], however, reported only one major complication (0.1%) and 20 readmissions (2%) in a total population of 1009 patients in an OJA setting. The latter mainly consisted of studies performed in an ambulatory surgery center (ASC) or orthopaedic specialty hospital in the United States. Readmission rates in the present study were slightly higher, yet similar to other studies (up to 6%).[7, 11, 12, 24] This variation may have resulted from different patient selection criteria, perioperative protocols, and program logistics, definitions of OJA, and discharge destination. Different study settings may have led to variation in patient cohorts across studies. ASCs or orthopaedic specialty hospitals, that have fewer medical resources, may apply stricter selection criteria than secondary and tertiary multispecialty hospital care facilities, like ours. The existing literature also includes numerous large sample studies on OJA, which base their results on claims and administrative databases.[10-12, 24] Although results are insightful and can provide a raw estimate of certain relationships, heterogenicity in the sample (as variations in practice patterns are not accounted for) may worsen the accuracy that comes with interpreting the results.[26] When comparing outcomes on OJA, variation in used definitions in the literature has to be accounted for. Some studies consider OJA as hospitalization of less than 24-hours, but with overnight stay or discharge to a care facility. Other studies, like ours, defined OJA as being discharged to home on the same day of surgery.[7] Large databases also lack consistent use of the same definitions (the term outpatient often does not correlate with LOS = 0), making the results hard to interpret.[26]

As patients in this study were preoperatively selected for OJA based on relatively strict selection criteria – and thus expected to be healthier compared with the average population undergoing hip or knee arthroplasty – a lower complication rate was to be expected. The complication rate in this study, however, was higher than in most other studies. We believe this can mainly be explained by the use of different definitions for complications in the literature and the lack of specification.[18] A strict

definition of complications was used, while other studies did not define complications at all. As a result, all patients that contacted or visited the outpatient clinic (apart from standard follow-up care) or emergency room were listed as a complication, irrespective of its severity. We found that wound discharge and excessive pain (5% and 1.5% of all cases, respectively) were the most common reason for complications (Appendix 6). Often, however, this could be solved on an outpatient basis (by wound care, reassurance, and/or prescribing pain medication; grade I complications, Table 4 and Appendix 6). Thirty-one percent of these specific cases were readmitted for in-hospital wound observation or pain management. When disregarding the cases that were treated on an outpatient basis, a similar 90-day complication rate to other studies of 9.9% was found.[10, 12, 24] Healthcare consumption because of noninfective wound discharge and pain occurred relatively more often (although not statistically significant) in the SDD group and usually occurred within the first two postoperative days (median 1 day; interquartile range [IQR] 1-2 days). This suggests that some visits could have been prevented by monitoring the patients longer in the hospital. We believe, patient expectation management, clear patient education, and discharge instructions on when and where to contact the specialist are important to reduce unnecessary consumption (and costs) of unplanned healthcare (e.g., emergency room visits). Other common reported complications of TJA in the literature are deep vein thrombosis (DVT) and/or pulmonary embolism (PE).[27] In this study, however, no cases of DVT/PE were found, which might be explained by the fact that we only selected 'healthy' patients. Early mobilization was encouraged and standard prophylactic antithrombotics were administered, which may have further reduced the risk. Also, no other serious medical complications (e.g., myocardial infarction/infection and stroke) occurred.

THA and UKA were associated with a lower risk of 90-day complications compared to TKA. This is consistent with the existing literature.[28] In the present study, we believe this finding is mainly explained by the relatively high prevalence of uninfected wound discharge in TKA. These findings could form an opportunity for protocol improvements (alternative wound closure techniques and/or routes of administration of tranexamic acid (TXA).[29] Complication rates were higher in the LOS ≥1 group compared to the SDD group, although only reaching statistical significance for patients undergoing THA (Table 5; Figure 1b). Even though we included a relatively homogenous population (patients deemed eligible for OJA), baseline differences between groups might still have influenced these results. Besides, the sample size of patients undergoing THA with a prolonged length of stay (LOS ≥1) was small (N = 20) and requires confirmation.

Although only making up for a small amount of the study population and therefore lacking power, patients classified ASA III (compared to ASA I) or Charnley C (compared to Charnley A) had a significantly higher risk of 90-day complications. Nevertheless, the increased risk of complications in these patient groups is supported by the existing literature and therefore suggesting that these patients are less eligible for OJA.[30]

In contrary to the literature, we found that preselected patients with a higher BMI had a negative association with hospital readmissions. It is generally accepted that a higher BMI is associated with a higher risk of complications – that may need hospitalization (e.g., surgical site infections, DVT) – following TJA.[30] However, BMI is not always an accurate indicator of physical health and fitness. As a possible explanation for our findings, patients with a mid-range BMI (25-29.9 kg/m^2) may be more muscular and strength helped them mobilize. As risks of complications and readmissions may be more pronounced in patients with a very high BMI, and the current study sample on severely obese patients (BMI 35-39.9 kg/m^2) is small and lacks morbidly obese patients (BMI ≥ 40 kg/m^2), no definite conclusions can be drawn from this.

5. CONCLUSIONS

In conclusion, same-day discharge did not result in more complications and hospital readmissions and is most likely safe in a selected population. The majority of complications and reasons for readmission were wound discharge and excessive pain, which can form a possible trigger for protocol and postoperative monitoring improvements. Great variation in the literature exists when reporting on complications and readmissions, which means definitions must be taken into account when interpreting the results.

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7. APPENDICES

Appendix 1. Discharge criteria for same-day discharge following OJA

Patients' general well-being and acceptable pain control (VAS < 5);
Dry wound;
Ability to safely make independent postoperative transfers;
Ability to safely mobilize with crutches and climb the stairs;
Patients' express acceptance of discharge;
Understanding of the living rules during the first 3 months (for THA).

OJA = outpatient joint arthroplasty; VAS = visual analogue scale; THA = total hip arthroplasty.

Appendix 2. Grading system for complications

Grade	Definition
Grade I	Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic, and radiological interventions. Allowed therapeutic regimens are drugs such as antiemetics, antipyretics, analgesics, diuretics, and electrolytes and physiotherapy. This grade also includes wound infections opened at bedside.
Grade II	Requiring pharmacological treatment with drugs other than those allowed for grade one complications. Blood transfusions and total parenteral nutrition are also included.
Grade III	Requiring surgical, endoscopic, or radiological intervention.
Grade IIIa	Intervention not under general anesthesia;
Grade IIIb	Intervention under general anesthesia.
Grade IV	Life-threatening complication (including CNS complications [a]) requiring IC/ICU management
Grade IVa	Single organ dysfunction (including dialysis);
Grade IVb	Multiorgan dysfunction.
Grade V	Death of a patient.

CNS = central nervous system; IC/ICU = intensive care/intensive care unit.

[a] Brain hemorrhage, ischemic stroke, subarachnoid hemorrhage, but excluding transient ischemic attacks.

Appendix 3a: Demographics and Clinical Characteristics for patients undergoing THA

	SDD (N = 70)	LOS ≥1 day (N = 20)	p value
Patient factors			
Age (years)	60 ± 9.1 (29-77)	65 ± 8.4 (50-80)	**0.047**
< 50	6 (8.6%)	0	
50 - 64	37 (53%)	10 (50%)	
65 - 79	27 (39%)	9 (45%)	
≥ 80	0	1 (5.0%)	
BMI (kg/m2)	27 ± 4.3 (17-40)	26 ± 3.8 (20-35)	0.11
< 25	19 (27%)	12 (60%)	
25 - 29.9	33 (47%)	6 (30%)	
30 - 34.9	15 (21%)	2 (10%)	
≥ 35	3 (4.3%)	0	
Female	34 (49%)	10 (50%)	0.91
ASA class			**0.015**
I	42 (60%)	5 (25%)	
II	27 (39%)	15 (75%)	
III	1 (1.4%)	0	
Charnley class			0.81
A	26 (37%)	8 (40%)	
B1	28 (40%)	6 (30%)	
B2	12 (17%)	4 (20%)	
C	4 (5.7%)	2 (10%)	
Previous surgery	1 (1.4%)	1 (5.0%)	0.4
Preoperative anticoagulant use	11 (16%)	2 (10%)	0.73
Preoperative opioid use	0	1 (5.0%)	0.22
Surgical factors			
Bloos loss (mL)	388 ± 160 (150 - 900)	466 ± 277 (150 - 1100)	0.25
Surgery duration (min)	51 ± 11 (31 - 78)	52 ± 12 (37-80)	0.91
Anesthesia type			**0.007**
Spinal	56 (80%)	10 (50%)	
General	14 (20%)	10 (50%)	

THA = total hip arthroplasty; SDD = same-day discharge; LOS = length of stay; BMI = body mass index; ASA = American Society of Anesthesiologists.

Discrete variables as frequency (percentage); continuous variables as mean ± standard deviation (range); **Bold** indicates statistical significance.

Appendix 3b. Demographics and Clinical Characteristics for patients undergoing TKA

	SDD (N = 211)	LOS ≥1 day (N = 66)	p value
Patient factors			
Age (years)	64 ± 7.3 (35-83)	65 ± 6.8 (48-80)	0.75
< 50	5 (2.4%)	2 (3.0%)	
50 - 64	107 (51%)	32 (48%)	
65 - 79	96 (45%)	31 (47%)	
≥ 80	3 (1.4%)	1 (1.5%)	
BMI (kg/m2)	28 ± 3.9 (21-40)	28 ± 4.6 (19-42)	0.48
< 25	48 (23%)	15 (23%)	
25 - 29.9	107 (51%)	31 (47%)	
30 - 34.9	39 (18%)	14 (21%)	
≥ 35	17 (8.1%)	6 (9.1%)	
Female	96 (45%)	39 (59%)	0.054
ASA class			0.49
I	115 (55%)	32 (48%)	
II	89 (42%)	30 (45%)	
III	7 (3.3%)	4 (6.1%)	
Charnley class			0.19
A	65 (31%)	24 (36%)	
B1	86 (41%)	29 (44%)	
B2	56 (27%)	10 (15%)	
C	4 (1.9%)	3 (4.5%)	
Previous surgery	127 (60%)	40 (61%)	0.95
Preoperative anticoagulant use	26 (12%)	4 (6.1%)	0.18
Preoperative opioid use	3 (1.4%)	2 (3.0%)	0.34
Surgical factors			
Bloos loss (mL)	236 ± 109 (50 - 1000)	248 ± 117 (100 - 600)	0.47
Surgery duration (min)	58 ± 15 (31 - 135)	59 ± 15 (28 - 96)	0.63
Anesthesia type			0.233
Spinal	171 (81%)	49 (74%)	
General	40 (19%)	17 (26%)	

TKA = total knee arthroplasty; SDD = same-day discharge; LOS = length of stay; BMI = body mass index; ASA = American Society of Anesthesiologists.

Discrete variables as frequency (percentage); continuous variables as mean ± standard deviation (range); **Bold** indicates statistical significance.

Appendix 3c. Demographics and Clinical Characteristics for patients undergoing UKA

	SDD (N = 134)	LOS ≥1 day (N = 24)	p value
Patient factors			
Age (years)	62 ± 6.9 (46 - 80)	61 ± 8.0 (45 - 75)	0.63
< 50	7 (5.2%)	2 (8.3%)	
50 - 64	80 (60%)	15 (63%)	
65 - 79	46 (34%)	7 (29%)	
≥ 80	1 (0.75%)	0	
BMI (kg/m2)	29 ± 3.7 (19 - 40)	30 ± 3.6 (20 - 36)	0.15
< 25	18 (13%)	2 (8.3%)	
25 - 29.9	69 (51%)	9 (38%)	
30 - 34.9	38 (28%)	12 (50%)	
≥ 35	9 (6.7%)	1 (4.2%)	
Female	66 (49%)	14 (58%)	0.41
ASA class			**<0.001**
I	89 (66%)	9 (38%)	
II	44 (33%)	12 (50%)	
III	1 (0.75%)	3 (13%)	
Charnley class			0.098
A	50 (37%)	14 (58%)	
B1	57 (43%)	9 (38%)	
B2	22 (16%)	0	
C	5 (3.7%)	1 (4.2%)	
Previous surgery	62 (46%)	13 (54%)	0.48
Preoperative anticoagulant use	11 (8.2%)	2 (8.3%)	1
Preoperative opioid use	11 (8.2%)	1 (4.2%)	0.69
Surgical factors			
Bloos loss (mL)	11 ± 26 (0 - 150)	15 ± 23 (0 - 50)	0.57
Surgery duration (min)	51 ± 15 (26 - 132)	53 ± 12 (36 - 85)	0.57
Anesthesia type			0.056
Spinal	103 (77%)	14 (58%)	
General	31 (23%)	10 (42%)	

UKA = unicompartmental knee arthroplasty; SDD = same-day discharge; LOS = length of stay; BMI = Body mass index; ASA = American Society of Anesthesiologists.

Discrete variables as frequency (percentage); continuous variables as mean ± standard deviation (range); **Bold** indicates statistical significance.

Appendix 4. Bivariate analysis for complications

	Complication (N = 75)	No complication (N = 450)	p value
Patient factors			
Age (years)	63 ± 8.4 (32-80)	63 ± 7.5 (29-83)	0.93
< 50	4 (5.3%)	18 (4.0%)	0.54
50 - 64	40 (53%)	241 (54%)	
65 - 79	29 (39%)	187 (42%)	
≥ 80	2 (2.7%)	4 (0.89%)	
BMI (kg/m2)	28 ± 3.9 (19-36)	28 ± 4.1 (17-42)	0.18
< 25	22 (29%)	92 (20%)	0.15
25 - 29.9	30 (40%)	225 (50%)	
30 - 34.9	20 (27%)	100 (22%)	
≥ 35	3 (4.0%)	33 (7.3%)	
Female	33 (44%)	226 (50%)	0.32
ASA class			**0.021**
I	37 (49%)	255 (57%)	
II	32 (43%)	185 (41%)	
III	6 (8.0%)	10 (2.2%)	
Charnley class			0.13
A	23 (31%)	164 (36%)	
B1	33 (44%)	182 (40%)	
B2	13 (17%)	91 (20%)	
C	6 (8.0%)	13 (2.9%)	
Previous surgery	36 (48%)	208 (46%)	0.78
Preoperative anticoagulant use	10 (13%)	46 (10%)	0.42
Preoperative opioid use	4 (5.3%)	14 (3.1%)	0.31
Surgical factors			
Clinical pathway type			0.25
Outpatient	56 (75%)	362 (80%)	
Inpatient	19 (25%)	88 (20%)	
Type of arthroplasty			0.077
UKA	15 (20%)	143 (32%)	
TKA	48 (64%)	229 (51%)	
THA	12 (16%)	78 (17%)	
Blood loss (mL)	217 ± 165 (0-700)	195 ± 180 (0-1100)	0.33
Surgery duration (min)	54 ± 14 (26-96)	55 ± 15 (28-135)	0.61

Appendix 4. Bivariate analysis for complications *(continued).*

	Complication (N = 75)	No complication (N = 450)	p value
Anesthesia type			0.64
Spinal	56 (75%)	347 (77%)	
General	19 (25%)	103 (23%)	

BMI = Body mass index; ASA = American Society of Anesthesiologists; UKA = unicompartmental knee arthroplasty; TKA = total knee arthroplasty; THA = total hip arthroplasty;

Discrete variables as frequency (percentage); continuous variables as mean ± standard deviation (range); **Bold** indicates statistical significance.

Appendix 5. Bivariate analysis for readmissions

	Readmission (N = 22)	No readmission (N = 503)	p value
Patient factors			
Age (years)	63 ± 10 (32-80)	63 ± 7.5 (29-83)	0.71
< 50	1 (4.5%)	21 (4.2%)	0.50
50 - 64	11 (50%)	270 (54%)	
65 - 79	9 (41%)	207 (41%)	
≥ 80	1 (4.5%)	5 (0.99%)	
BMI (kg/m2)	28 ± 4.6 (19-35)	28 ± 4.0 (17-42)	0.61
< 24.9	8 (36%)	106 (21%)	**0.016**
25 - 29.9	5 (23%)	250 (50%)	
30 - 34.9	9 (41%)	111 (22%)	
≥ 35	0 (0%)	36 (7.2%)	
Female	9 (41%)	250 (50%)	0.42
ASA class			0.13
I	9 (41%)	283 (56%)	
II	11 (50%)	206 (41%)	
III	2 (9.1%)	14 (2.8%)	
Charnley class			0.5
A	8 (36%)	179 (36%)	
B1	9 (41%)	206 (41%)	
B2	3 (14%)	101 (20%)	
C	2 (9.1%)	17 (3.4%)	
Previous surgery	9 (41%)	235 (47%)	0.59
Preoperative anticoagulant use	5 (23%)	51 (10%)	0.07

Appendix 5. Bivariate analysis for readmissions *(continued).*

	Readmission (N = 22)	No readmission (N = 503)	p value
Preoperative opioid use	1 (4.5%)	17 (3.4%)	0.54
Surgical factors			
Clinical pathway			0.74
Outpatient	18 (82%)	397 (79%)	
Inpatient	4 (18%)	106 (21%)	
Type of arthroplasty			0.66
UKA	5 (23%)	153 (30%)	
TKA	12 (55%)	265 (53%)	
THA	5 (23%)	85 (17%)	
Blood loss (mL)	198 ± 155 (0-600)	198 ± 179 (0-1100)	0.99
Surgery duration (min)	56 ± 14 (36-96)	55 ± 15 (26-135)	0.85
Anesthesia type			
Spinal	18 (82%)	385 (77%)	0.8
General	4 (18%)	118 (23%)	

BMI = Body mass index; ASA = American Society of Anesthesiologists; UKA = unicompartmental knee arthroplasty; TKA = total knee arthroplasty; THA = total hip arthroplasty;

Discrete variables as frequency (percentage); continuous variables as mean ± standard deviation (range); **Bold** indicates statistical significance.

Appendix 6. 90-Day surgical and medical complications by type of arthroplasty (N = 78) [#]

Surgical complication (N = 63)	Grade of complication*	THA		TKA		UKA		Total
		SDD (N = 70)	LOS ≥1 (N = 20)	SDD (N = 211)	LOS ≥1 (N = 66)	SDD (N = 134)	LOS ≥1 (N = 24)	(N = 525)
Noninfected wound discharge								
Requiring monitoring	1	3 (4.3%)	0	19 (9.0%)	2 (3.0%)	2 (1.5%)	0	26 (5.0%)
Requiring surgical exploration (suspected fascial defect)	3a	0	0	1 (0.47%)	0	0	0	1 (0.19%)
Excessive pain	1	0	0	4 (1.9%)	1 (1.5%)	2 (1.5%)	1 (4.2%)	8 (1.5%)
Urinary retention	1	1 (1.4%)	0	0	4 (6.1%)	0	1 (4.2%)	6 (1.1%)
Symptomatic instability	1	0	0	3 (1.4%)	0	2 (1.5%)	0	5 (0.95%)
Surgical site infection (SSI)								
Superficial SSI requiring antibiotics	2	0	1 (5%)	1 (0.47%)	1 (1.5%)	0	0	3 (0.57%)
SSI (suture fistula) requiring surgical debridement	3b	0	1 (5%)	0	0	0	0	1 (0.19%)
Arthrofibrosis requiring manipulation under anesthesia	3b	0	0	1 (0.47%)	0	1 (0.75%)	0	2 (0.38%)
Allergic reaction to bandage	1	0	0	1 (0.47%)	0	1 (0.75%)	0	2 (0.38%)

Appendix 6. 90-Day surgical and medical complications by type of arthroplasty (N = 78) [#] *(continued)*.

Surgical complication (N = 63)	Grade of complication*	THA		TKA		UKA		Total
Symptomatic postoperative anemia requiring transfusion	2	0	1 (5%)	0	0	0	0	1 (0.19%)
Subsidence	1	0	0	0	0	1 (0.75%)	0	1 (0.19%)
Insert dislocation	3a	0	0	0	0	1 (0.75%)	0	1 (0.19%)
Dislocation	3b	0	1 (5%)	0	0	0	0	1 (0.19%)
Symptomatic ruptured Baker's cyst	3a	0	0	0	0	1 (0.75%)	0	1 (0.19%)
Traumatic disrupted extensor mechanism	3a	0	0	1 (0.47%)	0	0	0	1 (0.19%)
Postoperative dystrophia	1	0	0	1 (0.47%)	0	0	0	1 (0.19%)
Falling without traumatic injury	1	0	0	1 (0.47%)	0	0	0	1 (0.19%)
Post-operative hypotension requiring intensive care admission	4	0	0	1 (0.47%)	0	0	0	1 (0.19%)
Other medical complication (N = 15)								
Erysipelas	2	0	1 (5%)	0	1 (1.5%)	0	0	2 (0.38%)
Pneumonia	2	0	0	0	1 (1.5%)	1 (0.75%)	0	2 (0.38%)
Malaise	1	0	0	2 (0.95%)	0	0	0	2 (0.38%)
Herpes zoster	1	1 (1.4%)	0	1 (0.47%)	0	0	0	2 (0.38%)

Appendix 6. 90-Day surgical and medical complications by type of arthroplasty (N = 78) [#] *(continued)*.

Surgical complication (N = 63)	Grade of complication*	THA		TKA		UKA		Total
Biliary pancreatitis requiring surgery	3b	0	1 (5%)	0	0	0	0	1 (0.19%)
Cholecystitis requiring surgery	3b	0	0	1 (0.47%)	0	0	0	1 (0.19%)
Gastroenteritis	1	0	0	1 (0.47%)	0	0	0	1 (0.19%)
Diverticulitis	1	0	0	0	0	0	1 (4.2%)	1 (0.19%)
Bell's Palsy	1	0	0	0	1 (1.5%)	0	0	1 (0.19%)
Cutaneous sarcoidosis	2	0	0	1 (0.47%)	0	0	0	1 (0.19%)
AV nodal reentrant tachycardia	2	0	0	1 (0.47%)	0	0	0	1 (0.19%)
Total (N = 78)	NA	5 (7.1%)	6 (30%)	41 (19%)	11 (17%)	12 (9.0%)	3 (13%)	78 (15%)

THA = total hip arthroplasty; TKA = total knee arthroplasty; UKA = unicompartmental knee arthroplasty; SDD = same-day discharge; LOS = length of stay; AV = atrioventricular.

[#] Multiple complications occurred in two patients; * Grading was done based on the classification system presented in Appendix 2.

Appendix 7. 90-Day hospital readmissions by type of arthroplasty

Surgical reason (N = 16)	THA		TKA		UKA		Total
	SDD (N = 70)	LOS ≥1 (N = 20)	SDD (N = 211)	LOS ≥1 (N = 66)	SDD (N = 134)	LOS ≥1 (N = 24)	(N = 525)
Noninfected wound discharge							
Requiring monitoring	2 (2.9%)	0	4 (1.9%)	1 (1.5%)	1 (0.75%)	0	8 (1.5%)
Requiring surgical exploration	0	0	1 (0.47%)	0	0	0	1 (0.19%)
Excessive pain monitoring	0	0	2 (0.95%)	0	0	0	2 (0.38%)
Arthrofibrosis requiring manipulation under anesthesia	0	0	1 (0.47%)	0	1 (0.75%)	0	2 (0.38%)
SSI requiring surgical debridement	0	1 (5%)	0	0	0	0	1 (0.19%)
Insert dislocation requiring insert revision	0	0	0	0	1 (0.75%)	0	1 (0.19%)
Ruptured Baker's cyst requiring surgical debridement	0	0	0	0	1 (0.75%)	0	1 (0.19%)
Other medical reason (N = 6)							
Pneumonia	0	0	0	1 (1.5%)	1 (0.75%)	0	2 (0.38%)
Biliary pancreatitis requiring surgery	0	1 (5%)	0	0	0	0	1 (0.19%)
Cholecystitis requiring surgery	0	0	1 (0.47%)	0	0	0	1 (0.19%)
Gastroenteritis	0	0	1 (0.47%)	0	0	0	1 (0.19%)
Malaise	0	0	1 (0.47%)	0	0	0	1 (0.19%)
Total (N = 22)	2 (2.9%)	2 (10%)	11 (5.2%)	2 (3.0%)	5 (3.7%)	0 (0%)	22 (4.2%)

THA = total hip arthroplasty; TKA = total knee arthroplasty; UKA = unicompartmental knee arthroplasty; SDD = same-day discharge; LOS = length of stay; SSI = surgical site infection.

PART IV

Outpatient joint arthroplasty

The surgeons’ perspective

CHAPTER 6

ORTHOPAEDIC SURGEONS' PERSPECTIVE ON THE IMPLEMENTATION OF OUT–PATIENT HIP AND KNEE ARTHROPLASTY

Results of a nationwide survey

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ABSTRACT

Background
Outpatient joint arthroplasty (OJA) for the hip and knee is gaining popularity among orthopaedic surgeons worldwide. The purposes of this study were to (1) assess the proportion of Dutch orthopaedic surgeons who perform OJA; (2) identify surgeons' willingness to implement OJA in the future; (3) identify reasons and barriers to implement OJA; and (4) gather surgeon's perspective on the implementation of OJA.

Methods
A 20-item survey was developed and administered by email to orthopaedic surgeons who are a member of the Dutch Hip Society and Dutch Knee Society. Survey response rate was 40% (N = 123).

Results
Twenty-two respondents (18%) already implemented OJA, and 46% of respondents (who don't perform OJA) were interested to implement OJA in the future. Reasons to perform OJA included own positive experiences (82%), available evidence (77%) and patients' request (77%). Proponents' and opponents' view on safety and added value conflicted with each other. Other barriers included patient selection and organizational related (e.g., multidisciplinary support). Surgeons' view on evolution and relevance of OJA significantly differed by respondents who perform OJA versus respondents who don't perform OJA. Most respondents agreed with one another that the healthcare institution benefits most from OJA, and that optimization of the arthroplasty pathway could be reached through better patient education and -participation (e.g., eHealth, wearables).

Conclusion
One in five respondents currently implement OJA pathways, and about half of the remaining respondents are interested to implement OJA in the future. OJA-opponents aren't convinced of the value and safety of OJA, despite accumulating evidence supporting OJA. Future research should inform patient selection and acceptance and organizational implementation.

1. INTRODUCTION

Over the last decades, the worldwide demand for total joint arthroplasty (TJA) continued to grow. In 2019, 33,248 total hip arthroplasties (THA) and 25,859 total knee arthroplasties (TKA) were performed in the Netherlands alone, according to data from the Dutch Arthroplasty Register (LROI).[1] These numbers are expected to increase to 51,680 THAs and 57,893 TKAs by 2030, and will have a major impact on the healthcare system and economic burden.[2]

Outpatient pathways of hip and knee arthroplasty are increasingly being implemented around the world. Data from the USA revealed an increase of 47% in elective outpatient joint arthroplasty (OJA) between 2012 and 2015, and this is expected to continue to grow over the next 10 years (and at a higher rate than inpatient TJA).[3] Data and projections on growth in other countries and the surgeon's perspective regarding the implementation of OJA are currently lacking.

Although most clinical studies on OJA are conducted in ambulatory surgery centers or orthopaedic specialty hospitals in the USA,[4, 5] studies from Europe (i.e., Scandinavia and The Netherlands) also proved its feasibility, effectivity, and safety in a selected patient population.[6-10] Studies also demonstrated that OJA is an effective method to accomplish cost reduction compared to the traditional inpatient pathways, without compromising the quality of care.[4, 11] From a patients' perspective, OJA is well accepted by a selected patient population as several studies reported overall high satisfaction with OJA.[12]

Despite patient's acceptance, clinical and economic feasibility, it remains unclear why only a few centers in The Netherlands have implemented OJA yet. With the current study design, we attempted to explore the Dutch practice. The primary research purpose was to assess the proportion of orthopaedic surgeons who perform OJA of the hip and/or knee. Secondary research purposes were (1) to identify surgeons' willingness to implement OJA in the future; (2) to identify reasons and barriers to implement OJA, and (3) to gather surgeon's perspective on the implementation of OJA in The Netherlands.

2. PATIENTS AND METHODS

This study was approved by the local IRB (study-number: Z20210053).

2.1 Settings and subjects

After permission was obtained from the boards of the Dutch Hip Society (DHS) and the Dutch Knee Society (DKS), active members were invited by e-mail to complete a web-based survey (SurveyMonkey™). At the time of survey administering, there were a total of 331 active members (DHS, N = 179 and DKS, N = 220; of which 68 were a member of both the DHS and DKS). Only orthopaedic surgeons performing hip and/or knee arthroplasty were included (N = 306), whereas other members (orthopaedic residents, physician assistants and nurse practitioners) were excluded from the study. Online-documented informed consent was obtained from those agreeing to participate. A maximum of two reminder e-mails (at 2 and 4 weeks after initial invitation) were sent. There was no financial or non-financial incentive for participants to complete the questionnaire.

2.2 Survey

An online survey on OJA of the hip and/or knee was developed. After consensus had been reached by all coauthors on the content of the survey, the final version was developed in collaboration with an epidemiologist. The survey was comprised in 3 major sections: surgeon's characteristics (i.e., age, sex, affiliation), current outpatient practices/experiences and surgeon's willingness to implement OJA (in the future), and their perspective on the implementation of OJA. The latter was assessed by means of the following statements: *(1) OJA is a logical development given the increasing healthcare costs in an aging population; (2) In the future, the setting for selected "healthy" patients undergoing hip or knee arthroplasty will increasingly shift from a (short-term) inpatient admission to OJA; (3) OJA in a selected patient population is the limit of pathway innovation for hip and knee arthroplasty; (4) The (OJA) pathway for hip and knee arthroplasty can be further optimized through better perioperative education and patient participation; (5) OJA of the hip and knee can further improve patient satisfaction compared to a (short-term) inpatient admission.* Responses were measured using 6-point Likert scales with the following answer options: 'I strongly agree', 'I agree', 'neutral', 'I disagree', 'I strongly disagree', and 'I don't know'. Consensus was reached if ≥ 75% of the respondents agreed (agree or strongly agree) or disagreed (disagree or strongly disagree) with the statement. The number of items varied individually (between 15 and 20 items) based on the responses of the participants. An English version of the survey is presented in the supplementary data (Appendix A).

OJA was defined as patients who were discharged to their own home environment on the day of surgery and who don't have an overnight stay at either the hospital or another non-home facility.

2.3 Statistics

All analyses were performed with SPSS (IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp.). Baseline characteristics and other descriptives were displayed as means with standard deviations (and range) for continuous variables and frequencies with percentages for categorical variables.

Differences in baseline characteristics between subgroups (respondents performing OJA versus respondents not performing OJA) were assessed using chi-square or (in case of cells with expected value < 5) Fisher's exact test for categorical variables and an unpaired t-test for continuous variables.

Bivariate analyses were also performed to assess differences in responses to the statements between respondents who perform OJA versus interested to perform OJA in the future versus not interested to perform OJA. A two-sided p value < 0.05 was considered to indicate statistical significance.

2.4 Study population

A total of 141 individuals initiated the survey. Eighteen respondents (13%) were excluded because of one of the following: incomplete response (N = 16, 11%); didn't fulfill the inclusion criteria (N = 1, 0.71%); no informed consent (N = 1, 0.71%). One hundred twenty-three respondents completed the survey (response rate of 40%) and were included in the analysis.

The majority of respondents were male (N = 120, 98%), performed both hip and knee arthroplasty (N = 71, 58%), and worked in a non-academic teaching hospital (N = 56, 46%) (Table 1).

Table 1. Demographics of the respondents

Number of respondents (N)	**Total 123**	**OJA 22**	**Non-OJA 101**	**p value**
Age (years)	46 ± 8.9 (32 - 66)	48 ± 9.2 (32 - 66)	46 ± 8.8 (33 - 63)	0.51
Gender				1.0
Female	3 (2.4%)	0 (0%)	3 (3.0%)	
Male	120 (98%)	22 (100%)	98 (97%)	

Table 1. Demographics of the respondents (*continued*).

	Total	OJA	Non-OJA	p value
Affiliation				0.25
Academic (University) hospital	14 (11%)	0 (0%)	14 (14%)	
Non-academic teaching hospital	56 (46%)	14 (64%)	42 (42%)	
Non-academic non-teaching hospital	34 (28%)	5 (23%)	29 (29%)	
Private clinic	14 (11%)	2 (9.1%)	12 (12%)	
Other	5 (4.1%)	1 (4.5%)	4 (4.0%)	
Orthopaedic (sub) specialty				0.19
Hip and knee arthroplasty	71 (58%)	15 (68%)	56 (55%)	
Only hip arthroplasty	16 (13%)	4 (18%)	12 (12%)	
Only knee arthroplasty	36 (29%)	3 (14%)	33 (33%)	
Hip arthroplasty group *				
Number of surgeons	87	19	68	
Number of hip arthroplasties performed (per year)	120 ± 67 (20 - 350)	165 ± 83 (70 - 350)	107 ± 57 (20 - 280)	**0.008**
Types of hip arthroplasty				
Primary	87 (100%)	19 (100%)	68 (100%)	1.0
Revision	62 (71%)	15 (79%)	47 (69%)	0.57
Knee arthroplasty group *				
Number of surgeons	107	18	89	
Number of knee arthroplasties performed (per year)	105 ± 69 (10 - 380)	114 ± 44 (40 - 180)	103 ± 73 (10 - 380)	0.56
Types of knee arthroplasty				
Primary	107 (100%)	18 (100%)	89 (100%)	1.0
Revision	67 (63%)	11 (61%)	56 (63%)	0.89

Table 1. Demographics of the respondents (*continued*).

OJA = outpatient joint arthroplasty.

Discrete variables as frequency (percentage); continuous variables as mean ± standard deviation (range); **Bold** indicates statistically significant difference ($p < 0.05$).
* Respondents who perform "hip AND knee arthroplasty" are included in both the hip arthroplasty group and the knee arthroplasty group.

3. RESULTS

3.1 Differences in baseline characteristics

No statistically significant differences in characteristics were found between surgeons who perform OJA and surgeons who don't perform OJA (Table 1), except for the number of hip arthroplasties performed by hip surgeons (the OJA subgroup performed significantly more hip arthroplasties compared to the non-OJA subgroup; $p = 0.008$).

3.2 Current OJA practice and experiences

Twenty-two respondents (18%) reported to perform OJA. Among these surgeons, most (54%) performed both outpatient hip and knee arthroplasty, and 68% had ≥ 3 years of experience with the OJA pathway. The ratio of outpatient to inpatient arthroplasties performed by the orthopaedic surgeon was 1:4 for both the hip and knee. Main reasons to perform OJA included 'own positive experiences' (82%), 'scientific evidence' (77%) and 'patients' request' (77%) (Table 2).

Table 2. Demographics of respondents who perform outpatient joint arthroplasty

Number of respondents who perform OJA (N)	22
Types of OJA performed	
Hip arthroplasty	7 (32%)
Knee arthroplasty	3 (14%)
Both	12 (54%)
OJA experience (years)	
<1	2 (9.1%)
1-2	5 (23%)
3-4	8 (36%)
>4	7 (32%)
Proportion OJA of the total amount of surgeries (%)	
Hip arthroplasty	25 ± 23 (0 - 99)
Knee arthroplasty	25 ± 22 (6.7 - 99)
Types of arthroplasties possible in an outpatient setting *	
THA	20 (91%)
TKA	15 (68%)
UKA	19 (86%)
PFA	10 (45%)
"Low risk" revisions (i.e., liner/insert replacement)	11 (50%)
Other	2 (9.1%)
Discharge options following OJA *	
Home	22 (100%)
Home with homecare	12 (54%)
Care hotel	5 (23%)
Reasons to perform OJA *	
Patients' request	17 (77%)
Scientific evidence	17 (77%)
Own positive experiences	18 (82%)
Financial incentive	2 (9.1%)
To reduce healthcare costs	14 (64%)
Marketing purposes	4 (18%)
Other reason (= innovation)	1 (4.5%)

OJA = outpatient joint arthroplasty; THA = total hip arthroplasty; TKA = total knee arthroplasty; UKA = unicompartmental knee arthroplasty; PFA = patellofemoral arthroplasty.

Discrete variables as frequency (percentage); continuous variables as mean ± standard deviation (range);
* Multiple answers were possible.

3.3 Barriers to implement OJA

Among surgeons who don't perform OJA (N = 101), 47% reported to be interested to implement OJA in the future. The main reasons not to perform OJA yet included uncertainties about 'effectiveness and/or safety' (45%) and 'added value' (32%) (Table 3). For respondents not interested to perform OJA in the future (responded with 'No' or 'Don't know'), the main reasons included not convinced of the 'added value' (70%), 'effectiveness and/or safety' (57%), and 'inappropriate patient population' (46%) (Table 3).

Table 3. Demographics of respondents who do NOT perform outpatient joint arthroplasty

Number of respondents who do NOT perform OJA (N)	101
Interested to implement OJA in the future	
Yes	47 (47%)
No	31 (31%)
Don't know	23 (23%)
Reasons 'why not yet' to perform OJA (N = 47) *	
Added value	15 (32%)
Effectiveness/safety	21 (45%)
Insufficient experience with clinical pathways	2 (4.3%)
Lack of time/assistance to implement	10 (21%)
No multidisciplinary support	13 (28%)
No support from direct colleagues	1 (2.1%)
No support from the hospital	9 (19%)
Not enough staff	4 (8.5%)
Current reimbursement by health insurance	8 (17%)
Never got around to it	9 (19%)
No reason	0
Other reason	12 (26%)
Reasons 'why not' to perform OJA (N = 54) *	
Added value	38 (70%)
Effectiveness/safety	31 (57%)
Insufficient experience with clinical pathways	0
Lack of time/assistance to implement	0
No multidisciplinary support	6 (11%)
No support from direct colleagues	0

Table 3. Demographics of respondents who do NOT perform outpatient joint arthroplasty *(continued)*.

Number of respondents who do NOT perform OJA (N)	**101**
No support from the hospital	2 (3.7%)
Not enough staff	0
Current reimbursement by health insurance	3 (5.6%)
Patient population	25 (46%)
Own preference	9 (17%)
No reason	0
Other reason	6 (11%)

OJA = outpatient joint arthroplasty.

Discrete variables as frequency (percentage); continuous variables as mean ± standard deviation (range);
* Multiple answers were possible.

3.4 Beneficiaries of OJA

Overall, respondents deemed that the healthcare institution (N = 42, 34%) benefits most from OJA. Opinions on who benefits most, however, significantly differed ($p < 0.001$) by type of respondent and were displayed in Figure 1 (and Appendix 2).

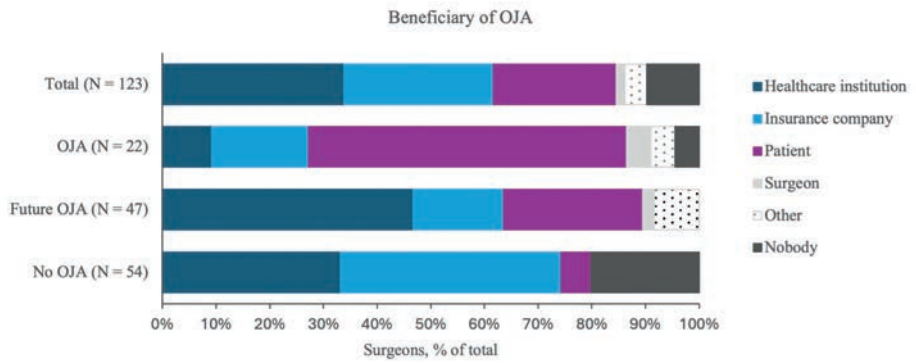

Figure 1. Distribution of survey responses (by total population and subgroups) on who benefits most from OJA. OJA = outpatient joint arthroplasty.

3.5 Views on OJA implementation

Overall, less than half of the respondents agreed that OJA is a logical development. The OJA and future-OJA groups had most proponents (55-65%). A shift from traditional inpatient to OJA pathways in the future was expected by a little more

than 50% of all respondents. Support of this statement was high among (potential) OJA-performers (>75%). Among the no-OJA group, only ~10% of respondents believed OJA is a logical development, but 25% still expected an increase in OJA. Almost half of the respondents (~40%) agreed that OJA is the limit of pathway innovation in hip and knee arthroplasty; in the OJA group, significantly more respondents disagreed with that statement (60%) as compared to the future-OJA and no-OJA groups (both ~30%). Consensus (>75% agreement) was reached for the proposition, that optimization of the arthroplasty pathway could be reached through patient education and participation, and no significant group-differences were observed. Lastly, we posed that OJA can improve patient satisfaction. Significant dissent was observed between the groups. Among the OJA group, 60% agreed, while among the no-OJA group, more than 60% disagreed; close to 50% of the future-OJA group were neither in favor nor opposed (Figure 2 and Appendix C).

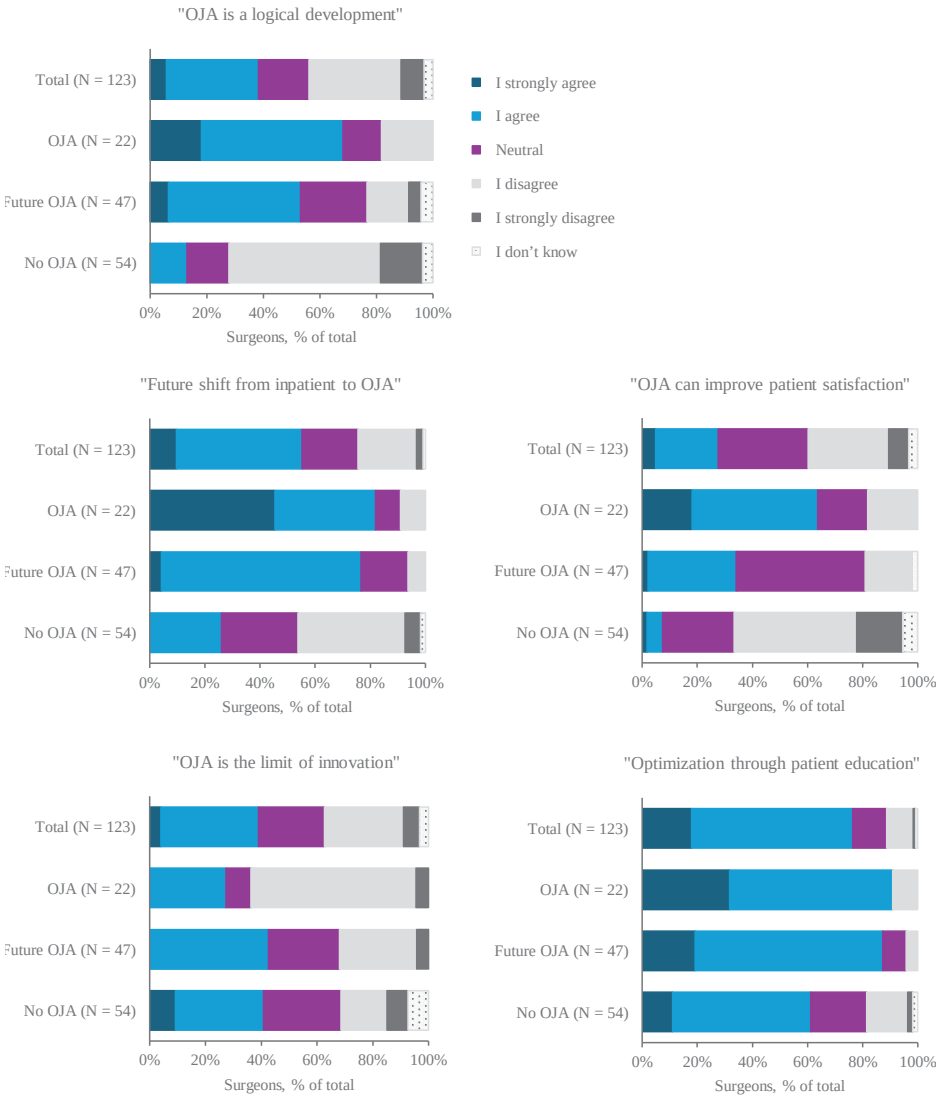

Figure 2. Distribution of survey responses (by total population and subgroups) on five statements regarding the implementation of outpatient hip and/or knee arthroplasty. OJA = outpatient joint arthroplasty.

4. DISCUSSION

During the last decade, OJA of the hip and knee has gained popularity. This study aimed to identify the surgeon's perspective (i.e., experiences, future willingness, their view on implementation) on OJA in the Netherlands. We found that only

18% of respondents had implemented an OJA pathway, and 54% of respondents (who don't perform OJA) weren't interested to implement this in the future. The main barriers for implementing OJA were uncertainties about the added value and safety, and organizational related barriers. Respondents agreed that optimization of arthroplasty pathways could be reached through better patient education and participation (e.g., eHealth, wearables).

4.1 Strengths and limitations

To the best of our knowledge this is the first study to assess the orthopaedic surgeon's perspective on OJA. The Netherlands is one of the leading countries in terms of clinical pathway innovation for TJA, and was one of the first European countries where OJA pathways emerged.[7, 8] The results represent the Dutch practice, and may not necessarily be transferrable to other countries, particularly with distinct healthcare systems. The survey was designed by a multidisciplinary team including high-volume hip and knee orthopaedic surgeons, researchers, physician assistants, and an epidemiologist. A powerful sample size (N = 123) was achieved by inviting members of the DHS and DKS (focus groups of the Dutch Orthopaedic Association). The strict study design (only 2 reminder emails were sent) favors its reproducibility but may have resulted in a relatively lower response rate. Nevertheless, we achieved a good response rate, which was above the expected average in such a study design.[13, 14] Yet this study may possess a risk for selection bias in favor of orthopaedic surgeons who perform OJA (i.e., selective non-response).

4.2 Current OJA practice and experience

The implementation of OJA is still in its infancy as our results suggest that a minority of respondents utilize such a pathway. Interestingly, we found that hip arthroplasty was more likely to be performed in the outpatient setting compared to knee arthroplasty (Table 2). This may be explained by the lower risk of THA vs TKA, which in routine practice translates into shorter length of stay (LOS) and recovery time, less postoperative pain perception, and higher satisfaction with meeting long-term expectations.[15-17] No comparative data on the proportion of surgeons who perform OJA from other countries is available. Studies from the USA, however, suggest a continuous growth, and with the Centers for Medicare and Medicaid Services' decision to remove THA and TKA from the Medicare inpatient-only list, future demand for OJA is even more likely to increase.

4.3 Reasons and barriers to implement OJA

Although the respondents' main reasons to implement OJA included scientific evidence and own positive experiences (Table 2), respondents who don't (yet) perform

OJA were concerned about its effectiveness and safety. In the Netherlands, the first feasibility studies on OJA appeared in 2015 and were performed in high-volume arthroplasty centers.[7,8] Although the study populations were small (<30 patients), the results suggested that OJA was feasible and safe in selected patients, as determined by success rates, PROMs, and complications/readmissions. More recent studies reported up to 5.5 year experiences with OJA pathways and likewise, beneficial outcomes.[9,10] A multicenter RCT demonstrated that most (76%) patients were successfully discharged on the same day of surgery, and no differences in early readmissions, visits to emergency departments, or acute office appointments were found.[5] Also, recent meta-analyses concluded that outpatient pathways were as safe and effective as inpatient pathways for hip and knee arthroplasty.[4,18] The American Association of Hip and Knee Surgeons, Hip Society, Knee Society, and American Academy of Orthopaedic Surgeons recently published a position statement in which they stated that OJA can be safe in selected cases and gave recommendations to guide hospitals, surgeons, and institutions who are considering to implement OJA.[19] Indeed, same-day discharge shouldn't be a goal in itself, rather be a result of a successful, already implemented fast-track program based on the concept "first better – then faster".[20]

Patient demand was another main reason to perform OJA (Table 2), suggesting that a subset of patients prefer to recover from joint replacement at home. This patients' perspective is confirmed by a study by Meneghini and Ziemba-Davis[21], which showed that two-third of patients believed it would be better to recover from joint replacement at home rather than in the hospital. Another study found that approximately one-third of patients believed they would be able to undergo OJA.[22] As relatively healthy, young, and active patients with advanced cox-/gonarthrosis can be considered functionally impaired rather than diseased, we agree that they don't necessarily need to be admitted to the inpatient clinic after surgery.

Barriers to perform OJA were related to patients and logistics. Patient barriers (i.e., unsuitable patient population) were predominantly found among respondents who worked in an academic hospital. Interestingly, none of these respondents performed OJA, and 79% were also not interested to implement this in the future. Tertiary healthcare in the Netherlands is usually reserved for complex and relatively uncommon care, that is associated with long-term hospitalization. The high complexity of care and patient profiles might make OJA less attractive and feasible.

Lack of multidisciplinary support was the most common logistic barrier among respondents who were interested to perform OJA in the future (Table 3). Multidisciplinary commitment to the outpatient pathway, team efforts between staff,

and a uniform approach (coordinating work through relationships of shared goals and knowledge) are key features for allowing implementation of OJA.[23] Suggested methods to overcome difficulty with implementing effective interdisciplinary communication, include frequent team meetings and standardized care plans.

4.4 Beneficiaries of OJA

Most of the respondents reported that healthcare institutions benefited most from OJA (Figure 1). In the Netherlands, treatment costs and related hospital reimbursement consists of a fixed price (defined as Diagnosis Treatment Combinations) and is pre-negotiated between hospitals and health insurance companies. This substantially increases the hospitals' incentive to shorten LOS. In other European countries (e.g., Germany and Austria) reimbursement is partly based on minimum LOS, and hospitals may have less incentive to implement OJA. Being able to safely discharge patients on the same day of surgery, OJA can facilitate optimized hospital capacity management, for example during the COVID-19 pandemic (without the need to delay elective surgery).

Interestingly, Dutch orthopaedic surgeons are less likely to benefit from OJA as it doesn't generate additional reimbursements. The lack of benefit opposed to the efforts and potential risk associated with implementation of OJA was even reported as a barrier by some of the respondents (Table 3). Nevertheless, by playing into the demand of patients, both the healthcare institutions as the surgeons will benefit, by attracting patients in the competition with nearby hospitals.

Most respondents who perform OJA believed that the patients benefited most from OJA (Figure 1). From a clinical perspective, patients don't benefit more from OJA, as complication rates and clinical outcomes were found comparable, but importantly, not less either.[4,5,18] However, by meeting the demand for OJA of a particular group of patients, as previously discussed, opportunity exists to improve satisfaction and increase patient's autonomy with the rehabilitation, and lower the perception of disease.[12,21,22]

4.5 The future of (outpatient) arthroplasty pathways

Thoughts on OJA differed between respondents, as no consensus was reached for most statements (Figure 2). Respondents, however, agreed that further optimization of clinical pathways could be achieved through better perioperative education and patient participation (e.g., by eHealth/wearables). Perioperative education and expectation management is becoming increasingly important given the shortened LOS and the time that passes until the next follow-up.[24] Patients' self-management

(i.e., controlling the level of pain, self-administering medication, physiotherapy exercises) has become a crucial factor in the rehabilitation process. eHealth can assist in self-management, lower postoperative healthcare consumption, and improve patients' satisfaction with the provided information and their perceived involvement by the hospital.[25] A recent RCT also demonstrated promising results of active education and coaching of patients on a day-to-day basis with such an interactive application.[26]

5. CONCLUSIONS

In conclusion, there is still dispute over the value of OJA. Half of the respondent surgeons aren't planning OJA in the future. While some concerns have merit, including logistical barriers for multidisciplinary implementation of OJA, others have been refuted by recent evidence, most importantly by studies demonstrating the safety of OJA and patients desire to undergo and satisfaction with OJA.

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7. APPENDICES

Appendix 1. Survey

Section 1: Demographics

1. What is your age?

..... years

2. What is your sex?

a. Male
b. Female

3. What type of healthcare facility do you work in?

a. Academic (University) hospital
b. Non-academic teaching hospital
c. Non-academic non-teaching hospital
d. Private clinic
e. Other, namely ....

4. Which of the following arthroplasty types do you perform in your daily practice?

a. Hip arthroplasty
b. Knee arthroplasty
c. Both
d. Neither

5. What types of hip/knee arthroplasty do you perform?

a. Primary arthroplasty
b. Revision arthroplasty
c. Both

6. Approximately how many hip/knee arthroplasties do you perform per year? (In numbers)

.....

Section 2: Outpatient joint arthroplasty

7. Do you perform outpatient joint arthroplasty (OJA) of the hip/knee?

a. Yes
b. No

If your answer to question 7 was 'yes', proceed with question 8.
If your answer to question 7 was 'no', proceed with question 13.

8. What are the possible discharge destinations following OJA of the hip/knee? (Multiple answers are possible)
a. Home
b. Home with home care
c. Care hotel or intramural rehabilitation facility
d. Other, namely…

9. In your opinion, which types of hip and/or knee arthroplasty can be performed in the outpatient setting? (Multiple answers are possible)
a. Total hip arthroplasty
b. Total knee arthroplasty
c. Unicompartmental knee arthroplasty
d. Patellofemoral arthroplasty
e. Low-risk revision surgery (e.g., liner/insert change)
f. Other, namely...

10. How many years of experience do you have with OJA of the hip/knee?
a. <1 year
b. 1-2 years
c. 3-4 years
d. >4 years

11. Approximately how many hip/knee arthroplasties do you perform in the outpatient setting? (In numbers)
……

12. What is the reason that you perform OJA of the hip/knee? (Multiple answers are possible)
a. Patient request/demand
b. Scientific evidence (with regard to effectiveness, safety, satisfaction)
c. Own positive experiences
d. Financially profitable (for the partnership and/or the healthcare institution)
e. Reduction of general healthcare costs
f. Marketing point of view (competing with other healthcare institutions)
g. No reason
h. Other, namely...

13. Are you interested to implement OJA of the hip/knee in your healthcare institution in the future?
a. Yes
b. No
c. I don't know

If your answer to question 13 was 'yes', proceed with question 14.
If your answer to question 13 was 'no' or 'I don't know', proceed with question 15.

14. What is the reason that you are currently not performing OJA of the hip/knee? (Multiple answers are possible)
a. Uncertainty about the added value
b. Uncertainty about effectiveness and safety
c. Low volume healthcare facility / insufficient experience with clinical pathways
d. No help and/or time with the design and implementation of the OJA pathway
e. No multidisciplinary support (anaesthesia, pain team, physiotherapy, nursing, etc.)
f. No support from direct colleagues
g. No support from the hospital
h. Not enough staff available
i. Current reimbursement (by health insurance companies)
j. Never got around to it
k. No reason
l. Otherwise, namely...

15. What is the reason that you are not interested to implement OJA of the hip/knee? (Multiple answers are possible)
a. Not convinced of the added value
b. Not convinced of effectiveness and safety
c. Low volume healthcare facility / insufficient experience with clinical pathways
d. No help and/or time with the design and implementation of the OJA pathway
e. No multidisciplinary support (anaesthesia, pain team, physiotherapy, nursing, etc.)
f. No support from direct colleagues
g. No support from the hospital
h. Not enough staff available
i. Current reimbursement (by health insurance companies)
j. Inappropriate patient population
k. Own preference

l. No reason
m. Other, namely...

Section 3: Statements

16. Who do you think benefits the most from OJA of the hip/knee?
a. Patient
b. Orthopeadic surgeon
c. Healthcare institution
d. Health insurance company
e. Nobody
f. Other, namely...

17. OJA is a logical development given the increasing healthcare costs in an aging population.
a. Completely agree
b. Agree
c. neutral
d. Don't agree
e. Completely disagree
f. I don't know

18. In the future, the setting for selected "healthy" patients undergoing hip or knee arthroplasty will increasingly shift from (short-term) inpatient admission to OJA.
a. Completely agree
b. Agree
c. neutral
d. Don't agree
e. Completely disagree
f. I don't know

19. OJA in a selected patient population is the limit of pathway innovation for hip and knee arthroplasty.
Examples of further innovation are: expanding the current selection criteria for patients undergoing OJA of the hip/knee; A shift from inpatient to outpatient care in ASA III/IV patients (early discharge to care hotels or the like).
a. Completely agree
b. Agree
c. neutral
d. Don't agree

e. Completely disagree
f. I don't know

20. The (OJA) pathway for hip and knee arthroplasty can be further optimized through better perioperative education and patient participation.
For example: by the implementation of eHealth (applications such as the 'Patient Journey App') and the use of wearable technology ('wearables' such as activity trackers and smartwatches).
a. Completely agree
b. Agree
c. neutral
d. Don't agree
e. Completely disagree
f. I don't know

21. OJA of the hip and knee can further improve patient satisfaction compared to a (short-term) inpatient admission.
a. Completely agree
b. Agree
c. neutral
d. Don't agree
e. Completely disagree
f. I don't know

Appendix 2. Who benefits most from OJA?

Number of respondents (N)	Total (N = 123)	OJA subgroup (N = 22)	Future subgroup (N = 47)	No subgroup (N = 54)	p value
Patient	28 (23%)	13 (59%)	12 (26%)	3 (5.6%)	**<0.001**
Surgeon	2 (1.6%)	1 (4.5%)	1 (2.1%)	0 (0%)	
Healthcare institution	42 (34%)	2 (9.1%)	22 (47%)	18 (33%)	
Health insurance company	34 (28%)	4 (18%)	8 (17%)	22 (41%)	
Nobody	12 (9.8%)	1 (4.5%)	0 (0%)	11 (20%)	
Other	5 (4.1%)	1 (4.5%)	4 (8.5%)	0 (0%)	

OJA = outpatient joint arthroplasty.

Discrete variables as frequency (percentage); **Bold** indicates statistically significant difference ($p < 0.05$).

Appendix 3. Responses to the general statements on the implementation of OJA

Number of respondents (N)	Total (N = 123)	OJA subgroup (N = 22)	Future OJA subgroup (N = 47)	No OJA subgroup (N = 54)	p value
Statement 1					**<0.001**
I strongly agree	7 (5.7%)	4 (18%)	3 (6.4%)	0 (0%)	
I agree	40 (33%)	11 (50%)	22 (47%)	7 (13%)	
Neutral	22 (18%)	3 (14%)	11 (23%)	8 (15%)	
I disagree	40 (33%)	4 (19%)	7 (15%)	29 (54%)	
I strongly disagree	10 (8.1%)	0 (0%)	2 (4.3%)	8 (15%)	
I don't know	4 (3.3%)	0 (0%)	2 (4.3%)	2 (3.7%)	
Statement 2					**<0.001**
I strongly agree	12 (9.8%)	10 (45%)	2 (4.3%)	0 (0%)	
I agree	56 (46%)	8 (36%)	34 (72%)	14 (26%)	
Neutral	25 (20%)	2 (9.0%)	8 (17%)	15 (28%)	
I disagree	26 (21%)	2 (9.0%)	3 (6.4%)	21 (39%)	
I strongly disagree	3 (2.4%)	0 (0%)	0 (0%)	3 (5.6%)	
I don't know	1 (0.81%)	0 (0%)	0 (0%)	1 (1.9%)	
Statement 3					**0.004**
I strongly agree	5 (4.1%)	0 (0%)	0 (0%)	5 (9.3%)	
I agree	43 (35%)	6 (27%)	20 (43%)	17 (31%)	
Neutral	29 (24%)	2 (9.0%)	12 (26%)	15 (28%)	

Appendix 3. Responses to the general statements on the implementation of OJA (*continued*).

Number of respondents (N)	Total (N = 123)	OJA subgroup (N = 22)	Future OJA subgroup (N = 47)	No OJA subgroup (N = 54)	p value
I disagree	35 (28%)	13 (59%)	13 (28%)	9 (17%)	
I strongly disagree	7 (5.7%)	1 (4.5%)	2 (4.3%)	4 (7.4%)	
I don't know	4 (3.3%)	0 (0%)	0 (0%)	4 (7.4%)	
Statement 4					0.078
I strongly agree	22 (18%)	7 (32%)	9 (19%)	6 (11%)	
I agree	72 (59%)	13 (59%)	32 (68%)	27 (50%)	
Neutral	15 (12%)	0 (0%)	4 (8.5%)	11 (20%)	
I disagree	12 (9.8%)	2 (9.0%)	2 (4.3%)	8 (15%)	
I strongly disagree	1 (0.81%)	0 (0%)	0 (0%)	1 (1.9%)	
I don't know	1 (0.81%)	0 (0%)	0 (0%)	1 (1.9%)	
Statement 5					**<0.001**
I strongly agree	6 (4.9%)	4 (18%)	1 (2.1%)	1 (1.9%)	
I agree	28 (23%)	10 (45%)	15 (32%)	3 (5.6%)	
Neutral	40 (33%)	4 (18%)	22 (47%)	14 (26%)	
I disagree	36 (29%)	4 (18%)	8 (17%)	24 (44%)	
I strongly disagree	9 (7.3%)	0 (0%)	0 (0%)	9 (17%)	
I don't know	4 (3.3%)	0 (0%)	1 (2.1%)	3 (5.6%)	

OJA = outpatient joint arthroplasty.

Discrete variables as frequency (percentage); **Bold** indicates statistically significant difference ($p < 0.05$).

CHAPTER 7

PERIOPERATIVE DIFFERENCES BETWEEN OUTPATIENT AND INPATIENT PATHWAYS FOLLOWING HIP AND KNEE ARTHROPLASTY

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ABSTRACT

Background
Optimization of clinical pathways and logistics led to the introduction of outpatient joint arthroplasty of the hip and knee. Nevertheless, little is known about what these current protocols look like and how they differ from "standard" inpatient protocols. This study aimed to find preoperative, intraoperative, and postoperative differences between outpatient and inpatient pathways.

Methods
A questionnaire (ranging between 23 and 37 items) was developed and administered by email to orthopaedic surgeons who were a member of the Dutch Hip Society and Dutch Knee Society. Survey response rate was 38% (N = 117).

Results
No significant differences were found in preoperative pathway characteristics. The administration regime for tranexamic acid significantly differed between outpatient and inpatient pathways ($p < 0.001$ and $p = 0.002$ for hip and knee arthroplasty, respectively), with outpatient pathways using a combined (e.g., oral and intravenous) administration regime more frequently. The perioperative antibiotic prophylaxis regime also significantly differed between outpatient and inpatient pathways ($p < 0.001$ and $p = 0.014$, respectively), with outpatient pathways more frequently incorporating fewer antibiotic doses. Same-day postoperative mobilization significantly less often occurred if surgery took place later that day in inpatient hip arthroplasty pathways (24%; $p = 0.034$). Postoperative hemoglobin-check occurred significantly more often on indication in outpatient than in inpatient hip and knee arthroplasty pathways (~75% vs ~25%; $p = 0.001$).

Conclusions
Few intraoperative and postoperative differences in outpatient and inpatient pathways were found and probably mainly relied on logistical grounds. Nonetheless, findings suggested that outpatient pathways tended to be more up-to-date and innovative than inpatient pathways.

1. INTRODUCTION

Clinical pathways were introduced in the USA in the 1980's to cut the costs and to reduce variation in care that does not influence outcome. It's basically an algorithm that outlines a structured evidence-based sequence and timing of interventions for the care of a specific group of patients with a particular diagnosis or procedure. The purpose is to standardize procedures to ensure an optimal and reproducible outcome regarding quality, efficiency and economic saving. Nowadays these pathways are widely implemented in high-volume, high-cost and high-predictable care processes.[1]

A variant on a clinical pathway was developed by Kehlet[2] in an effort to improve recovery after colorectal surgery: enhanced recovery after surgery (ERAS). He hypothesized that the surgical stress response was the key pathogenic factor in postoperative morbidity and contributed to 'organ dysfunction' by metabolic and endocrine derangements (e.g., pain, postoperative nausea and vomiting, fatigue). As no single surgical/anesthetic technique or drug regimen had been shown to eliminate postoperative morbidity, the ERAS concept promoted a multimodal approach to address the surgical stress response with multidisciplinary team effort.[3] The last two decades, these 'fast-track' pathways have also been implemented in hip and knee arthroplasty and successfully proved to enhance recovery and patient satisfaction with care, decrease morbidity, effectively reduce hospital length of stay (LOS) and healthcare costs.[4, 5]

Auditing is another important feature of the 'fast-track' concept, constantly revisiting and evaluating routines and current practices in an attempt to incorporate new evidence based clinical features in the perioperative pathway to promote recovery. As a result of these continuous improvements in perioperative care – in combination with optimized pathway and hospital logistics – outpatient joint arthroplasty (OJA; discharging patients on the same day of surgery) pathways emerged in several clinics.[6, 7] These OJA pathways have been proven to be feasible and safe in a selected group of patients and so they are gaining popularity.[8-10]

Although evidence and consensus statements exist for the organization of perioperative care in TJA of the hip and knee, there are no studies comparing perioperative features of outpatient versus standard inpatient pathways. The primary research purpose of this study was to assess preoperative, intra-operative and postoperative differences between outpatient and standard inpatient pathways following hip and knee arthroplasty in The Netherlands.

2. MATERIALS AND METHODS

This study was approved by the local IRB (study number Z20210053).

2.1 Settings and subjects

This study was conducted as a follow-up survey among the same study population (active members of the Dutch Hip Society [DHS] and the Dutch Knee Society [DKS]) as described previously by our research team.[11]

2.2 Questionnaire

A new questionnaire was developed and concerns a follow-up to a previous questionnaire (on the surgeon's perspective on the implementation of OJA), the results of which have already been published.[11] The questionnaire was comprised in four sections to determine surgeon's baseline characteristics and to identify preoperative, intra-operative and postoperative features of current outpatient or inpatient pathways. If the respondent performed OJA, then all subsequent questions were intended to specify their outpatient pathway (and vice versa). Outpatient was defined as patients who were discharged to their own home environment on the day of surgery (DOS) and who don't have an overnight stay at either the hospital or another non-home facility.[11]

The number of questionnaire items varied individually between 23 and 37 based on the responses of the participants. An English version of the questionnaire is presented in Appendix 1.

2.3 Statistics

All analyses were performed with SPSS (IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp.).

Descriptives were displayed as means with standard deviations (and range) for continuous variables and frequencies with percentages for categorical variables.

Differences between outpatient and inpatient pathways were assessed using chi-square or (in case of cells with expected value < 5) Fisher's exact test for categorical variables and an unpaired t-test for continuous variables. A two-sided P-value ≤ 0.05 was considered to indicate statistical significance.

2.4 Study population

Our prior administered survey was completed by 123 out of 331 orthopaedic surgeons.[11] One hundred seventeen of 123 respondents (95%) completed the follow-up survey and were included in the analysis. This resulted in a response rate of 35.3% for the entire study population. Demographics of respondents are summarized in Table 1.

Table 1. Demographics of the respondents

Number of respondents (N)	**Total 117**	**OJA 20**	**Non-OJA 97**	**p value**
Age (years)	46 ± 8.9 (32 - 66)	47 ± 9.3 (32 - 66)	46 ± 8.8 (33 - 63)	0.74
Sex				1.0
Female	3 (2.6%)	0 (0%)	3 (3.1%)	
Male	114 (97%)	20 (100%)	94 (97%)	
Affiliation				0.13
Academic (University) hospital	13 (11%)	0 (0%)	13 (13%)	
Non-academic teaching hospital	54 (46%)	14 (70%)	40 (41%)	
Non-academic non-teaching hospital	33 (28%)	4 (20%)	29 (30%)	
Private clinic	13 (11%)	2 (10%)	11 (11%)	
Other	4 (3.4%)	0 (0%)	4 (4.1%)	
Orthopaedic (sub) specialty				0.25
Hip and knee arthroplasty	68 (58%)	13 (65%)	55 (57%)	
Only hip arthroplasty	15 (13%)	4 (20%)	11 (11%)	
Only knee arthroplasty	34 (29%)	3 (15%)	31 (32%)	
Hip arthroplasty group *				
N, surgeons	83	17	66	
N, surgeries (per year)	116 ± 62 (20 - 330)	150 ± 71 (70 - 330)	108 ± 57 (20 - 280)	**0.011**
Types of hip arthroplasty				

Table 1. Demographics of the respondents *(continued)*.

Number of respondents (N)	Total 117	OJA 20	Non-OJA 97	p value
Primary	83 (100%)	17 (100%)	66 (100%)	N/a
Revision	60 (72%)	13 (76%)	47 (71%)	0.77
Knee arthroplasty group *				
N, surgeons	102	16	86	0.42
N, surgeries (per year)	102 ± 66 (10 - 380)	114 ± 46 (40 - 180)	100 ± 69 (10 - 380)	
Types of knee arthroplasty				
Primary	102 (100%)	16 (100%)	86 (100%)	N/a
Revision	64 (63%)	10 (63%)	54 (63%)	0.98

OJA = outpatient joint arthroplasty.

Discrete variables as frequency (percentage); continuous variables as mean ± standard deviation (range); **Bold** indicates statistically significant difference (p <0.05).
* Respondents that perform "hip AND knee arthroplasty" are included in both the hip arthroplasty group and the knee arthroplasty group.

3. RESULTS

3.1 Preoperative pathway characteristics

Informative leaflets were the most frequently used type of education tool. Prehabilitation was used by ~35% of respondents in both hip and knee arthroplasty. No major differences were found between outpatient and inpatient pathways (Table 2-3).

Approximately 80% of respondents made use of preoperative screening tools. The most used screening tool was the American Society of Anesthesiologists (ASA) classification. Protocollary defined selection criteria were more frequently used in both outpatient (~45%) compared with inpatient hip and knee arthroplasty (14% and 24%, respectively) pathways (Table 2-3).

Table 2. Preoperative characteristics of the outpatient and inpatient hip arthroplasty pathway

Number of respondents (N)	Total 83	Outpatient 17	Inpatient 66	p value
Preoperative education	83 (100%)	17 (100%)	66 (100%)	N/a
Type of education used *				N/a
Verbal	61 (73%)	14 (82%)	47 (71%)	
Informative leaflets	78 (94%)	17 (100%)	61 (92%)	
Videos	35 (42%)	5 (29%)	30 (45%)	
Decision aids	33 (40%)	7 (41%)	26 (39%)	
eHealth (e.g., patient journey app)	24 (29%)	4 (24%)	20 (30%)	
Other	5 (6.0%)	1 (5.9%)	4 (6.1%)	
Prehabilitation	27 (33%)	8 (47%)	19 (29%)	0.16
Preoperative screening	66 (80%)	15 (88%)	51 (77%)	0.50
Type of screening tools used *				N/a
Charlson comorbidity index (CCI)	3 (4.5%)	0 (0%)	3 (5.9%)	
American Society of Anesthesiologists (ASA) - class	57 (86%)	12 (80%)	45 (88%)	
Outpatient Arthroplasty Risk Assessment (OARA)	1 (1.5%)	0 (0%)	1 (2.0%)	
Total joint replacement (TJR) risk calculator	1 (1.5%)	0 (0%)	1 (2.0%)	
Readmission Risk Assessment Tool (RRAT)	1 (1.5%)	0 (0%)	1 (2.0%)	
Protocollary defined selection criteria	14 (21%)	7 (47%)	7 (14%)	
Other	7 (11%)	3 (20%)	4 (7.8%)	

Discrete variables as frequency (percentage);

* Multiple answers were allowed. Proportions of respondents that made use of this feature were displayed.

Table 3. Preoperative characteristics of the outpatient and inpatient knee arthroplasty pathway

Number of respondents (N)	Total 102	Outpatient 16	Inpatient 86	p value
Preoperative education	102 (100%)	16 (100%)	86 (100%)	N/a
Type of education used *				N/a
Verbal	77 (75%)	14 (88%)	63 (73%)	
Informative leaflets	96 (94%)	16 (100%)	80 (93%)	
Videos	43 (42%)	3 (19%)	40 (47%)	
Decision aids	39 (38%)	6 (38%)	33 (38%)	
eHealth (e.g., patient journey app)	28 (27%)	4 (25%)	24 (28%)	
Other	5 (4.9%)	1 (6.3%)	4 (4.7%)	
Prehabilitation	37 (36%)	9 (56%)	28 (33%)	0.091
Preoperative screening	81 (79%)	14 (88%)	67 (78%)	0.51
Type of screening tools used *				N/a
Charlson comorbidity index (CCI)	4 (4.9%)	0 (0%)	4 (6.0%)	
American Society of Anesthesiologists (ASA) - class	73 (90%)	12 (86%)	60 (90%)	
Outpatient Arthroplasty Risk Assessment (OARA)	1 (1.2%)	0 (0%)	1 (1.5%)	
Total joint replacement (TJR) risk calculator	2 (2.5%)	0 (0%)	2 (3.0%)	
Readmission Risk Assessment Tool (RRAT)	1 (1.2%)	0 (0%)	1 (1.5%)	
Protocollary defined selection criteria	22 (27%)	6 (43%)	16 (24%)	
Other	8 (9.9%)	3 (21%)	5 (7.5%)	

Discrete variables as frequency (percentage);

* Multiple answers were allowed. Proportions of respondents that made use of this feature were displayed.

3.2 Intra-operative pathway characteristics

3.2.1 Anesthesia

Spinal anesthesia (with or without sedation) was the most frequently used type of anesthesia (~75%). Little use of peripheral nerve (e.g., femoral/saphenous) blocks (PNBs) was reported and was only limited to inpatient pathways (6% in hip arthroplasty and 24% in knee arthroplasty). The use of local infiltration anesthesia (LIA) was common in knee arthroplasty (96%), but not in hip arthroplasty pathways (7.2%). No differences were found between outpatient and inpatient pathways (Table 4-5).

3.2.2 Surgical techniques

The posterolateral (PL) approach was preferred by most respondents (58%) in total hip arthroplasty. Higher rates of the direct anterior approach (DAA) were observed in outpatient compared with inpatient hip arthroplasty pathways (53% versus 29%, p = 0.057). Most respondents (98%) preferred the medial parapatellar (MPP) approach in total knee arthroplasty (Table 4-5).

3.2.3 Intra-operative medication

Tranexamic acid (TXA) was used by all respondents. Great variability – in when (perioperative timing) and how (route) TXA was administered – was observed in both hip and knee arthroplasty pathways (Table 4-5). Significant differences between outpatient and inpatient pathways on route of administration were found in both hip and knee arthroplasty (p < 0.001 and p = 0.002 respectively).

Also, great variability was observed in the use of antibiotic prophylaxis (Table 4-5). Significant differences in the number of antibiotic doses were found between outpatient and inpatient pathways in both hip and knee arthroplasty (p < 0.001 and p = 0.014, respectively).

Table 4. Intra-operative characteristics of the outpatient and inpatient hip arthroplasty pathway

Number of respondents (N)	Total 83	Outpatient 17	Inpatient 66	p value
Anesthesia, preference				0.55
General	13 (16%)	2 (12%)	11 (17%)	
Spinal with sedation	28 (34%)	6 (35%)	22 (33%)	
Spinal	34 (41%)	9 (53%)	25 (38%)	
No preference	7 (8.4%)	0 (0%)	7 (11%)	
Other	1 (1.2%)	0 (0%)	1 (1.5%)	
Surgical approach, preference				0.057
Posterolateral	48 (58%)	6 (35%)	42 (64%)	
Direct anterior	29 (35%)	9 (53%)	19 (29%)	
Straight lateral	3 (3.6%)	0 (0%)	3 (4.5%)	
Anterolateral	1 (1.2%)	1 (5.9%)	0 (0%)	
Direct superior	3 (3.6%)	1 (5.9%)	2 (3.0%)	
Peripheral nerve blocks				0.8
Lumbar plexus block	1 (1.2%)	0 (0%)	1 (1.5%)	
Fascia iliaca block	1 (1.2%)	0 (0%)	1 (1.5%)	

Table 4. Intra-operative characteristics of the outpatient and inpatient hip arthroplasty pathway *(continued)*.

Number of respondents (N)	Total 83	Outpatient 17	Inpatient 66	p value
Other	2 (2.4%)	0 (0%)	2 (3.0%)	
No	79 (95%)	17 (100%)	62 (94%)	
LIA use	6 (7.2%)	1 (5.9%)	5 (7.6%)	1.0
Composition of LIA used *				N/a
Ropivacaine	5 (83%)	1 (100%)	4 (80%)	
Bupivacaine	1 (17%)	0 (0%)	1 (20%)	
Adrenaline	2 (33%)	0 (0%)	2 (40%)	
Tranexamic acid use	83 (100%)	17 (100%)	66 (100%)	N/a
When				0.091
Preoperative	28 (34%)	3 (17%)	25 (38%)	
Intraoperative	9 (11%)	0 (0%)	9 (14%)	
Postoperative	3 (3.6%)	0 (0%)	3 (4.5%)	
Preoperative and intraoperative	14 (17%)	3 (17%)	11 (17%)	
Preoperative and postoperative	21 (25%)	8 (47%)	13 (20%)	
Intraoperative and postoperative	4 (4.8%)	2 (12%)	2 (3.0%)	
Preoperative, intraoperative and postoperative	4 (4.8%)	1 (5.9%)	3 (4.5%)	
How				**<0.001**
Oral	3 (3.6%)	2 (12%)	1 (1.5%)	
Intravenous	61 (73%)	6 (35%)	55 (83%)	
Intra-articular	0 (0%)	0 (0%)	0 (0%)	
Oral and intravenous	11 (13%)	8 (47%)	3 (4.5%)	
Intravenous and intra-articular	7 (8.4%)	1 (5.9%)	6 (9.1%)	
I don't know	1 (1.2%)	0 (0%)	1 (1.5%)	
Drain use	1 (1.2%)	0 (0%)	1 (1.5%)	1.0
Urinary catheter use	2 (2.4%)	0 (0%)	2 (3.0%)	1.0
Antibiotics				**<0.001**
1 dose	13 (16%)	2 (12%)	11 (17%)	
2 doses	11 (13%)	9 (53%)	2 (3.0%)	
3 doses	58 (70%)	6 (35%)	52 (79%)	
Other	1 (1.2%)	0 (0%)	1 (1.5%)	

Discrete variables as frequency (percentage);
* Multiple answers were allowed. Proportions of respondents that made use of this feature were displayed.

Table 5. Intra-operative characteristics of the outpatient and inpatient knee arthroplasty pathway

Number of respondents (N)	Total 102	Outpatient 16	Inpatient 86	p value
Anesthesia, preference				0.43
General	5 (4.9%)	0 (0%)	5 (5.8%)	
Spinal with sedation	36 (35%)	7 (44%)	29 (34%)	
Spinal	40 (39%)	8 (50%)	32 (37%)	
No preference	18 (18%)	1 (6.3%)	17 (20%)	
Other	3 (2.9%)	0 (0%)	3 (3.5%)	
Surgical approach, preference				0.061
Medial parapatellar	100 (98%)	15 (94%)	85 (99%)	
Midvastus	1 (0.98%)	1 (6.3%)	0 (0%)	
Subvastus	1 (0.98%)	0 (0%)	1 (1.2%)	
Tourniquet use	46 (45%)	6 (38%)	40 (47%)	0.51
Technique**				0.22
During the entire operation	32 (70%)	6 (100%)	26 (65%)	
During cementation	11 (24%)	0 (0%)	11 (28%)	
Other	3 (6.5%)	0 (0%)	3 (7.5%)	
Peripheral nerve blocks				0.30
Femoral nerve block	8 (7.8%)	0 (0%)	8 (9.3%)	
Saphenous nerve (adductor canal) block	8 (7.8%)	0 (0%)	8 (9.3%)	
Obturator nerve block	1 (0.98%)	0 (0%)	1 (1.2%)	
Other	4 (3.9%)	0 (0%)	4 (4.7%)	
No	81 (79%)	16 (100%)	65 (76%)	
LIA use	98 (96%)	16 (100%)	82 (95%)	1.0
Composition of LIA used *				N/a
Ropivacaine	85 (87%)	15 (94%)	70 (85%)	
Bupivacaine	13 (13%)	1 (6.3%)	12 (15%)	
Ketorolac	4 (4.1%)	1 (6.3%)	3 (3.7%)	
Adrenaline	31 (32%)	3 (19%)	28 (34%)	
Morphine	1 (1.0%)	0 (0%)	1 (1.2%)	
Corticosteroids	3 (3.1%)	1 (6.3%)	2 (2.4%)	
Don't know	2 (2.0%)	0 (0%)	2 (2.4%)	
Other	1 (1.0%)	0 (0%)	1 (1.2%)	

Table 5. Intra-operative characteristics of the outpatient and inpatient knee arthroplasty pathway *(continued)*.

Number of respondents (N)	Total 102	Outpatient 16	Inpatient 86	p value
Tranexamic acid use	102 (100%)	16 (100%)	86 (100%)	N/a
When				0.052
Preoperative	35 (34%)	2 (13%)	33 (38%)	
Intraoperative	12 (12%)	0 (0%)	12 (14%)	
Postoperative	2 (2.0%)	0 (0%)	2 (2.3%)	
Preoperative and intraoperative	16 (16%)	3 (19%)	13 (15%)	
Preoperative and postoperative	28 (27%)	8 (50%)	20 (23%)	
Intraoperative and postoperative	4 (3.9%)	2 (13%)	2 (2.3%)	
Preoperative, intraoperative and postoperative	5 (4.9%)	1 (6.3%)	4 (4.7%)	
How				**0.002**
Oral	6 (5.9%)	1 (6.3%)	5 (5.8%)	
Intravenous	72 (71%)	6 (38%)	66 (77%)	
Intra-articular	0 (0%)	0 (0%)	0 (0%)	
Oral and intravenous	15 (15%)	8 (50%)	7 (8.1%)	
Intravenous and intra-articular	7 (6.9%)	1 (6.3%)	6 (7.0%)	
Oral, intravenous and intra-articular	1 (0.98%)	0 (0%)	1 (1.2%)	
I don't know	1 (0.98%)	0 (0%)	1 (1.2%)	
Drain use	2 (2.0%)	0 (0%)	2 (2.3%)	1.0
Urinary catheter use	2 (2.0%)	0 (0%)	2 (2.3%)	1.0
Antibiotics				**0.014**
1 dose	17 (17%)	1 (6.3%)	16 (19%)	
2 doses	17 (17%)	7 (44%)	10 (12%)	
3 doses	66 (65%)	8 (50%)	58 (67%)	
Other	2 (2.0%)	0 (0%)	2 (2.3%)	

Discrete variables as frequency (percentage);

* Multiple answers were allowed. Proportions of respondents that made use of this feature were displayed.

3.3 Postoperative pathway characteristics

3.3.1 Mobilization

The timing of postoperative mobilization significantly differed between outpatient and inpatient pathways for hip arthroplasty (p = 0.034). In 24% of inpatient pathways, mobilization was delayed to the next day if surgery took place later that day (Table 6).

3.3.2 Postoperative medication

The majority of respondents preferred LMWHs as type of anticoagulant (~80%) and a 4–6-week length of anticoagulant use (~93%). The preferred length of anticoagulant prophylaxis significantly differed between outpatient and inpatient pathways for knee arthroplasty (p = 0.043), but not for hip arthroplasty (p = 0.12) (Table 6-7).

Although outpatient pathways more frequently incorporated opioid-sparing regimes in postoperative pain management, no statistical differences were observed between pathways (~70% versus 55%, p ≥ 0.40) (Table 6-7).

3.3.3 Postoperative checks

Outpatient and inpatient pathways for both hip and knee arthroplasty significantly differed in regime for postoperative Hemoglobin (Hb) check (p < 0.001 and p = 0.001, respectively) (Table 6-7).

Table 6. Postoperative characteristics of the outpatient and inpatient hip arthroplasty pathway

Number of respondents (N)	Total 83	Outpatient 17	Inpatient 66	p value
Average length of stay after standard inpatient THA (days) *	2.1 ± 0.80 (1-6)	2.1 ± 0.66 (1-3)	2.1 ± 0.84 (1-6)	0.73
Anticoagulant use	83 (100%)	17 (100%)	66 (100%)	N/a
Preferences **				N/a
LMWH	66 (80%)	14 (82%)	52 (79%)	
NOAC/DOAC	24 (29%)	4 (24%)	20 (30%)	
Platelet aggregation inhibitor	2 (2.4%)	0 (0%)	2 (3.0%)	
Length of use				0.12
1-3 weeks	2 (2.4%)	1 (5.9%)	1 (1.5%)	
4-6 weeks	77 (93%)	15 (88%)	62 (94%)	
>6 weeks	1 (1.2%)	1 (5.9%)	0 (0%)	
Other	3 (3.6%)	0 (0%)	3 (4.5%)	
Morphine use				0.42
Rescue medication	48 (58%)	12 (71%)	36 (55%)	
Standard/scheduled medication	26 (31%)	4 (24%)	22 (33%)	
Patient controlled analgesia	5 (6.0%)	0 (0%)	5 (7.6%)	
No	2 (2.4%)	0 (0%)	2 (3.0%)	
Other	2 (2.4%)	1 (5.9%)	1 (1.5%)	
Physical therapy				**0.034**
On the same day	67 (81%)	17 (100%)	50 (76%)	
Not the same day if surgery takes place later on the day	16 (19%)	0 (0%)	16 (24%)	
Hb check				**<0.001**
Always	54 (65%)	4 (24%)	50 (76%)	
Only if indicated	28 (34%)	12 (71%)	16 (24%)	
No	1 (1.2%)	1 (5.9%)	0 (0%)	

Table 6. Postoperative characteristics of the outpatient and inpatient hip arthroplasty pathway *(continued)*.

Number of respondents (N)	Total 83	Outpatient 17	Inpatient 66	p value
X-ray				0.19
Direct postoperative	77 (93%)	15 (88%)	62 (94%)	
During follow-up visit	2 (2.4%)	0 (0%)	2 (3.0%)	
Only if indicated	1 (1.2%)	0 (0%)	1 (1.5%)	
Other	3 (3.6%)	2 (12%)	1 (1.5%)	

THA = total hip arthroplasty; Hb = hemoglobin.

Discrete variables as frequency (percentage); continuous variables as mean ± standard deviation (range);
* Both groups of orthopaedic surgeons (performing both inpatient and outpatient joint arthroplasty versus only inpatient joint arthroplasty) estimated their average LOS for the standard inpatient total joint pathways.
** Multiple answers were allowed. Proportions of respondents that made use of this feature were displayed.

Table 7. Postoperative characteristics of the outpatient and inpatient knee arthroplasty pathway

Number of respondents (N)	Total 102	Outpatient 16	Inpatient 86	p value
Average length of stay after standard inpatient TKA (days) *	2.3 ± 0.85 (1-6)	2.1 ± 0.62 (1-3)	2.3 ± 0.89 (1-6)	0.51
Anticoagulant use	102 (100%)	16 (100%)	86 (100%)	N/a
Preferences **				N/a
LMWH	83 (81%)	14 (81%)	69 (80%)	
NOAC/DOAC	27 (26%)	2 (13%)	25 (29%)	
Platelet aggregation inhibitor	6 (5.9%)	1 (6.3%)	5 (5.8%)	
Mechanic (elastic compression stockings)	1 (0.98%)	0 (0%)	1 (1.2%)	
Length of use				**0.043**
1-3 weeks	2 (2.0%)	1 (6.3%)	1 (1.2%)	
4-6 weeks	94 (92%)	14 (88%)	80 (93%)	
>6 weeks	1 (0.98%)	1 (6.3%)	0 (0%)	
Other	5 (4.9%)	0 (0%)	5 (5.8%)	

Table 7. Postoperative characteristics of the outpatient and inpatient knee arthroplasty pathway *(continued)*.

Number of respondents (N)	Total 102	Outpatient 16	Inpatient 86	p value
Morphine use				0.40
Rescue medication	58 (57%)	11 (69%)	47 (55%)	
Standard/scheduled medication	35 (34%)	4 (25%)	31 (36%)	
Patient controlled analgesia	6 (5.9%)	0 (0%)	6 (7.0%)	
No	1 (0.98%)	0 (0%)	1 (1.2%)	
Other	2 (2.0%)	1 (6.3%)	1 (1.2%)	
Continuous passive motion device, use	2 (2.0%)	0 (0%)	2 (2.3%)	1.0
Physical therapy				0.15
On the same day	85 (83%)	16 (100%)	69 (80%)	
Not the same day if surgery takes place later on the day	16 (16%)	0 (0%)	16 (19%)	
Other	1 (0.98%)	0 (0%)	1 (1.2%)	
Hb check				**0.001**
Always	66 (65%)	4 (25%)	62 (72%)	
Only if indicated	36 (35%)	12 (75%)	24 (28%)	
X-ray				0.54
Direct postoperative	99 (97%)	15 (94%)	83 (97%)	
During follow-up visit	1 (0.98%)	0 (0%)	1 (1.2%)	
Only if indicated	1 (0.98%)	0 (0%)	1 (1.2%)	
Other	2 (2.0%)	1 (6.3%)	1 (1.2%)	

TKA = total knee arthroplasty; Hb = hemoglobin

Discrete variables as frequency (percentage); continuous variables as mean ± standard deviation (range);
* Both groups of orthopaedic surgeons (performing both inpatient and outpatient joint arthroplasty versus only inpatient joint arthroplasty) estimated their average LOS for the standard inpatient total joint pathways.
** Multiple answers were allowed. Proportions of respondents that made use of this feature were displayed.

4. DISCUSSION

Optimization of clinical pathways and logistics led to the introduction of OJA. This study aimed to find protocollary differences between outpatient and inpatient joint

arthroplasty pathways. Only slight differences were found in both the intraoperative and postoperative phase and probably relied mainly on logistical grounds to ensure efficient same-day discharge. Additionally, we found no significant different LOS for 'standard' inpatients in both groups (orthopaedic surgeons who performed both inpatient and outpatient versus inpatient alone), suggesting that many existing inpatient pathways might not be far removed from OJA, and OJA is most likely underutilized nationally.[12]

4.1 Preoperative characteristics

Preoperative patient education is not only mandatory to obtain informed consent, but also important as it can serve multiple purposes[13]: (1) adequate information may motivate patients to actively participate, adhere to the protocol and increase their sense of responsibility for a successful surgery[14]; (2) manage and modulate expectations as this is associated with patient satisfaction[15]; and (3) reduce preoperative anxiety related to the upcoming surgical event.[14-16] The format of education can range from conventional (verbal one-to-one / group sessions, written) to more innovative methods (audiovisual, decision aids and eHealth). Interestingly, we found that informative brochures (94%) and verbal education (~75%) were the most common used forms of preoperative education, whereas the use of decision aids (~40%) and eHealth (~30%) were relatively scarce. Although OJA might be considered more innovative than standard inpatient pathways, no significant differences in the use of innovative preoperative education types were found between the two pathways.

In outpatient pathways, respondents were more likely to use (self) predefined selection criteria. This makes sense as to date evidence suggests that OJA should be reserved for selected patients,[9] and therefore selection criteria were formulated by various research groups.[17, 18] However, interestingly we found that, except for ASA classifications, specific screening tools were hardly used in both pathways.[19]

Although not statistically significant, prehabilitation was more frequently applied in outpatient compared with inpatient hip and knee pathways. Evidence suggests that preoperative health status is a strong predictor of good postoperative outcome following joint replacement and as function often tends to deteriorate in the preoperative period, surgeons have the opportunity to optimize patient's health status in preparation for surgery. Although prior systematic reviews found conflicting effectiveness of prehabilitation, recent studies found that preoperative interventions (i.e., exercise/educational) significantly improved pain perception, function/quadriceps strength, and reduced LOS.[20] We believe that the concept of

prehabilitation can be broadened beyond functional improvement alone, and should also focus on other components (e.g., management of comorbidities, nutritional status, and addressing mental health problems such as depression/anxiety and negative coping strategies).[21]

4.2 Intra-operative characteristics

Spinal anaesthesia was most frequently used in both outpatient and inpatient pathways. Traditionally, spinal anaesthesia has been advocated over general anesthesia. However, high-quality studies comparing these anesthesia types in patients undergoing fast-track or outpatient TJA are lacking. Recent RCTs by Harsten et al[22] even failed to demonstrate differences in functional recovery, LOS, urinary complications, and early mobilization, questioning whether the assumed benefits of spinal anesthesia in reducing morbidity is relevant in this specific patient population and setting with already optimized perioperative care. This suggests that both general anesthetics (i.e., modern targeted total intravenous anesthetic and infusions targeted to anesthetic depth) and neuraxial techniques may be used as part of multimodal anesthetic regimens and should be based on institution's preferences, resources and skills available.[13, 23] In spinal anesthesia it is important to use a fast-onset and short-duration local anesthetic that advocates early mobilization. Our questionnaire however did not distinguish between the use of local anesthetics in either joint arthroplasty pathways.

LIA was mainly used by respondents performing TKA. A systematic review by Andersen and Kehlet[24] found that LIA was effective in pain reduction, opioid consumption, and LOS, only in TKA.[13] Although not supported by the concept of LIA, findings in a study by Keulen et al[6] suggested that LIA in TKA might compromise early mobilization and same-day discharge by transient common peroneal nerve palsy. Extra cautiousness when injecting LIA in the posterolateral joint capsule was suggested. No undisputed evidence regarding the mixture and dosage of drugs is available, which explains the variability in practices.

Interestingly, PNBs were rarely used by respondents in both pathways for hip and knee arthroplasty. This may be explained by the fact that nerve block were not recommended by the Dutch guidelines and not considered an essential ERAS component by the ERAS Society.[13, 25] Although the Dutch guideline has been revised quite recently, it only compared LIA with femoral nerve blocks (FNBs) for TKA. In outpatient pathways surgeons might have been afraid that blocks interfered with early ambulation, physical therapy and same-day discharge.[26] With growing evidence demonstrating the effectiveness of 'pure sensory' peripheral nerve blocks such as

Adductor Canal Block, we might see a change in (Dutch) practice within the next decade.[27, 28]

The PL approach in THA was most commonly used by our respondents. This is consistent with previous findings.[29] However, the last decade the DAA gained popularity among orthopaedic surgeons, as it is considered muscle-sparing and thought to be associated with less pain, a faster recovery, shorter LOS and reduced risk of dislocations. This might explain why respondents who perform OJA are more likely to use the DAA. Selection bias may also play a role given the technically challenging nature of the DAA, favoring patients that are also suitable for OJA. However, systematic reviews and meta-analyses are conflicting and to date fail to prove the superiority of DAA over other surgical approaches.[30, 31]

The MPP approach has been the standard in most cases of TKA. Interestingly, none of the respondents preferred minimally invasive surgery (MIS) approaches (e.g., mini-MMP/subvastus/midvastus). Evidence suggests that MIS in TKA might result in a faster functional recovery (and a better early range of motion) but was also associated with wound healing problems and infections.[32]

Although not statistically significant, tourniquet assisted TKA was less common in outpatient pathways compared to inpatient pathways. Evidence suggests that tourniquet assisted TKA does not reduce total blood loss and may impair early postoperative recovery by pain, swelling and compromised quadriceps function. A recent study also showed that use of a tourniquet was associated with higher postoperative pain, and an increased risk of serious adverse events (thromboembolic events, infection and reoperation).[33]

Strong evidence exists on the effectiveness and safety of TXA use in TJA to minimize intraoperative blood loss and transfusion rates.[34] However, significant differences in the regimes (i.e., route of administration) were found between outpatient and inpatient pathways. Studies found that all routes of administration (oral, intra-articular and intravenous) were significantly effective compared to routine hemostasis, and no differences between administration routes were found.[35] A combined administration regimen of TXA methods, however, is supposed to be superior to single administration.[36] The latter was used more often in outpatient hip and knee arthroplasty pathways.

Results showed that outpatient pathways more often included two doses of antibiotics, whereas inpatients pathways more often included 3 doses (24-hours span).

A recent study found that even single dose antibiotic prophylaxis is as effective in reducing the risk of periprosthetic joint infections, suggesting that the reduction of antibiotic doses can be safely done in order to optimize pathway logistics.[37]

4.3 Postoperative characteristics

No significant differences were found between both pathways in terms of opioid use and antithrombotic prophylaxis preference and duration. Interestingly, we found relatively high proportions of standard/scheduled opioids or patient-controlled analgesia in both pathways (relatively more in inpatient than outpatient) and this seems very contradictory to the well-founded opioid-sparing multimodal anesthetic regimen for fast-track and outpatient joint arthroplasty. We advise multidisciplinary teams to address this feature in order to optimize their pathway.[13]

The Dutch national guidelines advised thromboprophylaxis with an LMWH for a period of 4 to 6 weeks after THA and TKA.[38, 39] However, guidelines have been developed based on outdated studies with treatment algorithms different from the fast-track methodology. More recent studies suggested a more patient tailored approach as the incidence of thromboembolic events were substantially lower in a fast-track setting.[40] A recent study even found that "in-hospital only" prophylaxis for patients staying less than 5 days in the hospital was safe.[41] In terms of antithrombotic agent, more recent literature even advocates ASA monotherapy in certain groups of patients.[42-44]

Consensus exists patients should be mobilized as early as possible postoperatively to achieve early discharge.[13, 45] We found that in ~20% of inpatient pathways, mobilization was delayed to the next day if surgery took place later that day. We hypothesize that logistics (e.g., the reduced availability of physical therapists and nurses during after-work hours) and proper titration of anesthesia are main reasons for this delay and is rarely a problem in outpatient pathways because patients will be mainly operated first or second of the day.[6] Also for a well-established inpatient joint arthroplasty pathway we strongly recommend the multidisciplinary team to optimize logistics so that all patients are mobilized by the PT on the day of the operation (also after work hours), regardless of the planned operating time.[13, 45]

Significant differences in postoperative regime for Hb-check were found between outpatient pathways (check only on indication) and inpatient pathways (standard check). Because of the standard use of TXA in present perioperative care, the blood loss and transfusion rates are dramatically reduced. Therefore, patients – that are

often subject to strict selection criteria in OJA – that underwent uncomplicated TJA probably have a negligible risk for transfusion need.

4.4 Strengths and limitations

To the best of our knowledge this is the first study that assessed differences between outpatient and inpatient arthroplasty pathways in detail. The results represent the Dutch practice and therefore limits external validity to countries with different healthcare systems or less experience in TJA pathway innovation. While interpreting the results, one should also take into account that guidelines and consensus statements for perioperative care in THA and TKA may be different internationally. The survey was designed by a multidisciplinary team including high-volume hip and knee orthopaedic surgeons, researchers, physician assistants, and an epidemiologist. A good sample size was achieved, including surgeons who were a member of either the DHS or DKS (focus groups of the Dutch Orthopeadic Association). Although the overall response rate seems low, the literature shows that the response rate was above average as physicians are often a group with a low survey response rate to web-based surveys.[46, 47] Moreover, if we focus at the response rate of our follow-up survey, it is very high at 95%. Yet our results may possess a risk for selection bias in favor of orthopaedic surgeons who have more affinity with clinical pathway optimization for TJA.

5. CONCLUSION

In conclusion, significant differences between current outpatient and standard inpatient pathways for TJA in The Netherlands were found only in the intraoperative (administration regimes of TXA and antibiotic prophylaxis) and postoperative phase (postoperative mobilization regime in THA, duration of thromboembolic prophylaxis in TKA, and the need for postoperative Hb checks). These differences probably relied mainly on logistical grounds to ensure efficient same-day discharge in outpatient pathways. Our findings also suggested that OJA pathway may be underutilized in the Netherlands and informs orthopaedic surgeons and their multidisciplinary team that formulating selection criteria for eligible patients and the logistical optimization of an already successful inpatient pathway may be the key factors for a successful OJA implementation.

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7. APPENDICES

Appendix 1. Survey

Section 1: Demographics

For questions 1–7, please refer to Appendix 1 of Chapter 6.

If your answer to question 7 was 'yes': The upcoming questions all relate to the outpatient pathway for hip/knee arthroplasty as it is currently being used in your healthcare facility.

If your answer to question 7 was 'no': The upcoming questions all relate to the inpatient pathway for hip/knee arthroplasty as it is currently being used in your healthcare facility.

Section 2: Preoperative pathway characteristics

8 What type of (pre-)operative education do you use? (Multiple answers are allowed)
a. Verbal (one-to-one or group meetings)
b. Informative leaflets
c. Videos
d. Decision aids
e. eHealth (e.g., patient journey app)
f. None
g. I don't know
h. Other, namely…

9 Should patients undergo preoperative physical therapy and/or exercise programs (also known as 'prehabilitation')?
a. Yes
b. No

10 Do you use risk stratification aids for preoperative screening? (e.g., ASA classification, Charlson Comorbidity Index, protocollary defined selection criteria)
a. Yes
b. No

11 (If your answer to the previous questions was *'yes'*) Which risk stratification aids do you use? (multiple answers are allowed)
a. Charlson Comorbidity Index (CCI)
b. American Society of Anesthesiologists (ASA) – class
c. Outpatient Arthroplasty Risk Assessment (OARA)
d. Total joint replacement (TJR) risk calculator
e. Readmission Risk Assessment Tool (RRAT)
f. Protocollary defined selection criteria
g. I don't know
h. Other, namely…

Section 3: Intraoperative pathway characteristics

12 What type of anesthesia do you prefer?
a. General
b. Spinal with sedation
c. Spinal
d. No preference
e. Other

13 Do you use peripheral nerve blocks in the multimodal pain protocol for hip arthroplasty? (only hip surgeons)
a. Lumbar plexus block
b. Femoral nerve block
c. Fascia iliaca block
d. Sciatic nerve block
e. No
f. Other, namely…

14 Do you use peripheral nerve blocks in the multimodal pain protocol for knee arthroplasty? (only knee surgeons)
a. Lumbar plexus block
b. Femoral nerve block
c. Obturator nerve block
d. Sciatic nerve block
e. Saphenous nerve (adductor canal) block
f. No
g. Other, namely…

15 Do you use "Local infiltration analgesia" (LIA) with a long-acting anesthetic?
a. Yes
b. No

16 (If your answer to the previous questions was *'yes'*) How is the LIA composed? (multiple answers are allowed)
a. Bupivacaine
b. Ropivacaine
c. Ketorolac (or another NSAID)
d. Epinephrine (adrenaline)
e. Morphine
f. Clonidine
g. Corticosteroids
h. I don't know
i. Other, namely…

17 Which surgical approach do you prefer when performing total hip arthroplasty? (only hip surgeons)
a. Posterolateral
b. Direct anterior
c. Straight lateral
d. Anterolateral
e. Direct superior
f. No preference
g. Other, namely…

18 Which surgical approach do you prefer when performing total knee arthroplasty? (only knee surgeons)
a. Medial parapatellar
b. Lateral parapatellar
c. Midvastus
d. Subvastus
e. Minimally invasive
f. Quadriceps-snip
g. No preference
h. Other, namely…

19 Do you administer tranexamic acid (TXA) to prevent perioperative blood loss?
a. Yes
b. No

20 (If your answer to the previous questions was *'yes'*) When do you administer TXA? (multiple answers are allowed)
a. Preoperative
b. Intraoperative
c. Postoperative
d. I don't know

21 How do you administer TXA? (multiple answers are allowed)
a. Oral
b. Intravenous
c. Postoperative
d. I don't know

22 How many doses of antibiotics (prophylaxis) do you usually give perioperatively?
a. 1 (only preoperative)
b. 2 (1 preoperative dose and 1 postoperative)
c. 3 (1 preoperative dose and 2 postoperative)
d. I don't know
e. Other, namely…

23 Do you use wound drains perioperatively?
a. Yes
b. No

24 Do you use a urinary catheter perioperatively?
a. Yes
b. No

25 Do you use a tourniquet during surgery? (only knee surgeons)
a. Yes
b. No

26 (If your answer to the previous questions was *'yes'*) How do you use a tourniquet in primary total knee arthroplasty?
a. During the entire operation
b. During cementation
c. Other, namely…

Section 4: Postoperative pathway characteristics

27 For inpatients, what is the average length of stay after a primary total hip/knee replacement in your healthcare institution? (in days)
…… days

28 Do you use morphines in the multimodal pain protocol?
a. Only as 'rescue medication'
b. Standard/scheduled morphine
c. Patient controlled analgesia
d. No
e. Other, namely…

29 Do you treat patients postoperatively with thrombosis prophylaxis?
a. Yes
b. No

30 (If your answer to the previous questions was *'yes'*) Which anticoagulant/treatment do you prefer for thrombosis prophylaxis? (multiple answers are allowed)
a. LMWH (dalteparin, enoxaparin, nadroparin)
b. NOAC/DOAC (apixaban, dabigatran, rivaroxaban)
c. Platelet aggregation inhibitor (acetylsalicylic acid)
d. Vitamin K antagonists (acenocoumarol, fenprocoumon)
e. Pentasaccharides (fondaparinux)
f. Mechanic (elastic compression stockings)
g. I don't know
h. Other, namely…

31 For how long do you treat patients with thrombosis prophylaxis?
a. <1 week
b. 1-3 weeks
c. 4-6 weeks
d. >6 weeks
e. I don't know
f. Other, namely…

32 Do patients who are undergoing primary total knee arthroplasty receive a continuous passive motion (CPM) device postoperatively? (only knee surgeons)
a. Yes
b. No

33 Are patients always mobilized postoperatively on the day of surgery (by the physiotherapist or nurse)?
a. Yes
b. Not if the surgery takes place later on the day
c. No, patients are always mobilized the next day
d. I don't know
e. Other, namely…

34 Is the hemoglobin level checked postoperatively?
a. Yes, always
b. Only if indicated
c. No
d. I don't know
e. Other, namely…

35 Do you take an X-ray postoperatively?
a. Yes, the same/next day
b. Yes, at the follow-up in the outpatient clinic
c. Only if indicated
d. No
e. I don't know
f. Other, namely…

PART V

Outpatient joint arthroplasty

The patients' perspective

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CHAPTER 8

PATIENTS' PERCEPTIONS AND EXPERIENCES WITH OUTPATIENT HIP AND KNEE ARTHROPLASTY

A qualitative study

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ABSTRACT

Background

Outpatient joint arthroplasty (OJA) of the hip and knee is becoming increasingly popular within the orthopaedic community. Most evidence regarding the safety and feasibility of OJA has been gathered from the perspectives of surgeons and healthcare organizations. However, the success of these pathways also hinges on patients feeling safe and adequately prepared to return home. This study aimed to explore patients' perspectives, experiences, and challenges during the preoperative phase, the day of surgery, and the postoperative phase of outpatient total hip arthroplasty (THA) or total knee arthroplasty (TKA). Patient satisfaction was also assessed.

Materials and Methods

Twelve patients who underwent outpatient THA or TKA, along with their informal caregivers, participated in face-to-face semi-structured interviews. The transcripts were analyzed using thematic analysis, following the Grounded Theory approach.

Results

OJA was well received by patients, with 33% making a patient-driven decision to undergo the pathway, while the majority supported the idea following their surgeon's recommendation. Key areas for enhancing the patient experience included better preoperative education and expectation management, streamlined pathway logistics, and reassurance through robust intra- and extramural safety nets. Notably, 92% of patients indicated they would choose OJA again over an inpatient procedure if faced with the same decision.

Conclusions

Although patients were generally very satisfied with outpatient THA and TKA, the findings create scope to further refine existing pathways. Additionally, insights from the interviews suggest potential improvements to patient selection criteria to better identify suitable candidates for OJA.

1. INTRODUCTION

1.1 Background

Outpatient total hip arthroplasty (THA) and total knee arthroplasty (TKA) have gained popularity over the last decade. The feasibility and safety of these procedures have been repeatedly demonstrated in both selected and unselected patient populations.[1-3] Key drivers of this growing interest include continuous advancements in perioperative management, the implementation of evidence-based practices, more efficient use of resources amidst a near-unsustainable burden of joint replacements, and the ability to reduce costs within the episode of care.[4, 5] The recent COVID-19 pandemic has further emphasized the trend toward risk stratification and outpatient joint arthroplasty (OJA). Efficient resource utilization, minimizing patient exposure to hospital wards, and reducing the strain on already overburdened inpatient beds became critical, especially as many elective surgeries (e.g., hip and knee arthroplasties) were intermittently halted, leading to dramatically increased waiting lists. In response, more OJA pathways were established in several clinics, enabling optimized hospital capacity management while safely discharging patients on the same day as their surgery.[6, 7]

A recent survey by Keulen et al[8] confirmed the growing interest in OJA among Dutch orthopaedic surgeons. The survey revealed that approximately 20% had already established outpatient hip and/or knee arthroplasty pathways. At the same time, about half of the remaining surgeons expressed interest in implementing such pathways in the future.[8] Furthermore, the survey highlighted that patient demand was one of the primary reasons orthopaedic surgeons adopted OJA. From this perspective, OJA can be described as "patient-driven".

Most available evidence on the safety and feasibility of OJA has been gathered from the perspective of healthcare providers, including orthopaedic surgeons and healthcare organizations. These studies typically evaluate success rates, complications, readmission rates, and cost efficiency.[4, 5] However, a successful discharge also requires patients to feel safe and ready to return home without overburdening their informal caregivers. Orthopaedic surgeons offering OJA should not overlook the principle of "first better than faster",[9] ensuring that patient-reported outcomes and experiences are prioritized to optimize the pathway. To date, however, only a limited number of studies have investigated the patient perspective regarding the implementation of OJA or their experiences with it.[10-16] To the best of our knowledge, this is the first in-depth qualitative study to interview patients and their informal caregivers who have undergone outpatient THA or TKA.

1.2 Aims

We aimed to assess patients' perspectives, experiences, and challenges during the preoperative phase, the day of surgery, and the postoperative phase of outpatient THA or TKA. Additionally, we aimed to evaluate patient satisfaction with outpatient THA or TKA.

2. MATERIALS AND METHODS

This qualitative study was approved by the Medical Ethical Review Committee of Zuyderland and Zuyd University of Applied Sciences (approval number: METCZ20200047). Verbal and written informed consent were obtained from all study participants.

2.1 Inclusion and exclusion criteria

All patients scheduled consecutively for outpatient THA or TKA were invited by a researcher to participate in this study. Inclusion criteria were patients aged 18 years or older, with an indication for elective primary THA or TKA; deemed eligible for OJA (defined as discharge to their own home on the day of surgery) according to the orthopaedic surgeon (eligibility was primarily based on previous research by our group)[17-19]; and fluent and literate in Dutch. Exclusion criteria included dementia or other medical conditions affecting the ability to provide verbal or written consent or reliably participate in the interview, as well as unwillingness to participate. Patients initially enrolled in the outpatient pathway but who failed same-day discharge (SDD) were not excluded from the study.

There was no financial or non-financial incentive for participation in the study. To minimize bias, all healthcare professionals involved in the OJA pathway were unaware of the enrollment period.

The sample size was determined using the principle of data saturation in qualitative research.[20] Recruitment ceased when both researchers (MK and YB) agreed that additional interviews no longer yielded new information or insights.

2.2 Settings and data collection

The study was conducted in the orthopaedic department of a Dutch non-academic teaching hospital where OJA of the hip and knee was introduced in 2013.[17, 18] After obtaining informed consent, patients were invited to participate in a face-to-face, semi-structured interview. Patients were encouraged to bring their informal caregivers to the interview. Interviews were scheduled 7-14 days after surgery to

minimize recall bias. The interviews took place in the orthopaedic outpatient clinic and were conducted by one of two authors (MK or YB) accompanied by a research student. None of the interviewers were directly involved in the treatment of the participants. A topic list (Table 1) was developed prior to the study to guide the interviews. This list was divided into four main categories (preoperative phase, day of surgery, postoperative phase, and satisfaction), with subtopics selected based on expert opinions and researchers' observations of the OJA pathway prior to the start of the study. Open-ended questions were included to provide a general structure for the interviews, and participants received the topic list in advance. Follow-up questions were used during the interview to explore participants' experiences in greater depth.

Table 1. Topic list

Topic	Subtopic	Sample questions
Preoperative phase	Decision making	How was the option of OJA introduced during your preoperative consultation with the orthopaedic surgeon? What motivated your decision to undergo OJA?
	Preoperative expectations	What were your expectations of the OJA pathway? What were your thoughts on the feasibility of same-day discharge after surgery? How did you feel when deciding to undergo OJA? Did you experience any anxiety or fear?
	Education	How did you perceive the information provided to you prior to the OJA? How was the information delivered to you, and did you find it sufficient?
	Past experiences	Have you had previous experience with joint replacement or outpatient surgery? How did this influence your current decision? In what ways did your past experiences with joint replacement or outpatient surgery impact your journey through the OJA process?
Day of surgery	Short hospital stay	How would you describe your experience on the day of surgery?
	Burden	How would you describe the burden of the day of surgery for both you and your caregiver?
	Pathway logistics	Did you encounter any organizational or logistical challenges on the day of surgery?
	Discharge	How prepared and ready did you feel for discharge from the hospital?
	Anxiety/fear	What were your emotions during the day of surgery? Did you experience any anxiety or insecurity during the day or at the time of discharge?

Table 1. Topic list *(continued)*.

Topic	Subtopic	Sample questions
Postoperative phase	Stay at home	How did you experience the first few days after returning home?
	Feelings and emotions	How would you describe your emotions after discharge (e.g., anxiety, fear, distress, uncertainty, loss of sleep)?
	Pain and medication	How would you describe your pain management after discharge? How did you find the adequacy and sufficiency of the medication provided after discharge?
	Safety net	How safe did you feel at home after being discharged from the hospital? Were there any times when your informal caregiver felt uncomfortable with the level of care required? How well were you informed about who to contact and when, in case of an emergency or adverse event? Have you ever needed to use any healthcare resources (other than your informal caregiver) for support after discharge?
	Adverse events	What adverse events, if any, did you experience after surgery?
Satisfaction	Meeting expectations	How did your experience compare to your preoperative expectations?
	Repeat	How likely are you to choose OJA again if it were indicated?
	Recommend	How likely are you to recommend OJA to others? Do you believe OJA is suitable for everyone? If not, what factors do you think are important for someone to be eligible for OJA?
	Tips/advice	What suggestions or advice would you offer to improve the OJA pathway?

OJA = outpatient joint arthroplasty.

2.3 Data analysis

The interviews were tape-recorded and transcribed verbatim using oTranscribe (https://otranscribe.com). Thematic analysis of the transcripts was conducted according to grounded theory principles.[21] Categories ("preoperative phase", "day of surgery", "postoperative phase", and "satisfaction") and subcategories were partly predetermined based on the interview guide, so initial coding was deductive. Inductive coding was also applied, as categories were continuously refined based on the data analysis conducted by both the first author (MK) and the research students.

The final list of codes is presented in Figure 1. Since the interviews were conducted in Dutch, all quotes were translated into English. A structured overview of quotes from all interviews is presented.

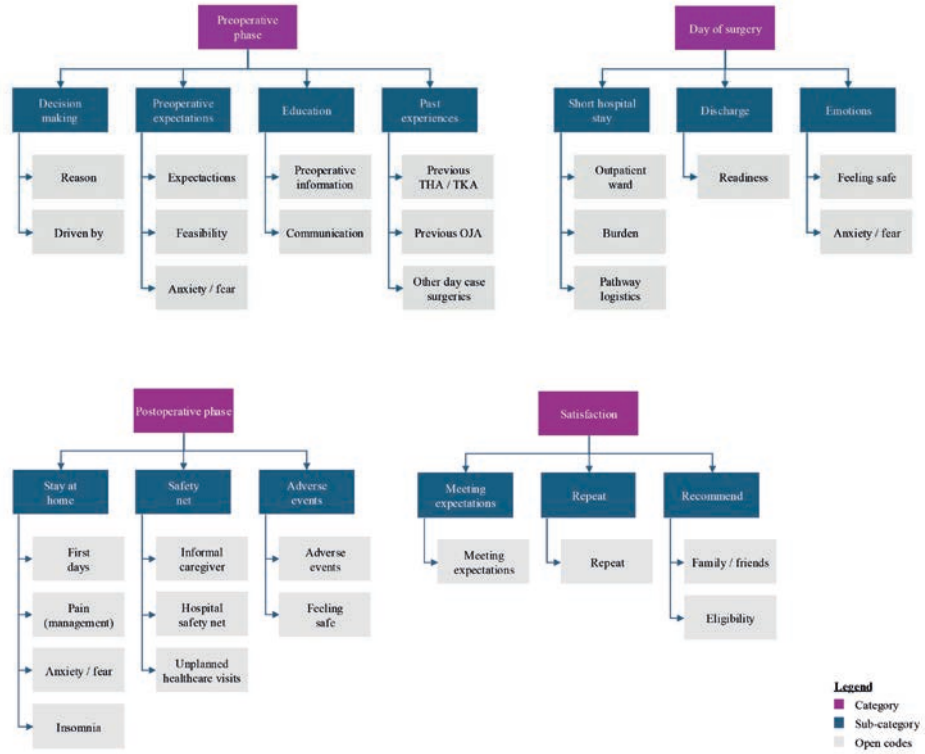

Figure 1. Code tree used for thematic analysis. THA = total hip arthroplasty; TKA = total knee arthroplasty; OJA = outpatient joint arthroplasty.

3. RESULTS

3.1 Demographics

A total of 12 patients and their informal caregivers were interviewed. The mean age of the patient cohort was 65 years (with a standard deviation of 7.5 years, ranging between 54 and 74 years) (Table 2). SDD was successful in 83%.

Table 2. Patient demographics

Patient	Sex	Age (in years)	Type of arthroplasty	Discharge	Highest educational level	Work (previous)
P1	Female	74	THA	SDD	Senior secondary vocational education	Retired (nurse)
P2	Male	71	THA	SDD	Prevocational secondary education (police training)	Retired (policeman)
P3	Male	56	TKA	SDD	Prevocational secondary education	Bus driver
P4	Female	67	THA	Unsuccessful SDD LOS = 1 day	Higher vocational education (secondary teacher education)	Retired (secondary school teacher)
P5	Male	54	THA	SDD	Senior secondary vocational education	Electrical installer
P6	Female	72	THA	SDD	Higher vocational education	Retired (nurse)
P7	Female	70	TKA	SDD	University education	Retired (policy officer)
P8	Female	60	THA	SDD	Higher vocational education	Customer service employee
P9	Male	57	THA	SDD	Prevocational secondary education (police training)	Policeman
P10	Female	60	THA	SDD	Senior secondary vocational education	Personal health care assistant in elderly care
P11	Female	59	TKA	Unsuccessful SDD LOS = 1 day	Senior secondary vocational education	Office worker
P12	Female	74	THA	SDD	Prevocational secondary education	Retired (hospitality worker)

P = patient; THA = total hip arthroplasty; TKA = total knee arthroplasty; SDD = same day discharge; LOS = length of stay.

3.2 Preoperative phase

3.2.1 Decision making

The orthopaedic surgeon recommended undergoing OJA in eight cases based on the appropriate indication. However, most patients and their informal caregivers accepted the idea of SDD. The decision to undergo OJA was specifically requested by four patients, making it "patient-driven". The main reasons for choosing OJA included the surgeon's recommendation, the patient's level of fitness, the presence of a supportive informal caregiver, faster and better rehabilitation at home, the desire for more privacy, and the comfort of being surrounded by personal belongings (Table 3).

Patient 4: "The surgeon suggested it, and I agreed right away. My partner and I are both in good shape. If I had been on my own, I probably would not have done it."

3.2.2 Preoperative expectations

Although 67% of patients had expectations aligned with the OJA pathway as described and just expected to be discharged home on the same day without any issues, some patients had no specific expectations. However, two patients found the idea of SDD ambitious, with one of them even doubting its feasibility at first. Additionally, two patients and two informal caregivers expressed concerns, fearing the unknown and the loss of control (Table 3).

Informal caregiver 2: "At first, I was a bit unsure. I kept thinking, what if something goes wrong the first night after he gets home? Like if he had too much pain or the wound started bleeding. That made me nervous."

Table 3. Patients' and caregivers' statements regarding the preoperative phase

P	Decision making	Preoperative expectations	Education	Past experiences
1	"I just trust the surgeon on his words. I'm a layman, and I have no idea. I'll just go with what he tells me."	"I am not someone who overthinks things. I knew what to expect and felt confident that I could go home the same night as long as there were no complications."	"The surgeon explained everything clearly during the consultation. I also got a bag with some brochures, which I read through. That was enough for me." "The only thing is, I'd never used crutches before. It would've been nice if someone had shown me how to use them beforehand."	"I have had a few day surgeries for other medical reasons before, so I think that helped me know what to expect."
2	"The surgeon mentioned day surgery to me, and I thought it sounded good to be able to go home the same day. After all, the hospital is for people who are really sick."	"I didn't really mind it." "At first, I was a bit unsure. I kept thinking, what if something goes wrong the first night after he gets home? Like if he had too much pain or the wound started bleeding. That made me nervous." (caregiver)	"I got a folder with information. It could always be a bit more detailed, but it was enough for me." "Also, I had already been researching it myself online."	"I have had three day surgeries before, but that did not necessarily help me prepare for this one. I'm just not someone who gets anxious."
3	"I asked for it myself because I wanted to recover quickly, go home, and just do my own thing."	"I was not afraid. I just wanted to have the surgery, recover, and go home once the doctors said it was okay." "I thought it was a good idea too. I was not worried about it." (Caregiver)	"The information before the surgery could have been a bit clearer. I just got a bag with brochures, but I did not really find them helpful."	"I have had surgery before for other things, and each time I just wanted to get home as soon as I could."

Table 3. Patients' and caregivers' statements regarding the preoperative phase (*continued*).

P	Decision making	Preoperative expectations	Education	Past experiences
4	"The surgeon suggested it, and I agreed right away. My partner and I are both in good shape. If I had been on my own, I probably would not have done it."	"I felt fit enough to go home the same day. As long as you have someone to help you at home, I thought it is definitely doable."	"The information from the surgeon was good. I also got a brochure with all the details on rehab and some helpful tips." "I felt well prepared."	"I had surgery once before, but that was a long time ago. No, it was not really similar to this one." "My sister told me about her two hip surgeries, but I guess everyone experiences it differently."
5	"The surgeon suggested it, but that was not an issue for us. We trust the surgeon's judgment."	"At first, I never thought I would be able to go home the same day."	"The surgeon explained the procedure and sketched the rehab process for me. I also got a brochure, but it did not have much info about the day surgery itself." "At first, they even told me I would stay in the hospital for 2 to 3 days."	"Not really."
6	"I asked for it myself. The sooner I am home, the better."	"I knew what to expect since I went through the same procedure on the other side. I didn't see any issues and just assumed I would be able to go home the same day."	"I was satisfied with the information the surgeon gave me."	"Last year, I had the same surgery on my right side and was happy to go home the same day. I think that made this experience easier for us."

Table 3. Patients' and caregivers' statements regarding the preoperative phase (*continued*).

P	Decision making	Preoperative expectations	Education	Past experiences
7	"The surgeon told me that the usual stay was about two days, but same-day discharge was also an option. Personally, I think it is best to stay in the hospital for as little time as possible, as long as the surgeon says it is safe... I prefer being at home where I feel more comfortable and have my privacy, so that's why I chose to go home the same day."	"At first, I was a bit nervous because last time I had to stay in the hospital for 3 days because my wound was leaking." "... on the other hand, it felt great knowing I could go home the same day."	"The surgeon explained everything to me, and I got a brochure with a lot of information. I also did some research online myself. It was reassuring to know that I could stay the night if things didn't go as planned."	"I had surgery on the other side before, so I had an idea of what to expect."
8	"Actually, day surgery sounded logical to the surgeon so another option wasn't really offered to me. He just mentioned that I could go home the same day."	"Day surgery made sense to the surgeon. At first, I was not sure what to expect and felt like I had to figure it out on my own. It was a bit scary."	"I received a brochure with a lot of information, but theory is different from practice. They should have reassured us a bit more."	"I had surgery a couple of times a long time ago, but this was different. Everything was new, and with something new, it's always a bit scary at first. You just don't know what is normal and what is not." "Other people I know had undergone joint replacement in day surgery before, but you know, everyone is different."

Table 3. Patients' and caregivers' statements regarding the preoperative phase (*continued*).

P	Decision making	Preoperative expectations	Education	Past experiences
9	"The surgeon gave me the option to go home the same day." "There's no place like home. I feel more comfortable recovering at home, away from the hospital environment where you are exposed to a lot of external impulses."	"I just hoped the pain would be better. I did not have many other expectations, really. I sort of went into the program without much in mind."	"The information we got was more than enough. If there was something I didn't understand, I would just look it up online. There's so much information out there." "Before the surgery, I made sure to stay as active as possible and ate a healthy diet. I think that really helped with my recovery, and I would recommend it to anyone."	"I had not had surgery before, so I was not sure what to expect."
10	"The surgeon suggested I go home the same day, and I was fine with that. Honestly, I don't like being in the hospital, and I thought I would recover faster at home. Plus, if anything went wrong, I knew I could stay longer if needed."	"I had surgery on the other hip three years ago, so I expected it to be pretty similar. I figured I could handle going home the same day."	"I felt that the information I got before the procedure was not enough. The brochure I received did not have any details about day treatment specifically." "Three years ago, there was a meeting before the surgery where they checked the crutches and showed some exercises. I missed that this time, as I found it really helpful."	"When I had my other hip replaced three years ago, I had to stay in the hospital overnight and went home the next day."

Table 3. Patients' and caregivers' statements regarding the preoperative phase (*continued*).

P	Decision making	Preoperative expectations	Education	Past experiences
11	"The surgeon suggested same-day discharge, and I thought that was normal, so I agreed. If I had been given the choice to stay a few days or go home the same day, I probably still would have chosen to go home because I prefer recovering at home rather than in the hospital."	"Sometimes I think it is a bit ambitious to go home so soon after an operation. But I guess I wasn't the first, and I definitely won't be the last."	"The information I received was great. I didn't feel like I missed anything."	"I have had day surgery before, but for something different. It didn't really help me know what to expect this time."
12	"I agreed to the surgeon's suggestion for day surgery. I am not a fan of being in the hospital, so if I'm feeling okay and things are going well, I would rather go home as soon as possible." "Staying in the hospital will only make you sicker."	"I had no doubts about the program. I just expected that if I felt good, I would be able to go home the same day." "Since I'd had surgery on the other hip before, I knew what to expect."	"The information I received was more than enough. Having gone through the procedure a few years ago, I already knew what to expect."	"After my previous operation, I stayed in the hospital for 6 days. I understand that some people prefer to stay and be pampered in the hospital, but personally, I preferred to go home as soon as I could."

3.2.3 Education

Patients primarily received information through face-to-face communication and informational brochures, with 25% reporting self-research online for additional details. Four patients were not entirely satisfied with the information they received: two felt the information was too impersonal, and three suggested a more detailed explanation of the OJA pathway. Patients agreed that better information provision and practical tips through face-to-face joint school sessions could have alleviated some concerns about the surgery and the outpatient pathway (Table 3).

> *Patient 5: "The surgeon explained the procedure and sketched the rehab process for me. I also got a brochure, but it did not have much info about the day surgery itself."*

3.2.4 Past experiences

Five patients reported a history of contralateral joint replacement, one of whom had previously completed the OJA pathway. According to most patients, this experience helped manage their expectations and reduce preoperative anxiety (Table 3).

> *Patient 6: "Last year, I had the same surgery on my right side and was happy to go home the same day. I think that made this experience easier for us."*

3.3 Day of surgery

3.3.1 Short hospital stay

All patients were generally satisfied with the short hospital stay. Subsequent care was well-coordinated in most cases, and while some found the day long, none felt it was overwhelming. Most patients valued their autonomy in rehabilitation and were pleased with their rapid progress. However, two patients felt they could have been discharged earlier due to extended periods of waiting or inactivity and suggested that physical therapy could be more intensive. Additionally, three patients reported long waiting times (two to three hours) on the ward before surgery, and medication dispensing logistics were inadequate in four cases because of delays at the hospital pharmacy (Table 4).

The two patients admitted to the inpatient ward after unsuccessful SDD reported issues with the quality of handover and internal communication between wards and disciplines. These included being overlooked for meals, miscommunication about medications, and scheduling challenges for postoperative X-rays.

Patient 2: "Because we stayed longer and the nursing staff changed, they almost forgot to take the X-ray. The communication could have been a bit smoother."

Patient 7: "When I had surgery on the other side, rehab with the physical therapist went a lot slower and was more gradual.." "Now, I actually liked the intensity of the day. At least there was something to do, and it felt more suited to my level. Otherwise, you're just lying in the hospital bed all day."

3.3.2 Discharge

All patients successfully discharged on the day of surgery reported feeling safe and ready for discharge. Three patients noted that they felt ready even earlier than planned. Two patients, however, were not deemed medically fit for SDD and required overnight stays - one as a precaution due to 1000 mL intraoperative blood loss and the other because of weakness and numbness that impaired early ambulation (Table 4).

Patient 3: "I felt like I could have gone home two hours earlier than planned, but I had to wait for the last dose of antibiotics. I think I was ready to leave before the schedule allowed it."

3.3.3 Emotions

Eleven patients reported no fear or uncertainty during the day of surgery. However, one patient and one informal caregiver expressed slight uncertainty about the first night at home (Table 4).

Patient 8: "I was a bit worried about the first night and the morning after. I thought it would have been helpful if the hospital staff had provided more guidance and reassurance, like 'this is the best way to do this and that.' In my opinion, that's a downside of day surgery."

Table 4. Patients' and caregivers' statements regarding the day of surgery

P	Short hospital stay	Discharge	Emotions
1	"It was a day that went by smoothly."	"I felt safe and ready to go home."	'I was not scared at all. I have had surgery plenty of times before, and I knew my daughter would be there to help me if I needed anything the first few nights."
2	"You know what's going to happen and that you'll be able to go home at the end of the day." "Because we stayed longer and the nursing staff changed, they almost forgot to take the X-ray. The communication could have been a bit smoother." "I was expecting more practical advice from the physical therapist or nurse to help my husband, especially for things like getting out of bed or going to the bathroom." (Caregiver)	"After the surgery, the numbness lasted for a long time, so I couldn't do much with physical therapy initially. Since I was expected to go home the same day, I would have preferred if I had my strength and feeling back sooner. Now we were just waiting there. ...Eventually however, I was ready for discharge."	"I wasn't afraid or anxious at all. I went into the surgery feeling very confident."
3	"The day of surgery went smoothly overall. My partner just dropped me off and picked me up. The only issue was having to wait a long time at the hospital pharmacy for the discharge medication. I understand it can be busy, but after surgery, the wait feels uncomfortable. Why not prepare the medication in advance and bring it to you on the floor?"	"I felt like I could have gone home two hours earlier than planned, but I had to wait for the last dose of antibiotics. I think I was ready to leave before the schedule allowed it."	"I was relieved to go home. I was not scared at all."

Table 4. Patients' and caregivers' statements regarding the day of surgery *(continued)*.

P	Short hospital stay	Discharge	Emotions
4	"Everything was well organized until the point when I needed to stay overnight." "Even though it was clear I had to stay overnight, I was not logged in the system as an active patient, so I was not included for breakfast, the X-ray was not scheduled for the next day, and getting my discharge medication from the pharmacy did not go smoothly either. That was frustrating."	"The surgeon reassured me that the surgery went well, but I had to stay overnight as a precaution because of some blood loss. I thought this was a good idea. It felt safer to stay in the hospital for a night rather than risk going home and facing any complications that you can't foresee. The next day, I also felt ready to go home." "As a caregiver, I think it's important to consider not just physical fitness, but also stress levels before discharge. It's essential to make sure the patient is mentally ready to handle rehabilitation at home." (Caregiver)	"I felt a healthy dose of tension at the time of discharge."
5	"You can't say anything bad about it. The healthcare professionals were supportive and made me feel confident throughout the day." "The day itself felt calm. I was happy to stay, receive tips and tricks advice, and help guide him throughout the day." (Caregiver)	"It all felt good to go home."	"I wasn't scared at all, even when the physical therapist tried to get me out of bed for the first time and I felt dizzy." "I'm a nurse myself, so I'm used to these situations. I don't get scared easily." (Caregiver)
6	"It all went very smoothly. The whole process felt very professional, and that was reassuring." "That day we realized we were a bit lucky. The surgical schedule was partly blown off because of COVID. Since I had surgery early in the morning and was scheduled to go home the same day, it didn't affect me. It just gives another reason to promote day surgery."	"I 100% agreed with the doctor and physical therapist, and felt ready to go home."	I did not feel overwhelmed or anxious during the day or when it was time to go home." "We're both not the anxious type. Plus, we've both worked in the hospital for a long time." (Caregiver)

Table 4. Patients' and caregivers' statements regarding the day of surgery *(continued)*.

P	Short hospital stay	Discharge	Emotions
7	"When I had surgery on the other side, rehab with the physical therapist went a lot slower and was more gradual..." "Now, I actually liked the intensity of the day. At least there was something to do, and it felt more suited to my level. Otherwise, you're just lying in the hospital bed all day."	"There was a bit of bleeding from the wound, but the nurse took care of it, and after that, I was ready to go home."	"I didn't feel scared at all. I wasn't worried about the wound leaking again either."
8	"I had to be there at 7:15 AM and I didn't go to the OR until 10:00 AM. Why do you have to be there 3 hours in advance? That waiting time could have been shorter." "The day went well overall. I appreciated how active they were with walking and rehab. I just wish they had addressed some of my concerns before the surgery."	"I was in the hospital for about 13 hours, knowing I would be going home. When it was time to leave, I felt good enough and safe to go." "However, if I had been given the choice before the surgery, I probably would have chosen to stay the night."	"I was a bit worried about the first night and the morning after. I thought it would have been helpful if the hospital staff had provided more guidance and reassurance, like this is the best way to do this and that. In my opinion, that's a downside of day surgery."
9	"It was quite a long day. In my opinion, the waiting time from when I arrived at the hospital until the surgery was too long. It could have been shorter since the preparations were minimal." "After surgery, I liked the quick movement and exercises with the physical therapist."	"The doctor, physical therapist and nurse all said I was ready to go home, and I felt the same way."	"I was not scared at all. I was really looking forward to the surgery and getting home afterward."
10	"The first time the physiotherapist gets you moving always feels too soon, but once you start and see that things are going well, you quickly feel more confident."	"I felt ready to go home by 1:00 PM, and the physical therapist agreed. But we had to wait until 4:00 PM for the ward doctor to clear me. It could have been more efficient, but I guess there are things happening behind the scenes we don't know about."	"I wasn't worried at all during my short stay or when it was time to go home."

Table 4. Patients' and caregivers' statements regarding the day of surgery (*continued*).

P	Short hospital stay	Discharge	Emotions
11	"By the end of the day, I still had no feeling or strength in my legs, so I couldn't do therapy and had to stay overnight."	"The next day I was able to go home. If the anesthesia had worn off sooner, I probably could have gone home the same day."	"I was not worried, even though the feeling in my legs did not come back at first. I knew I was in good hands."
12	"Therapy in the hospital was too limited. They just walked with me down the hallway and up the stairs, and then I went back to my room…" "The whole day felt too long. I was already trying to figure out for myself when I could go home."	"I felt comfortable going home."	"If I did not feel comfortable going home, I would have told the doctor that I was worried. But I was not."

3.4 Postoperative phase

3.4.1 Stay at home

Most patients found their pain levels acceptable, recognizing it as a normal response to surgery. However, two patients reported significant pain during the first few postoperative days. All 12 patients stated that the prescribed pain medication was sufficient or more than adequate. In addition to regular paracetamol (1000 mg, four times daily) and meloxicam (15 mg, once daily), eight patients required rescue medication (OxyNorm® Instant 5 mg) at some point at home. Three patients (25%) experienced insomnia and suggested the temporary addition of benzodiazepines to the postoperative medication regimen. Only one patient reported mild anxiety related to postoperative swelling in the leg, which resolved without intervention (Table 5)

Patient 11: "Every day I noticed some progress in my recovery, so everything went well. We were also able to manage the pain on our own with the medication provided."

3.4.2 Safety net

All interviewed patients had an informal caregiver at home, and seven explicitly emphasized that having an informal caregiver is essential for successful OJA. Only one informal caregiver experienced a moment of discomfort due to the patient's pain level. Eleven patients (92%) expressed satisfaction with the safety net provided by the hospital. Two patients (17%) required unplanned healthcare visits - one to the family doctor and one to the emergency department - and two patients (17%) contacted the outpatient clinic with questions (Table 5).

Informal caregiver 2: "The first night he was in a lot of pain and did not sleep well. All I could do was give him the painkillers, but I'm not a nurse, so I felt a bit helpless."

Informal caregiver 4: "As a caregiver, you spend most of the day taking care of him. We were wondering, how do people who live alone do all this?"

3.4.3 Adverse events

Four patients reported minor adverse events, including superficial wound infection, nonspecific knee pain following THA, headache and nausea, and postoperative fever of unknown origin. Patients who experienced these events while at home sought care for treatment or reassurance. However, they did not feel that staying in the hospital would have provided a significant advantage in managing these issues (Table 5).

Patient 6: "Luckily, everything went well. That's really the only thing you might feel anxious about."

3.4 Satisfaction

3.4.1 Meeting expectations

Patients' experiences aligned with their expectations in 42% of cases. Three other patients (25%) were pleasantly surprised by how quickly they recovered, noting that the process was smoother than anticipated. Similarly, three others, initially hesitant about the feasibility - perceiving SDD as too ambitious or feeling anxious about it - were ultimately satisfied and positively surprised with the result. However, one patient expressed mild disappointment, stating they had underestimated the intensity of the OJA experience (Table 6).

Patient 10: "It was harder than I expected. I thought I could handle it easily, but maybe I underestimated it. I should have prepared myself better and read more about it."

3.4.2 Repeat

The majority of patients (92%) indicated that they would prefer SDD over an inpatient procedure if they had to undergo THA or TKA again (Table 6).

Patient 9: "I would do it again. The less time spent in hospital, the better!"

3.4.3 Recommend

All 12 patients stated that they would recommend OJA of the hip or knee to family, friends, and relatives. However, they emphasized that eligibility for OJA depends on individual circumstances. Patients highlighted intrinsic motivation, self-reported vitality (regardless of age), and the availability of an informal caregiver as critical factors for a successful outcome (Table 6).

Patient 12: "Everybody is different, but If they are open to it, then I would definitely recommend it."

Table 5. Patients' and caregivers' statements regarding their experience with the postoperative phase

P	Stay at home	Safety net	Adverse events
1	"The first couple of days, I couldn't do much because of the pain, but the medication helped. I wasn't worried because I knew it was surgery related pain."	"The physiotherapist visited me at home to instruct me and was able to answer my questions. If something unexpected had happened, I probably would have called my GP. Plus, I had an emergency number from the hospital just in case."	"Nothing unexpected really happened. I did have some swelling in my leg, but the physiotherapist assured me that it was normal after this kind of surgery."
2	"The only thing I might have done differently if I had stayed in the hospital is ask the doctor for a sleeping pill. I always struggle to sleep on my back." "I feel like it might have been better if he had stayed in the hospital overnight. The nurses could probably have managed his pain complaints better." (Caregiver)	"I felt like we had a safety net because the nurses gave us clear instructions, phone numbers, and told us when to call if needed." "The first night he was in a lot of pain and did not sleep well. All I could do was give him the painkillers, but I'm not a nurse, so I felt a bit helpless." (Caregiver)	"Other than the pain in the first few days, everything went as expected."
3	"I didn't sleep the first night, but I also didn't take any painkillers. The second night, I took Oxycodone and slept like a baby. It's still surgery, so I guess some pain is normal. Other than that, the recovery went smoothly, and I was not worried."	"For the small wounds on my leg I went to the family doctor, because the physical therapist advised me to do so. I felt no need to contact the hospital and the family doctor is only 100 meters away from where I live. I knew, however, that I could contact the orthopaedic department in case of emergencies."	"The two small wounds on my lower leg got infected, so my family doctor prescribed antibiotics."

Table 5. Patients' and caregivers' statements regarding their experience with the postoperative phase (*continued*).

P	Stay at home	Safety net	Adverse events
4	"Everything went well, I only had mild pain, and I was able to walk with crutches fine. I did have some swelling in my leg. Then I started to question everything: Is this normal? Should I rest more? Or should I be doing more exercises? It would've been nice to have some reassurance or tips from a professional." "I was glad I had someone to help me at home. I must admit, I felt a little emotional at times, wondering if everything would turn out fine, since the rehab process is long. It was comforting to share that with my partner and go through it together."	"We didn't feel left in the dark at all. We even called the orthopaedic department a few days after surgery with a question about the wound, and they were able to reassure us right away." "As a caregiver, you spend most of the day taking care of him. We were wondering, how do people who live alone do all this?" (Caregiver)	"No."
5	"I had some swelling after surgery, but I knew that was normal. Each day it got a little better."	"I felt like I could always call or go to the hospital if there was an emergency."	"We had no problems. It all felt very good."
6	"We were able to manage everything on our own with the tips and medication they gave us at the hospital. I didn't even need the oxycodone."	"We knew who to reach out to if anything went wrong. The hospital also called the next day to check on me, which made me feel more comfortable."	"Luckily, everything went well. That's really the only thing you might feel anxious about."
7	"I did not feel like I needed extra help from the nurses or physical therapists. The pain was manageable, I did my exercises, and I didn't have any other issues like nausea. I think we managed just fine on our own."	"The most important thing was having my partner with me at home. I also knew who to call if something went wrong. A few days later, the department called to check in and see how I was doing. I liked that."	"Everything went fine. There were no problems."

Table 5. Patients' and caregivers' statements regarding their experience with the postoperative phase (*continued*).

P	Stay at home	Safety net	Adverse events
8	"At home, I felt a bit dizzy and nauseous at first, but it only lasted for a day, and I thought that it was probably part of the surgery. The pain was manageable with the medication."	"I didn't like that they hadn't called the day after surgery." "On Sunday, we went to the emergency department. It was really reassuring to know that professional help is available 24/7." (Caregiver)	"Over the weekend, I visited the emergency department because of pain in my knee on the same leg. The orthopaedic surgeon examined me, and the X-rays came back fine. That was reassuring."
9	"We haven't really had any big issues or moments of worry."	"We didn't really miss help from the medical staff in the first few days after surgery. We knew who to contact if anything came up. Besides they called me a couple of days later to check in and see how I was doing."	"None."
10	"The first night went fine, but overall, I had more pain and rehab was harder for me compared to last time. That was a bit disappointing."	"The next day my leg was swollen, and I felt a bit feverish. My daughter called the outpatient clinic, and they said they would discuss it with the doctor and call me back, but I never received that call."	"Other than my leg being swollen, I didn't have any issues. After resting, it felt better the next day, which was reassuring."

Table 5. Patients' and caregivers' statements regarding their experience with the postoperative phase *(continued)*.

P	Stay at home	Safety net	Adverse events
11	"Every day I noticed some progress in my recovery, so everything went well. We were also able to manage the pain on our own with the medication provided."	"I couldn't have done it without my caregiver. Especially the first couple of days after surgery" "We felt safe at home and knew who to contact if anything went wrong. Plus, the physical therapist came by, checked everything, and gave us exercises. It was reassuring because they have a good sense of what is normal and what's not." "I took care leave from work. But seeing how she improves every day, I think she'll manage just fine when I go back." (Caregiver)	"No, it went really well."
12	"The day of surgery went fine, but the next day at home, the pain really kicked in." "I would have appreciated it if they had given me something to help me sleep. Not being able to sleep makes it even harder to deal with everything." "The pain was manageable on my own, and I don't think staying in the hospital would have added any benefit."	"You definitely need a caregiver to help with daily activities and personal care for the first few days after surgery." "If there had been an emergency, I would have called the emergency department." "I felt confident enough to assist her." (Caregiver)	"Not really, but since the surgery, I have had some nausea and headaches. I guess this is pretty common after such a major surgery."

Table 6. Patients' and caregivers' statements regarding their overall satisfaction with the pathway

P	Meeting expectations	Repeat	Recommend
1	"I knew what to expect, so yeah! You just need to stay positive and go with the flow."	"I would prefer day surgery again for a next time. I like to be home and do whatever and whenever I want. I love the privacy."	"Absolutely!"
2	"For me, everything went as I expected. It was also helpful that I had discussed the process with my physiotherapist beforehand."	"I would not want it any other way. If the other hip needs surgery, I'd choose the same surgeon and go for day surgery again." "Even though I had some worries at first, I'd definitely recommend day surgery again next time." (Caregiver)	"No one believed I had surgery in the morning and was able to go home the same day. I would recommend the same to anyone." "Yesterday, we had a friend visiting from Germany, and she couldn't believe it. She said in Germany, patients would stay in the hospital for 1-2 weeks." (Caregiver)
3	"I recovered faster than I thought I would."	"Yes, I would definitely choose day surgery again if needed."	"Yes, I would definitely recommend it to others." "I can understand if someone needs to stay longer, especially if they are older or do not have someone to help at home."
4	"If the surgeon had not told me about the excessive blood loss during surgery, I probably would have gone home the same day."	"Yes, I would do it again, but only if the surgeon thinks it is a good option."	"Yes, but only if the patient has a caregiver at home who is fit enough to help."
5	"Before surgery, I never thought I'd be able to go home the same day, but everything went well, and I could see the progress each day. In the end, going home was the best option for us." "We could say it actually went better than expected." (Caregiver)	"I would do day surgery straight again." "Yes, now we know the procedure and what to expect."	"Yes, I would definitely recommend it to others and suggest they follow the surgeon's advice."

Table 6. Patients' and caregivers' statements regarding their overall satisfaction with the pathway *(continued)*.

P	Meeting expectations	Repeat	Recommend
6	"It went exactly as we had imagined it before surgery. It was very similar to last year when I had surgery, but this time it felt a bit smoother and easier."	"I already did it again and I wouldn't have it any other way."	"I'm going to recommend day surgery to everyone, but I think it's important that people are motivated to participate in such a program. Besides, having a caregiver at home is crucial. If you are all alone, it's a whole different story."
7	"I'm actually more positive about it now than I thought I would."	"I've already had both of my knees replaced, but if I ever need a hip replacement or something similar, and going home the same day is an option, I would definitely go for it."	"I would recommend it to others, but it really depends on the person. They should be in good shape, motivated, and have someone available at home to help them."
8	"In the end, the day treatment went really well and was not as bad as I thought. But, of course, anything unknown can be a little scary at first. I think I just needed to experience it myself."	"If my caregiver and I are still fit, I would prefer day surgery. Now I know all the ins and outs."	"I wouldn't strongly recommend it to someone, but I would share my experience and give my opinion. Ultimately, it's up to them to decide what is best for them."
9	"As I mentioned earlier, I didn't have any specific expectations, but I was really happy with how everything turned out."	"We don't see any downsides to same-day discharge." "I would do it again. The less time spent in hospital, the better!"	"Yes, I would recommend it to everyone, but I think they need to be healthy, motivated, and resilient."
10	"It was harder than I expected. I thought I could handle it easily, but maybe I underestimated it. I should have prepared myself better and read more about it."	"If I had to choose again, I'd probably stay overnight. I think I overthink to much, and maybe staying longer would help me find my internal peace and recover more smoothly."	"It really depends on the person, but in general, I would recommend it to family or friends who I think are capable of handling it."
11	"Even though I had to stay in the hospital, I was really satisfied with the treatment." "At first, I thought the idea of going home the same day seemed a bit ambitious, but in the end, I wasn't disappointed."	"Now that I know what to expect. Everything is going really well, and based on that, I would definitely choose it again."	"Yes, yes, yes!"
12	"Everything went as expected, and there were no complications." "I always try to stay positive and don't worry about tomorrow, because it will bring its own challenges."	"In case I need another hip operation, it will be a day treatment again as far as I'm concerned." "Even if I were 80 and felt like I do now, I would still prefer to go home the same day. Age is just a number."	"Everybody is different, but If they are open to it, then I would definitely recommend it."

4. DISCUSSION

OJA represents a natural evolution in joint replacement pathways, primarily driven by clinical and economic considerations. Until now, most efforts have focused on optimizing the perioperative phase from the healthcare provider's perspective to achieve favorable outcomes.[2-5] However, while patients play a central and active role in the entire process and stand to benefit the most from such optimized pathways ("first better than faster"), their perspectives as care recipients remain underexplored. With the successful reduction of length of stay (LOS) to SDD, a significant portion of care shifts from intramural (the hospital) to extramural (home). This shift highlights the importance of identifying common challenges patients and their informal caregivers face - from the preoperative consultation and preparation to the (non-) medical issues that may arise in the first postoperative days at home.

4.1 Preoperative phase

We found that 67% of patients' preoperative expectations were met with the OJA pathway described, and only 58% were satisfied with the information they received preoperatively. These findings suggest a gap in patient education and expectation management, which in some cases may have contributed to preoperative fear of losing control and hesitation about the feasibility of SDD. The discontinuation of preoperative joint classes during the course of this study due to the COVID-19 pandemic may be one possible explanation for this gap. To improve the current pathway, patients suggested adding specific informational materials (e.g., brochures) that outline the OJA pathway, including the benefits and risks of SDD, their role in a successful outpatient experience, discharge criteria, and the availability of an in-hospital backup plan in case SDD is unsuccessful. A recent study by Tolk et al[22] emphasized the importance of enhanced preoperative patient education, concluding that it can help modify patient expectations, leading to higher postoperative fulfillment of expectations and greater satisfaction. In our study, postoperative fulfillment of expectations occurred in about half of the patients, while most others were positively surprised by the outcome of OJA.

Interestingly, we found that for patients who preoperatively reported fear or had mismatched expectations, the decision to undergo OJA was predominantly recommended by the surgeon ("surgeon-driven"). This highlights the importance of recognizing that OJA may not suit everyone. In an online crowdsourcing survey, the majority of the public preferred inpatient TJA, with only a minority expecting to be discharged home the same day.[23] A study by Adelani and Barrack[10] revealed that approximately 70% of patients did not believe they could undergo TKA as an

outpatient, a finding also supported by Meneghini and Ziemba-Davis[11], who showed that in an unselected patient population, only 34% felt comfortable with the idea of SDD after THA or TKA. In line with these studies, our patients indicated that intrinsic motivation was a critical factor for success in addition to overall good health and a supportive home environment (Table 3). In addition to existing selection criteria,[19] surgeons should consider these factors when consulting with patients. We recommend shared decision-making to optimize patient autonomy and ensure the best possible outcomes.

4.2 Day of surgery

Although the day of surgery can often be perceived as "timed and intense for patients" by healthcare professionals, our results showed that patients viewed it as "a long day, but easy to handle." Patients were generally satisfied with the day of surgery. Despite the relatively short stay, many chose to shorten it further due to long waiting times before and after surgery, which they deemed "unnecessary." This again underscores the idea that outpatient surgery and reduced LOS can be "patient-driven". Equally important, we found no discrepancy between patients and healthcare professionals' perceptions of safety and readiness for discharge from the hospital.[24] However, one patient and their informal caregiver expressed some fear, felt helpless, or lacked guidance during the first days at home. Interestingly, this patient had initially hesitated to undergo OJA, and the decision was largely "surgeon-driven". With OJA, the time patients spend with healthcare professionals postoperatively is shortened, which means that patients and their informal caregivers assume more autonomy and responsibility during rehabilitation. This includes managing pain and other postoperative discomforts, as well as coping with setbacks. To better select ideal candidates for OJA, we believe it may be beneficial to expand the selection criteria to include factors such as self-efficacy, resiliency, effective coping strategies, and mental well-being.[25-27]

Our findings also emphasize the need for continuous improvement in pathway logistics to reduce patient burden and enhance their experience.[9, 28] Patients suggested several improvements to our pathway, including better handover communication between outpatient and inpatient nursing wards and reducing unnecessary waiting times both before and after surgery. Suggestions included reducing waiting between physical therapy sessions, taking postoperative X-rays in the post-anesthesia care unit, and dispensing discharge medications directly on the ward (Table 4).

4.3 Postoperative phase

The shift from intramural to extramural care can evoke concerns among both patients and healthcare professionals regarding the safety of mobilization, pain management at home, and potential complications.[10, 11, 14, 23, 27, 28] This underscores the importance of a robust intramural safety net, ensuring that patients can be admitted to the nursing ward if necessary, as well as an effective extramural safety net, where all parties involved (e.g., emergency department, general practitioners, and district nurses) are well-informed about possible complications.[9]

Our findings also highlight the critical role of the social safety net, with the informal caregiver (coach) serving as an essential link throughout the entire pathway. Most patients reported a normal postoperative course, consistent with the recovery patterns described for THA by Klapwijk et al[29] and TKA by Van Egmond et al[30], and anxiety did not play a major role. This aligns with findings of Hoorntje et al[26] that OJA does not negatively affect outcomes related to anxiety, depression, satisfaction, or pain levels.

Interestingly, some patients even believed their recovery was faster in their home environment compared to the hospital, a sentiment consistent with Adelani and Barrack's[10] findings. Four patients experienced adverse events and sought care. The frequency of unplanned healthcare episodes was comparable to those reported in the literature.[1, 2, 13] Of these, only one was considered a complication (superficial wound infection), while the others were primarily related to anxiety over self-limiting postoperative symptoms. Since patients reported that they would not have been better off in the hospital during these events, these results underscore the safety of OJA from the patients' perspective (Table 5).

4.4 Satisfaction

Overall, patient satisfaction was very high, with more than 92% of patients stating they would prefer OJA if the contralateral limb required THA or TKA and 100% indicating they would recommend OJA to family and friends. These findings align with other studies that also report high satisfaction rates with OJA, which may even surpass inpatient pathways in terms of patient satisfaction. OJA may enhance the patient experience by providing dedicated postoperative support, reducing postoperative inconveniences, optimizing pain management, allowing patients to return home sooner, and facilitating faster functional recovery (Table 6).[12-16]

4.5 Strengths and limitations

This study's results should be interpreted considering its strengths and limitations. While existing literature emphasizes favorable patient experiences with OJA,[12-16] this study is the first to conduct in-depth qualitative interviews shortly after patients underwent outpatient THA or TKA. Unlike prior research, which often focuses exclusively on successful cases,[12, 14] our study also included patients (and their informal caregivers) for whom planned SDD was unsuccessful, providing a more representative population. However, as interviews were conducted one to two weeks post-surgery, there is a potential risk of recall bias, particularly concerning preoperative sentiments.

The distribution of patients undergoing THA and TKA presents a potential limitation, as we recognize the inherent differences in recovery between these procedures.[29, 30] Nevertheless, we found no significant differences in patients' perspectives and experiences across both pathways, enabling data saturation and supporting our ability to answer the primary research question. Additionally, the study sample size aligns with norms for qualitative research of this type.

Our study found success rates for SDD comparable to those reported in the literature,[2, 3, 17] and the study population displayed good diversity in patient characteristics. However, this study was conducted within the orthopaedic department of a large non-academic teaching hospital with significant experience in OJA and pathway optimization, which may limit external validity. This setting differs substantially from many ambulatory surgical centers, where the threshold for inpatient admission may be higher.

5. CONCLUSIONS

From the patients' perspective, outpatient THA and TKA were generally well accepted. However, the decision to undergo the OJA pathway should be mutual between the caregiver and care receiver, as OJA may not be suitable for everyone. While patients reported high satisfaction with OJA in a well-established pathway, their feedback highlights the ongoing need to refine the pathway to ensure both high-quality and patient-centered care. Key areas that could improve the patient experience include strengthening preoperative education and expectation management, providing reassurance through the availability of both intramural and extramural safety nets, and reducing patient burden by streamlining pathway logistics.

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PART VI

General discussion, impact paragraph and summary

CHAPTER 9

GENERAL DISCUSSION

1. OUTPATIENT JOINT ARTHROPLASTY

The perioperative care of patients undergoing total joint arthroplasty (TJA) of the hip and knee is continuously being optimized in care pathways (CPs), driven by the ERAS principles outlined by Kehlet (see Section 3 of the general introduction of this thesis).[1-4] These advances in perioperative care processes and operative technique allowed us to suppress the surgical stress response, and effectively manage pain and other comorbidities.[2, 5, 6] In combination with improved logistics and efficient resource allocation this resulted in accelerated recovery, improved patient reported outcomes and patient safety (reducing the number of complications).[7-10] As a welcome side benefit of this accelerated recovery and better functional outcome, over time we have been able to successfully discharge patients even faster and faster following total hip- (THA) and total knee arthroplasty (TKA).[11-13] Over the past decades, this gradual decrease in length of stay (LOS) led to the introduction of fast-track arthroplasty,[9-12] and later (in the early 2000's) even outpatient joint arthroplasty (OJA) pathways, allowing same-day discharge (SDD) with an average time to discharge between 4 and 8 hours, emerged in the USA.[14-16] These OJA pathways have been proven feasible in these high-volume, experienced orthopaedic surgical centers and have been gaining popularity worldwide ever since.

As with any new development in healthcare (e.g., OJA), it is of great importance that its implementation is evidence-based. In this chapter, the implementation of hip and knee OJA will be discussed from multiple perspectives, substantiated with the study results presented in the previous chapters.

2. PERSPECTIVE OF HEALTHCARE INSTITUTIONS AND PROVIDERS

The healthcare perspective on OJA of the hip and knee is pivotal as it shapes the implementation and sustainability of this evolving approach to joint arthroplasty. The transition from traditional inpatient to outpatient pathways is typically guided by considerations of efficacy, safety, and cost-effectiveness, focusing on factors such as success rates, clinical outcomes (functioning and quality of life [QoL]), complications, readmissions, and reoperation rates, and costs.

2.1 Key findings addressing the research questions

Returning to the research questions posed in section 5.1.3 of the general introduction, this thesis found that outpatient pathways for hip and knee arthroplasty were as safe and effective as traditional inpatient pathways in appropriately selected populations,

yielding comparable rates of (serious) adverse events, readmissions, and patient-reported outcome measures (PROMs), while reducing overall costs. Although not all patients enrolled in an OJA pathway were successfully discharged on the day of surgery, reported same-day discharge (SDD) rates in the literature were generally high, averaging 92% (range: 61–100%). In our own cohort study, 79% of patients were successfully discharged on the same day, with the most common barriers to SDD being common undesirable sequalae of the surgical stress response (e.g. pain, nausea, orthostatic hypotension, wound discharge), transient neurological symptoms impairing early ambulation, and patient anxiety. Females, ASA III patients, and those undergoing TKA were at higher risk of unsuccessful SDD. Within the same cohort, the overall 90-day complication rate was 15%, with a readmission rate of 4.2%. The most frequent causes of complications and readmissions were non-infected wound discharge and pain, while no major medical emergencies – such as cardiopulmonary events, venous thromboembolism, stroke, or renal failure – were observed, highlighting the safety of OJA in appropriately selected patients. Patients undergoing TKA, as well as those classified as ASA III or Charnley C, had a higher risk of complications. These findings will be further discussed in the following paragraphs.

2.2 Efficacy and safety

2.2.1 Success rates

Similar to the systematic review presented in chapter 2 of this thesis, several other systematic reviews have demonstrated overall high OJA success rates – defined as successful discharge as planned – of outpatient THA, TKA, and unicompartmental knee arthroplasty (UKA). Success rates across the reviewed studies varied, ranging from 61% to 100%.[17, 18] The generalizability, however, may be limited as the body of evidence is largely driven by (retrospective) observational studies on OJA conducted in high-volume surgical centers by highly experienced orthopaedic surgeons, often with carefully selected patient populations and without a comparative inpatient group.[17-20] Although these systematic reviews included a different selection of studies, they revealed that, within the timeframe between studies, only one randomized controlled trial (RCT) had been conducted comparing OJA with the traditional inpatient approach. Interestingly, the rate of successful SDD in this RCT appeared to be on the lower end of the success spectrum, at 76%.[21] More recently however, a second RCT has been published and they reported a slightly higher SDD rate of 86% within the outpatient group.[22] Aside from the 'failures' – defined as patients who were unable to be discharged home on the day of surgery – it's also important to note that both RCTs reported that 16.7%[21] and 8%[22] of inpatients were discharged on the

day of surgery. This suggests there is scope for improvement in the selection process (see Chapter 4 of this thesis).

The finding of imperfect SDD rates among OJA patients also suggests that existing pathways could benefit from further optimization. This should prompt multidisciplinary teams (MDTs) to explore barriers to achieving SDD within their institutional pathways by asking themselves a key question posed by Kehlet: *"Why is the patient still in the hospital today?"*.[2, 3, 23] In our own institutional experience with the outpatient pathway for THA, TKA, and UKA, we observed similar success rates (79%) and barriers to those reported in the literature,[17, 18, 23, 24] as detailed in Chapter 3 of this thesis. Although one of our findings suggested the need to improve the local infiltration anesthesia (LIA) regimen – since it limited early ambulation in TKA patients – other barriers included common undesirable postoperative sequela in the surgical ward as a result of the surgical stress response, such as orthostatic intolerance, postoperative nausea and vomiting and pain.[2, 4, 24, 25] These "often-negative findings" in perioperative recovery, even within what are considered optimized CPs, highlight the need for further research to achieve the ultimate goal of "pain- and risk-free" surgery and to enhance SDD rates following OJA.[4] For example: despite the widespread use of multimodal opioid-sparing approaches for pain management, additional research is necessary for "high-pain responders". In our pathway, there may also be a role for the increased use of peripheral nerve blocks.[26-28]

The lack of guaranteed SDD should also encourage healthcare providers to consider practical aspects when implementing OJA. Institutions with inpatient capabilities should have a backup plan, such as the availability of inpatient beds, while those without inpatient facilities (e.g., ambulatory surgery centers [ASC]) must have emergency medical services and transfer policies in place, such as protocols for transferring patients to a general hospital if discharge criteria are not met.[29, 30] Higher rates of unsuccessful SDD reduce capacity planning efficiency, impacting bed occupancy and surgical wait lists.

2.2.2 Functional recovery

Both THA and TKA are effective in improving functional outcomes by relieving pain and regaining mobility, resulting in a better QoL.[31, 32] One potential concern with OJA is the brief hospital stay, which might affect rehabilitation and subsequently impact postoperative pain and functional outcomes. However, our systematic review in chapter 2 of this thesis showed that improvements in pain and function were similar for both outpatient and inpatient pathways, with follow-up periods ranging from 3 months to 2 years. These findings align with both older and more recent

literature.[17-21, 33, 34] While most functional gains occur within the first few months,[35-37] continued improvement is possible beyond one year. Although the general recovery process after THA and TKA is well understood,[38, 39] the transition to OJA may impact this dynamic and alter the early recovery process, as the critical differences in care occur during the acute postoperative phase. This shift, which effectively reduces the time for patient-healthcare provider interaction, may result in patients receiving less guidance and fewer instructions (see Section 4.1 of the general introduction of this thesis), potentially leading to outcomes that may not be fully captured in standard follow-up intervals of 6 weeks, 3 months, and 1 year.[40]

Two studies found that 16% to 19% of patients reported postoperative pain as a problem or not well-controlled after outpatient THA or TKA.[41, 42] However, it should be recognized that pain is a typical response following major surgery, and neither study included an inpatient control group for comparison. Advancements in recent multimodal approaches may have helped to further reduce these pain levels over time.[43] Although the difference was small (a mean difference of -0.9 on the visual analogue scale) and measured only on the first day of the acute postoperative phase, Goyal et al[21] reported significant higher pain levels in outpatients compared to inpatients, potentially due to noncompliance with pain management protocols or inadequate instructions on medication intake. Conversely, Husted et al[44] found no significant differences in daily postoperative pain levels and morphine use during the first postoperative week between patients discharged on the day of surgery and those who stayed longer. Another study by Gauthier-Kwan et al. using 4-week patient diaries found similar quality of recovery, pain levels, satisfaction with pain control, and comparable short- and long-term functional outcomes for both outpatient and inpatient TKA procedures.[45]

Despite some conflicting evidence, most findings suggest minimal to no difference in functional outcomes between patients undergoing outpatient versus inpatient hip and knee joint arthroplasty.

2.2.3 Complications, unplanned readmissions and reoperation rates

The development of a complication following TJA can often halt or set back the patient's functional recovery, potentially necessitating reoperation to manage the complication and/or readmission to the hospital. Such events have been associated with less favorable outcomes, including (1) failure to meet patient's expectations and nearly double the rate of dissatisfaction[46, 47]; (2) impeded functional recovery and lower self-reported QoL[48-50]; (3) higher comorbidity and mortality[51]; (4) higher healthcare consumption and expenditures, primarily due to extended LOS and the

severity of complications.[52-55] Given the significant burden these issues place on patients, healthcare systems, and society, complications, unplanned readmissions, and reoperation rates are regarded as important indicators of safety and quality of care. Tracking these metrics can also help providers justify the implementation of new developments, such as OJA.

While some have expressed concerns about the safety of hip and knee OJA,[56-58] the systematic review in chapter 2 of this thesis found similar complications and readmission rates for outpatient compared to inpatient hip and knee arthroplasty pathways. This is largely consistent with findings from previously conducted systematic reviews, suggesting OJA is efficacious and safe.[17-20] However, it should be noted that most of the included studies are subject to a high risk of selection bias, feature small sample sizes and are conducted in high-volume centers with significant experience in OJA. This limits the generalizability of the findings to the average arthroplasty population.[59] This is further supported by the fact that most studies, including our own, found the OJA population tended to be younger and healthier (e.g., lower ASA class, fewer comorbidities and lower BMI), which complicates direct comparisons between outpatient and inpatient pathways.[17-20, 60, 61]

To address baseline differences from patient selection, one RCT and several observational studies with matched cohorts were conducted. These studies consistently showed that, among carefully selected patients undergoing outpatient THA, TKA, or UKA, outcomes like complications, readmissions, and reoperations were comparable to – or even better than – those of matched inpatients.[21, 62-76] A more recent RCT by Zomar et al[22], comparing 49 patients discharged the same day with 56 patients who stayed at least overnight, confirmed that complication rates were lower for outpatient hip arthroplasty (6% versus 12%). Burnett et al[77] recently also demonstrated a decline in complication rates over time, suggesting ongoing improvements in perioperative protocols and the quality of OJA pathways.

2.2.3.1 Timing of severe complications

Although there is some conflicting evidence in the literature,[78, 79] much of the reluctance toward early hospital discharge after joint replacement stems from Parvizi et al's[79] study in 2007, which highlighted that most serious complications requiring intervention – such as cardiopulmonary issues, venous thromboembolisms, stroke, renal failure – occurred within the first four days post-surgery, while patients were still hospitalized. However, these complications were predominantly seen in frail patients (i.e., elderly, severe obese, with a high ASA score) which is not representative of the typical OJA population as described above. Besides, the adoption of ERAS

protocols and advancements in perioperative care have significantly reduced the incidence of these serious complications over time, rendering these earlier findings less relevant.[3, 4, 7, 9, 10, 80, 81] As described in chapter 5 of this thesis, we found that in a strictly selected population undergoing OJA, a large proportion of complications also tended to occur in the early postoperative period. However, these were mostly minor (e.g., wound discharge, postoperative urinary retention or pain), with no major medical complications like those previously reported. Moreover, observed medical complications requiring intervention or posing life-threatening risks (Dindo-Clavien classification of 3 or higher) were not necessarily related to the surgery and surgical stress response but just happened to occur within the 90-days follow-up period. The safety of OJA was further supported by a recent study by Reddy et al[82], which did not identify differences in the risk of severe adverse events or mortality with the conventional inpatient pathway.

2.2.4 Unplanned episodes of care

Shortening the time patients spend in the hospital under healthcare professionals' supervision could impair their ability to manage common issues in the acute postoperative phase. This could be due to lack of instructions or heightened anxiety and insecurity about self-care (see Section 4.1 of the general introduction of this thesis). Consequently, patients may require more unplanned healthcare visits – defined as any contact with health services that was not part of the routine follow-up protocol – such as trips or calls to the emergency department, outpatient office, or primary care.[18] Although these episodes may not necessarily be recorded as complications and may not result in readmissions, they still strain the healthcare system. While many authors have used unplanned healthcare visits as standalone outcome measure, in Chapter 5 of this thesis, we took a different approach. All unplanned visits (e.g., those due to pain or wound discharge) were defined as failures of the OJA pathway and, therefore, as complications. This complicates direct comparison with existing literature and may explain why we observed higher overall complication rates.

Hoffmann et al[17] reported a mean rate of unplanned healthcare visits as low as 1.15% in their systematic review, though this was likely skewed by selection bias, with many studies from a single, highly experienced institution.[14-16] Another review found unplanned visit rates within 90 days ranging from 0.9% to 11.4%,[18] with no significant difference between outpatients and inpatients.[56, 64, 65, 83-86] Similarly, more recent studies have shown no increase in unplanned visits, and suggested that most unplanned visits were for minor issues not requiring intervention, supporting the feasibility of transitioning to the OJA pathway.[22, 43, 45, 72]

An important feature of the OJA pathway, however, is the frequent assessment of patients through phone calls from the physician's office during the early postoperative period. This helps ensure patient safety and addresses any questions they may have, potentially reducing unnecessary, unplanned healthcare visits. Nevertheless, postoperative care following OJA places a substantial resource burden on the physician's office rather than the inpatient staff.[86, 87] Shah et al[87] reported an average of 2.5 calls per patient, with two-thirds being outgoing calls and averaging 4.74 minutes in duration.

2.3 Cost-effectiveness

Both THA and TKA significantly improve patient's QoL, reduce pain, and enhance mobility, but they are also among the most costly surgical procedures, placing a significant financial burden on healthcare systems.[88] Despite this, the current literature supports its cost-effectiveness, as the cost per quality-adjusted life year (QALY) gained from both THA and TKA typically falls below the accepted threshold levels.[89-92] However, it is important to note that these thresholds can vary by country and depend on the severity and burden of the disease.[93] In the Netherlands, for example, the cost-effectiveness threshold typically ranges from €20,000 to €80,000 per QALY.[94]

Over the years, a steady increase in average hospital costs for TJA has been observed, driven by a complex interplay of factors such as general inflation, the growing complexity of care related to aging and comorbidities, advancements in perioperative care, including more expensive implants, and rising labor costs. However, as demonstrated by Molloy et al[95], this trend has been partially offset by a concurrent reduction in LOS, which led to approximately 20% less cost increase from 2002 to 2013. The implementation of ERAS likely contributed to this cost reduction. While the exact savings vary across studies, ERAS in joint arthroplasty has consistently proven to be both clinically superior and cost-effective compared to traditional pathways.[96-100] However, with the shortened LOS, concerns have arisen about shifting the cost of care onto patients, highlighting the need to consider the societal perspective.[18] A Dutch cohort study with cost-effectiveness analysis from a societal perspective found that ERAS pathways also led to significant cost savings for THA (11% cost reduction: net US$1,261) and TKA (26% reduction: net US$3,336), mainly due to shorter hospital stays.[99] This study concluded that ERAS pathways could potentially save around $36 million annually in the Netherlands. Similarly, Larsen et al[100, 101] conducted a RCT and found that ERAS not only improved QALYs and functioning but also resulted in average cost savings of approximately $4,000 per patient.[100, 101]

As OJA has been proven efficacious and safe with similar or better outcomes than contemporary inpatient pathways in a selected population at high-volume TJA centers, it is expected that implementing these pathways will further reduce costs due to shorter LOS.[60, 95, 102] The systematic review in Chapter 2 of this thesis confirmed this hypothesis, showing a mean cost reduction of US$6,797 compared to inpatient pathways, which was consistent with 18% to 58% cost savings for outpatient versus inpatient hip and knee arthroplasty as described in the literature.[61, 103, 104] Significant savings on inpatient costs can be attributed to reductions in expenses related to surgical floor care, nursing and allied care (such as physical and occupational therapy) on the ward, as well as inpatient meals and pharmacy costs.[104] More recently, Zomar et al[22] conducted a preliminary cost-effectiveness analysis as part of a larger RCT comparing outpatient THA to standard overnight stays. Their findings demonstrated significant cost savings from both a healthcare payer perspective (approximately US$750) and a societal perspective (around US$1,250), with total savings increasing to about US$2,000 when all indirect costs were considered. While these savings are lower than those reported by Crawford et al[103], comparison may be limited as difference may be due to several factors, including country-specific costs (e.g., inpatient stays cost around US$30,000 in the USA while a 'fast-track' 2-day stay in Denmark was calculated at around US$2,500),[98, 105, 106] different healthcare systems with variable access to care and reimbursement by third party payers (leading to differences in cost incurred by the patients), the analytical perspective (healthcare versus societal), types of costs considered (direct versus indirect), differences in groups (such as achieved LOS reduction) and setting (ASCs may benefit from reduced overhead costs compared with general hospitals).[29] Interestingly Husted et al[105] found that the time-driven activity-based costs (estimates of the time needed from staff members to perform an activity and the cost per minute of that staff member) of OJA were similar between in the hospital and ASC setting.

2.4 Limitations and other considerations

Beyond the limited methodological quality of many studies on OJA, other factors should also be considered when evaluating the evidence. Clinical outcomes and the amount of cost minimization show considerable variability across the available literature,[17-20] reflecting differences in several key aspects of the CP and definitions as outlined below.

2.4.1 Definition of outpatient joint arthroplasty

Contemporary literature employs varying definitions for OJA, complicating the interpretation of results and comparisons between studies. Some authors define outpatient as a stay of less than 24 hours,[60, 107] including an overnight stay, while

others define it as SDD.[29, 40, 44, 63] The former should be considered a short hospital stay (fast-track), not true OJA. According to Vehmeyer et al[29], OJA should only refer to patients discharged to their own home on the day of surgery without an overnight stay in any facility. McClatchy et al[108] highlighted the impact of these definitional differences in a systematic review, noting that 44% of reported outpatients from 35 studies were kept overnight for 23-hour observation. This inconsistency in defining outpatient status underscores the importance of carefully selecting studies for systematic reviews to ensure reliable comparisons and conclusions.[20] In chapter 2 of this thesis, these definitions for outpatients were addressed in a systematic review, enabling the data to be pooled for meta-analysis with distinct subgroups (true outpatient versus semi-outpatient).

2.4.2 Databases

Many authors use registry databases (e.g., the American College of Surgeons - National Surgical Quality Improvement Program [ASC-NSQIP], and the Medicare claims database in the USA) to compare outcomes between outpatient and inpatient joint arthroplasty. However, these databases appear to have no good discriminatory power for defining outpatient status. Bovonratwet et al[109] found that only 11–12% of patients labeled as outpatients in the ASC-NSQIP were actually discharged on the day of surgery, as U.S. regulations allow these patients to stay more than one night in the hospital under observation status. Similarly, Gordon et al[110] reported that the outpatient status in Medicare databases was misleading, with more than half of the cases not correlating with SDD, and 22% of patients having LOS of two or more days. Studies using NSQIP and Medicare data often rely on two variables to indicate OJA: (1) the "outpatient status" variable and (2) the "LOS = 0 days" variable. The latter is more accurate and aligns more closely with the true definition of OJA.[61] Another limitation of these databases when interpreting OJA outcomes is the potential for sample heterogeneity, as variations in practice patterns and perioperative protocols are not accounted for.[17, 18, 20]

2.4.3 Definitions for outcomes

While most PROMs, such as WOMAC, Oxford Hip/Knee score, and EQ-5D, are validated instruments, the lack of consensus on definitions leaves other commonly researched outcomes open to interpretation. For example, success rates can be influenced by how OJA is defined, as discussed in Section 2.4.1. Contemporary literature also highlights various approaches to reporting complications, which differ based on their nature (surgical vs. medical), timing (acute vs. post-discharge), severity (minor vs. major or adverse vs. serious adverse events), and follow-up period (30-day vs. 90-day).[17-20, 111] In addition to how complications are reported, it's essential

to consider what is defined a complication in the first place.[112] For example, in Chapter 5 of this thesis, all post-discharge unplanned care episodes were classified as complications of the OJA pathway, differing from many other study approaches as explained in Section 2.2.4. This likely accounts for the relatively high complication rates observed in Chapter 5.

A similar issue arises with the definitions of readmissions and reoperations. In some healthcare organizations, an emergency department visit that includes an overnight stay for diagnostics may not be categorized as a readmission.[63, 113] Additionally, procedures such as manipulation under anesthesia for knee arthrofibrosis or closed reduction of a dislocated hip are not always listed as surgeries.[65, 114, 115]

2.4.4 Institutional cohorts

Despite the identification of individual factors that could predict poor outcomes,[116, 117] no standardized screening metric, has been widely accepted that helps to predict success or mitigate risk for outpatient or short-stay arthroplasty, as illustrated in a systematic review by Howie et al.[118-121] As a result many authors use 'self-defined' criteria when selecting the ideal patient characteristics for OJA.[122] While the overall concept of outpatient selection will probably be generally consistent across institutions, systematic reviews have shown that individual variations can lead to populations that are more or less clearly defined, potentially affecting the reported outcomes.[17-19] The surgical setting can significantly affect the patient selection process. ASCs and orthopaedic specialty hospitals for instance, which have fewer medical resources, typically apply stricter selection criteria than secondary and tertiary multispecialty hospitals.[18, 84, 123]

At the opposite end of the spectrum, some research has been conducted in unselected populations, which improves generalizability of outcomes.[63, 124-126] While it is clear that not all patients are suitable for OJA, these findings suggest that some existing criteria may be relative rather than absolute, and there is potential to expand these criteria to increase OJA utilization.[127-129] To address this at our institution, Chapters 4 and 5 of this thesis examined factors affecting these 'efficacy and safety' outcomes in a strict selected OJA population. Recent literature supports our findings and suggests that there is scope to reevaluate some selection criteria. For instance, it may be beneficial to move beyond arbitrary limits for age and BMI in an otherwise healthy and active population, and to reconsider the usefulness of the ASA class, which may not effectively identify specific comorbidities that influence early discharge.[45, 130-134] That's where the surgeon's discretion often comes into play – evaluating a patient's fitness level and activity patterns during the outpatient consultation. Performance-

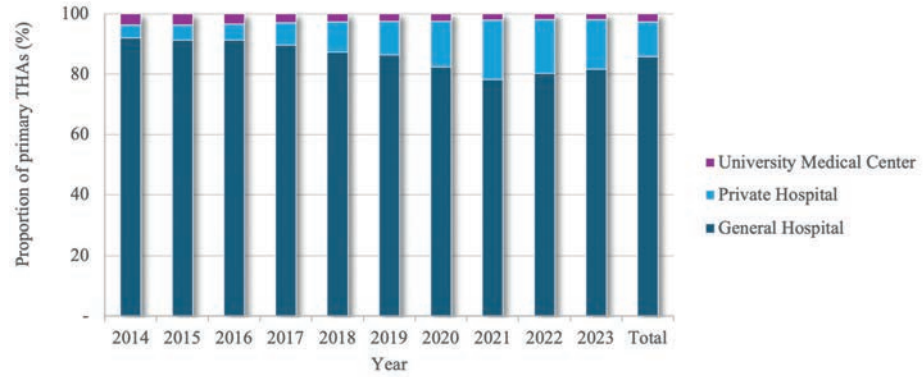
based physical tests could maybe complement this judgment, helping to refine the process to select patients who are fit enough to undergo OJA.[135]

2.4.5 Institutional pathways and setting

The effectiveness of patient selection, as outlined in the previous section, however is closely linked to the success of the institutional pathway and the perioperative protocols in place.[128] As multiple systematic reviews have shown, these institutional protocols can vary significantly, and there is no widely accepted perioperative protocol.[17-19] Although consensus statements on key aspects of perioperative care for hip and knee arthroplasty have been published,[136] the growing body of literature, along with individual preferences, beliefs, logistical challenges, and limited resources, contributes to this variation in protocols. While this diversity is understandable, it should not be overlooked when comparing study outcomes. Not only perioperative protocols, but for instance also the structure of post-discharge care – such as discharge destination (home or skilled nursing facility), outpatient physical therapy, home care visits by a nurse, and follow-up practices – can greatly influence various outcomes.[18] The increasing shortage of healthcare workers – not only nursing staff in operating rooms and on wards but also in home care – might pose an additional challenge to the OJA pathway.

When reviewing the literature on outpatient hip and knee arthroplasty, it's important to recognize that the setting for these procedures vary by country and healthcare system. In the Netherlands, most primary THA and TKA are still performed in general hospitals (~80%), although there has been a shift toward the private setting ("Zelfstandig behandelcentrum [ZBC]") in the past decade (Figure 1a-b),[59] likely accelerated by the COVID-19 pandemic.[137, 138] ZBCs offer highly protocolized care with predictable outcomes and shorter waiting times but generally have stricter patient selection due to limited resources for handling complications. Most of the data in this thesis (Chapter 3 to 5 and Chapter 8) were collected in a general hospital setting, similar to other Dutch studies on OJA.[139, 140] To date, there are no published studies on OJA in ZBCs and interest in implementation among "ZBC-surgeons" appears to be low (though possibly underestimated; Chapter 6), hypothetically due to financial disincentives for SDD. For instance, in the Netherlands, TJA procedures are reimbursed at a higher diagnosis-related group (DRG; "Diagnose Behandel Combinatie") rate for inpatient admissions, which might create an incentive for overnight stays and discharging them early the next morning instead to still accommodate new patients and maximize bed turnover.

A.



B.

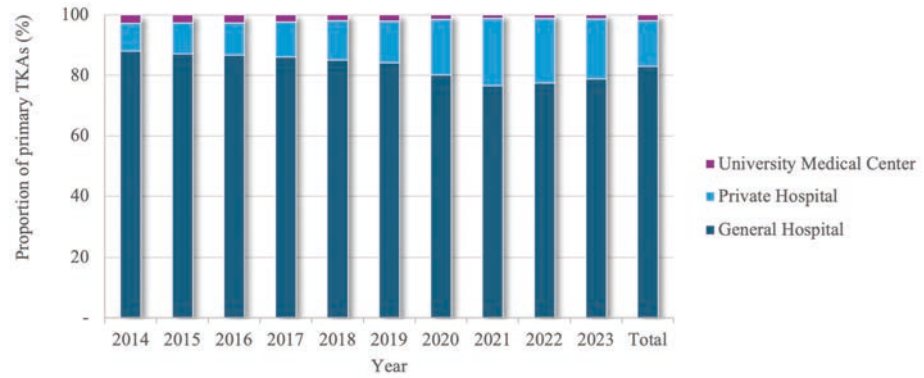


Figure 1. Trend (proportion [%] per year) in type of hospital performing (A) primary total hip arthroplasties and (B) primary total knee arthroplasties in the Netherlands from 2014 to 2023. Reproduced with written permission from the LROI[59].

Nevertheless, many international studies report outcomes of OJA performed in ASCs, which are specialized facilities for ambulatory surgeries primarily found in the USA that serve a similar purpose as ZBCs.[141] The systematic review by Jaibaji et al[18] found that even 65% of the cohort was from ASCs. Although studies consistently show low rates of complications, reoperations, and readmissions, practice variability continue to exists in these settings (as described in previous sections), and might be even more prone to selection bias or underreporting early complications due to the absence of an acute care facility.[42, 66, 115, 130, 142] Comparative studies found similar, or even superior, outcomes for ASCs compared to general hospitals, though only a few matched their cohorts.[65, 84, 143] A Danish RCT found similar SDD rates for THA (both 100%), but higher for TKA (94% versus 64%), in ASCs compared to general hospitals, suggesting that the logistical set-up of an ASC might have several advantages over a general

hospital (i.e., psychological priming to SDD as the patient is only surrounded by other patients who are all intended to be discharged on the day of surgery, better focus on recovery rather than comfort, differences in staff-patient ratios, and immediate availability of dedicated anesthesiologic assistance).[144]

Overall, adopting OJA in ASCs may offer more advantages compared to general hospitals due to the lower difficulties and costs associated with setting up outpatient surgeries in ASCs. Multispecialty general hospitals face challenges such as managing operating room coverage, higher caseloads, scheduling limitations, rotating trainees, and provider variability. In contrast, ASCs are designed specifically for outpatient procedures, allowing for more streamlined and cost-effective surgeries, and resulted in as much as 17% to 43% direct cost savings when compared to an academic medical center.[145, 146]

3. PERSPECTIVE OF ORTHOPAEDIC SURGEONS

The perspective of orthopaedic surgeons and insights into differences between current outpatient and inpatient pathways are key to the adoption and implementation of OJA.

3.1 Key findings addressing the research questions

Returning to the research questions posed in Section 5.2.3 of the general introduction, this thesis found that approximately one in five Dutch orthopaedic surgeons currently offer OJA, while about half of non-users are interested in future implementation. Although outpatient pathways were generally more up to date, differences between outpatient and inpatient pathways were minor and primarily driven by logistical factors. These findings, along with specific facilitators and barriers to OJA adoption, will be further discussed in the following paragraphs.

3.2 Implementation and willingness

While the primary focus should be to improve perioperative care and functional outcomes rather than to reduce LOS and cut costs, successfully implementing OJA pathways offers a significant opportunity to reduce expenses in healthcare systems that are already under strain from the growing demand for TJA, as earlier discussed in section 2.3. In this context, orthopaedic surgeons have the chance to fulfill a social responsibility by helping to develop more affordable and sustainable care for a select patient population undergoing joint arthroplasty.

However, demonstrating the safety and feasibility of OJA in the literature doesn't guarantee its widespread adoption in clinical practice.[124, 128] Although global interest in OJA is increasing, reflected in the annual increase of outpatient THA, TKA, and UKA procedures over the past decade in countries like the USA (from 11.1% to 15.8%) and Denmark (see Figure 4a in the General Introduction of this thesis),[13, 147-149] the study by Jensen et al[13] found that this growth is largely confined to a few healthcare institutions. Unlike the Danish colleagues, no data on the annual number of OJA procedures or their growth in Dutch practice is available due to limitations in the Dutch national arthroplasty register (LROI), which does not include detailed information on LOS. To address this gap, Chapter 6 of this thesis presented a survey among Dutch orthopaedic surgeons. While the study design may not be ideal for precisely determining OJA utilization, the survey revealed that only around 20% of respondents currently perform OJA for the hip and/or knee. Similar to findings by Jensen et al, these surgeons are likely concentrated in a small number of institutions that have implemented OJA pathways.[40, 139, 140] The primary reasons for adopting OJA in Dutch practice were cited as evidence of safety and effectiveness, patient demand, and cost savings.

While half of the remaining Dutch orthopaedic surgeons expressed interest in adopting OJA in the future, they identified conflicting evidence and logistical challenges – such as time constraints, insufficient intercollegiate/multidisciplinary support, or inadequate backing from healthcare institutions – as common barriers. Similarly, an article by Rozell et al[150] highlighted barriers on both the hospital and patient sides in the USA, such as a culture of "noblesse oblige", where physicians are expected to take on leadership and administrative tasks without compensation, and a perceived lack of operational support, including marketing and operating room access. Additionally, physicians are often excluded from decisions that impact the quality of care, such as nursing procedures and therapy protocols, and incentives related to volume, quality, and efficiency are insufficient. Although the 'lack of evidence' argument can be contested with the findings of this thesis and more recent research (as described in section 2 of the General Discussion), healthcare institutions should take some of the responsibilities for addressing these logistical shortcomings and barriers. As key stakeholders in achieving cost savings, optimizing surgical capacity planning, and managing bed occupancy, they play a critical role. Some actionable steps include (1) allocating budget to hire dedicated personnel to foster collaboration among relevant medical disciplines (see Figure 5 in the General Introduction of this thesis) and to coordinate the CP, such as a physician assistant or nurse practitioner, (2) recruiting role models within each discipline who are familiar with the latest evidence and CPs, and providing them with non-patient hours to

focus on development and implementation, and (3) developing an infrastructure and environment conducive to supporting the implementation of these clinical pathways.[151]

Jensen et al[129] found that approximately half of the Danish TJA population was deemed eligible for OJA (Figure 2a), consistent with eligibility rates reported in smaller cohort studies, which ranged from 31% to 75%.[85, 124, 152] However, only 8% of those eligible were actually discharged on the day of surgery, indicating significant underutilization.[128, 129] While the eligibility rates for SDD were relatively similar for THA (47%) and TKA (49%) compared to UKA (55%), the proportion of eligible patients actually discharged on the day of surgery was notably lower for THA and TKA (Figure 2b). This suggests that the greatest potential for increasing SDD utilization lies with THA and TKA, though orthopaedic surgeons should acknowledge the inherent differences between these procedures. Additionally, lower success rates for TKA (76% versus 87% for UKA), as highlighted in Chapters 3 to 5 of this thesis,[153] further emphasize this disparity. Consequently, it is unsurprising that the study in Chapter 6 of this thesis found that most Dutch orthopaedic surgeons considered THA (91%) and UKA (81%) feasible for outpatient settings. However, there was greater reluctance toward outpatient TKA, with only 68% deeming it appropriate for SDD.

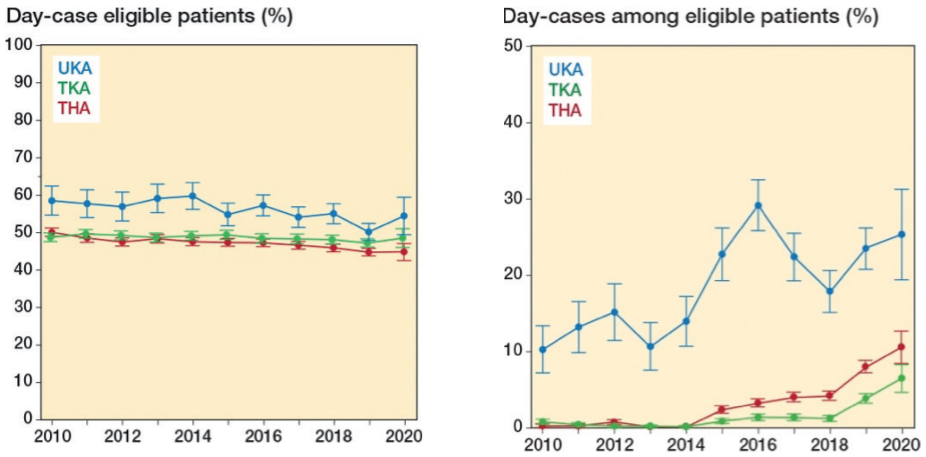


Figure 2. A: Proportion of total hip arthroplasty (THA), total knee arthroplasty (TKA), and unicompartmental knee arthroplasty (UKA) patients considered eligible for day-case surgery over time. B: Proportion of discharge on the day of surgery for day-case eligible THA, TKA and UKA patients. Reproduced with written permission from Jensen et al[129]

3.3 Impact of healthcare systems and reimbursement models

Most research on OJA originates from North America (USA and Canada) and Nordic European countries like Denmark. Unsurprisingly, these countries are early adopters of OJA, showing the largest annual growth rates (see section 3.2 of the general discussion).[13, 147-149] Conversely, other countries still report relatively low outpatient rates for hip and knee arthroplasty. For example, in the UK, outpatient rates range from 0.5% for THA and TKA to 5.4% for UKA.[154] Similarly, a French study reported an outpatient rate of 1.1% for TKA.[83] Meanwhile, other Western European countries like Germany, Austria and Switzerland have not yet published OJA adoption data.

The successful adoption of OJA is highly complex and is influenced by factors such as healthcare infrastructure, cultural attitudes towards hospitalization and postoperative recovery, support from national scientific societies, and reimbursement models in each country.[155, 156]

3.3.1 Healthcare infrastructure

For instance, a wider availability of specialized ASCs ("ZBCs" or "focusklinieken" in the Dutch context) and a high proportion of selected TJA cases in these centers can drive higher OJA rates, as these facilities generally have the potential to be more efficient at facilitating SDD and perform procedures at lower costs (also see section 2.3 of the general discussion). Financial incentives also play a key role in promoting OJA, particularly in overburdened healthcare systems seeking to alleviate pressure on inpatient beds and address staffing challenges, such as recruiting personnel for inpatient wards and night shifts. While the latter may be less pressing in multidisciplinary general hospitals where inpatient wards are consistently staffed, reducing the LOS still allows hospitals to increase their surgical caseload, meeting patient demand more efficiently.

3.3.2 Cultural attitudes

Differences in cultural attitudes significantly affect patient preferences and acceptance of OJA. In Germany, for example, both orthopaedic surgeons and patients probably tend to favor longer hospital stays due to a tradition of comprehensive inpatient care and integrated rehabilitation programs, aimed at ensuring full stabilization before discharge. Conversely, patients in countries like the US, Denmark, or the Netherlands may value independence and favor earlier discharge to recover in the comfort of their own homes.[41]

3.3.3 Reimbursement systems

Reimbursement models significantly impact OJA adoption. In traditional fee-for-service (FFS) systems, for example, providers are paid per service, which can encourage higher volumes but may lead to increased overall costs and less focus on efficient care. Conversely, models incorporating capitation-like elements make OJA more financially attractive, as healthcare institutions receive fixed reimbursements regardless of LOS.[128] However, providers may resist OJA if they face financial disincentives for early discharge.[128, 157, 158]

3.3.3.1 The U.S. reimbursement system

The U.S. healthcare system is highly complex, operating as a mixed system where both public programs (e.g., Medicare and Medicaid) and private insurance plans (through employer-based group insurance or individual marketplace plans) coexist. While FFS remains common – particularly outside of Medicare's alternative payment models – there is a growing shift toward value-based care and bundled payments, such as the Bundled Payments for Care Improvement (BPCI) and Comprehensive Care for Joint Replacement (CJR) models.[159, 160] These bundled payments offer predetermined reimbursements for services related to a condition or procedure over a defined period, typically from hospitalization or an outpatient procedure through 90 days post-discharge. The goal is to incentivize coordinated, cost-effective care – such as OJA, provided quality of care remains uncompromised – by reducing overutilization of resources and financially rewarding providers with shared savings if actual costs are below the predetermined rates.[161] However, the potential risk of complications or costly readmissions may discourage providers from adopting OJA, particularly for complex or high-risk patients. By lowering total reimbursement rates, these models have also incentivized the use of lower-cost care settings, such as ASCs.

Despite hospital lobbying, the Centers for Medicare and Medicaid Services' (CMS) removed TKA (2018) and THA (2020) from the inpatient-only list, allowing these procedures to be reimbursed under the Ambulatory Payment Classification (APC) system, incentivizing OJA for selected patients.[153, 162] Although reimbursements are still site-specific – with higher reimbursements for inpatient than for outpatient procedures – financial incentives for OJA persist due to reduced overhead costs in ASCs and the absence of extended inpatient care expenses. Potential other cost-containment efforts, such as implementing site-neutral payments (equalizing reimbursements across inpatient and outpatient settings for cases of similar complexity), could further increase the volume of procedures performed in outpatient settings like ASCs. Conversely, providers in inpatient settings might lose financial

incentives, as they would no longer receive higher reimbursements for inpatient surgeries.

Additionally, lack of universal coverage and high out-of-pocket costs (e.g., copayments, coinsurance, and deductibles) may encourage U.S. patients to opt for OJA, particularly if out-of-pocket spending is not capped.

3.3.3.2 The Dutch reimbursement system

In the Netherlands, the prospective payment system, based on DRGs, reimburses hospitals a fixed amount per diagnosis, regardless of the resources used. While this promotes cost control and efficiency, it does not strongly incentivize OJA. Hospitals typically receive lower reimbursements for OJA than for inpatient procedures, as the latter include additional compensation for inpatient care expenses. Chapter 6 of this thesis suggests that this financial disincentive, combined with the added effort and perceived risks of OJA, discourages its adoption by some of the orthopaedic surgeons. Dutch insurance companies could play a pivotal role in promoting OJA by prioritizing contracts with hospitals offering outpatient procedures or by rewarding providers who meet quality benchmarks.

3.3.3.3 The German reimbursement system

The German DRG system, however, provides a contrasting example. Hospitals are reimbursed a fixed amount based on average costs for cases within an expected LOS range (e.g., 5 to 7 days for TJA). If a patient is discharged earlier than the minimum, the hospital receives reduced reimbursement, whereas longer stays beyond the standard range generate modest per diem payments.[163-165] Although this system allows some flexibility in LOS for medically necessary care, it does not strongly incentivize OJA adoption.

3.4 Differences in pathway characteristics

Key factors for a successful OJA pathway include a multidisciplinary approach and specific protocols that address patient and caregiver education, expectation management, patient selection (e.g., ensuring the availability of a caregiver who also acts as a "joint coach") and preoperative optimization if deemed necessary, as well as multimodal (opioid-sparing) pain control and early mobilization with functional discharge criteria.[128] In Chapter 7 of this thesis, we found that OJA pathways in the Netherlands, as depicted by orthopaedic surgeons, were broadly similar to those outlined in the systematic reviews by Hoffmann et al[17], and later Jaibaji et al[18]. However, both Dutch and international practices showed variations, with some notable (though not necessarily significant) differences in key factors. For

example, regional nerve blocks were rarely used in multimodal analgesic protocols, and in about a quarter of cases, these protocols did not prioritize opioid sparing.[2, 166] Additionally, less than half of the Dutch OJA pathways employed predefined criteria for patient selection, which seems contradictory given that OJA is mainly proven successful in carefully selected patient populations.

Other differences between Dutch and international OJA pathways included variations in perioperative strategies, such as VTE prophylaxis regimens (e.g., LMWHs versus aspirin) and surgical approaches (e.g., direct anterior versus posterolateral). These differences are likely due to individual surgeon preferences and the challenge busy clinicians face in navigating numerous, sometimes slightly differing guidelines and consensus statements.[136, 167-174] Although not covered in Chapter 7 of this thesis, several systematic reviews have also noted variability in selection criteria and aftercare, as previously discussed in the limitation sections 2.4.4 and 2.4.5.

Interestingly, the study in Chapter 7 of this thesis shows that perioperative protocols for both outpatient and inpatient pathways in Dutch practice are largely consistent. While some institutions may need to further refine specific aspects of their perioperative interventions, this indicates that MDTs should primarily focus on defining selection criteria and optimizing pathway logistics. With these adjustments, they are close to achieving successful adoption of OJA within a pathway that has already demonstrated a reduction in LOS without compromising safety. The importance of pathway logistics and surgical planning – such as scheduling surgeries early in the day – was underscored by several studies that identified these factors as key reasons for not achieving functional discharge criteria.[8, 125, 127, 175]

4. PERSPECTIVE OF PATIENTS

Given the natural trend of decreasing LOS following TJA, it seems this development was largely driven by healthcare providers – institutions and MDTs – motivated by an increasing push to improve efficiency, as well as by insurers. This view was shared by Dutch orthopaedic surgeons, 34% of whom believed healthcare institutions benefited the most from OJA, followed by 28% who identified insurance companies as the primary beneficiaries (Chapter 6). Meanwhile, patients have gradually had to adapt to the shift towards earlier discharge and even SDD after joint arthroplasty. Although patients are central to the process and stand to benefit most from an optimized pathway ("First better than faster"), the impact of OJA from the patients' perspective has often been overlooked.

4.1 Key findings addressing the research questions

Returning to the research questions posed in Section 5.3.1 of the general introduction, this thesis found that the idea of OJA was well accepted by most patients and their caregivers, and satisfaction with the pathway was high. However, areas for improvement were identified, particularly in preoperative education, expectation management, and pathway logistics. These findings will be further explored in the following paragraphs.

4.2 Patients' attitude towards OJA

In Chapter 6 of this thesis, a survey revealed that patient demand was a significant factor driving Dutch orthopaedic surgeons to implement OJA. Additionally, about 60% of surgeons who already performed OJA believed that patients benefited the most from the pathway, making it a "patient-driven" approach. Dorr et al[41] were among the first to show that one-third of patients under 65 years old desired OJA, though not all were successfully discharged on the day of surgery. These patients appreciated the psychological benefit of quickly regaining control and independence, which they believed boosted their confidence and accelerated recovery.

However, when considering patient-perceived safety, studies showed mixed feelings. For example, Adelani and Barrack[176] found that in an unselected population who had recently undergone TKA, about 30% of patients felt uncomfortable with the idea of SDD. Despite this, many believed that recovering at home would lead to a faster recovery. Meneghini and Ziemba-Davis[177] reported similar preoperative perceptions of SDD among patients planned for THA or TKA, noting that males were more likely to feel comfortable with it. Similar to our findings in Chapter 8 of this thesis, patients believed that good overall health, presence of an informal caregiver and intrinsic motivation were key factors for selecting a good candidate for OJA.

In line with the findings in Chapter 8, these studies emphasize that most patients see home as the best place for recovery after surgery. However, concerns about costs, pain management, mobility, self-care and potential complications still lead many to favor inpatient over outpatient arthroplasty.[176-178] This was evident in Pagani et al's[178] online survey, where although over half of U.S. participants believed they would have been comfortable with SDD, two-thirds still preferred to stay in the hospital after surgery.

4.2.1 Satisfaction

In general, satisfaction with TJA is often achieved when patients' expectations align with the surgical outcomes of pain reduction and functional improvement.[179] With SDD, greater emphasis will be placed on managing these expectations by

clear communication and comprehensive preoperative education, as the reduced hospital stay requires more effective preparation (see section 4.1 of the general introduction of this thesis). Effective strategies such as optimized pain management and faster functional recovery,[180, 181] and coherence in care, are essential for reducing postoperative discomfort and enhancing the overall patient experience. Providing clear self-care instructions and ensuring caregiver support are essential, as immediate healthcare professional assistance may not be available at home. To prevent patients from feeling abandoned post-discharge, it is important to offer reassurance by discussing and having a backup plan in place, ensuring caregiver adherence to postoperative support, and arranging support such as scheduled home nurse visits, follow-up calls from the surgeon's office, or a postoperative follow-up schedule that suits the patient's needs. The integration of digital tools aims to enhance patient engagement in preoperative and postoperative care and has the potential to reduce surgeon's burden. With real-time guidance on exercises, medication reminders, and mobility routines, it fosters patient confidence and self-sufficiency. Additionally, its interactive features allow two-way communication with the surgical team for timely support if complications or questions arise.

In Chapter 8 of this thesis, as well as in other studies, over 90% of patients who underwent outpatient hip or knee arthroplasty preferred this approach over inpatient procedures, would choose it again if needed, and would recommend it to others.[41, 43, 44, 56, 145, 182, 183] While patients were generally equally satisfied with THA, TKA, and UKA, Ghosal et al[145] found that fewer patients preferred to be discharged on the same day after TKA (about 80% compared to 95% for THA and UKA) if repeat surgery on the contralateral joint was required. Although no reasons were provided, and our structured interviews did not replicate these findings, they seem somewhat consistent with the results of previous chapters, suggesting that further improvements are needed to enhance the effectiveness of TKA in the outpatient setting.

Patient mentality might also influence these outcomes, as those with a more positive attitude toward SDD may report higher levels of satisfaction.[44] Nevertheless, these findings indicate that select patients deemed suitable for OJA generally view SDD as a safe option and are satisfied with the overall experience. Aside from the medical ineligibility of some patients, it is crucial to acknowledge that OJA may not be appropriate for everyone. This emphasizes the need for the decision to pursue this pathway to be made collaboratively between the caregiver, the patient and their informal caregiver.

4.3 Burden of care for informal caregivers

As a result of increasingly rapid discharge to home following joint arthroplasty, patients request to recover at home, and nowadays healthcare providers offering SDD, both patients and healthcare systems are heavily relying on the ability and willingness of informal caregivers – such as family and friends – to provide care. However, the impact of shifting this burden from healthcare professionals to informal caregivers, often just hours postoperatively, is not well understood, as only a few studies have examined this within the general TJA population.[184, 185] A scoping review by Page et al[186] even found no studies addressing caregiver burden following outpatient joint arthroplasty. Their research group proposed a framework with several domains containing a variety of stressors (e.g., emotional, financial, physical, psychological, and social) and can be used to quantify the overall burden of care experienced by the caregiver.[187, 188]

Unlike chronic diseases such as dementia, where caregiving needs persist, with elective OJA, caregivers experience the burden of care at its peak. This burden gradually decreases and eventually usually disappears as the patient completes rehabilitation and becomes independent again.[189] Although capturing the caregiver's perspective was not the primary focus of the study in Chapter 8, we intentionally included patient-caregiver pairs in our interviews to gain some insight into caregiver strain. Both patients and caregivers emphasized that the vitality of both parties is crucial to the success of OJA. In the inpatient population undergoing TJA, significant predictors of caregiver strain, such as age, sex, and self-efficacy, health literacy, have been identified.[185, 189] Given that the OJA population tends to be younger and more active, and that informal caregivers are often spouses of a similar age, it can be hypothesized that they may be better equipped to handle caregiving demands than the average inpatient caregiver. Nevertheless, our study revealed that 17% of informal caregivers experienced preoperative anxiety, worrying about the unknown and potential loss of control. The care burden was highest in the initial days after discharge, involving both physical and emotional strain as patients were functionally limited and experiencing surgery-related pain. However, only 8% of caregivers felt uneasy about the care they provided during this phase, particularly due to the patient's high pain levels on the first postoperative day. Similar concerns about early discharge of patients or caregivers were reported by Hunt et al, who also noted that patients, while reluctant to express it, often worried about burdening their informal caregivers.[176, 190] The importance of strong social support cannot be underestimated, as it has been shown to boost patient confidence with early discharge and reduce the likelihood of unplanned healthcare visits.[191]

To improve the care process for orthopaedic patients, it's vital to enhance the education and information provided to both patients and caregivers. This should include detailed guidance on postoperative issues, potential risks, and clear definitions of the roles of patients and caregivers. Proper education, supported by behavioral interventions such as healthcare advice, medication management, and psychological strategies as described by Longo et al[184], can help to reduce stress and strain. Additionally, different follow-up methods (including the role of digital tools as described in the previous section) from the care provider, may not only offer support to patients, but also to informal caregivers. Given the significant societal impact of the shift from inpatient to OJA, further research is essential to better understand and quantify the often-overlooked care burden on informal caregivers.[192, 193] In addition to examining the differences among various types of caregivers – such as those who are employed versus those who are not – it would be valuable to investigate the skills and resources necessary for caregivers to provide effective support after OJA. Furthermore, identifying the barriers and limitations they often encounter can help inform strategies to enhance support systems.

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CHAPTER 10

IMPACT AND VALORISATION

1. GROWING EVIDENCE SUPPORTING OUTPATIENT JOINT ARTHROPLASTY

In most countries, inpatient pathways with a short length of stay (LOS), known as rapid recovery or fast-track programs, remain the gold standard for lower extremity arthroplasty, including total hip (THA), total knee (TKA), and unicompartmental knee arthroplasty (UKA).[1, 2] Advances in perioperative care and the drive to achieve a "stress- and pain-free" surgery have improved outcomes, expedited recovery, and further reduced LOS, even enabling select patients to undergo these procedures and be discharged the same day.[3, 4] These "outpatient joint arthroplasty (OJA)" pathways have gained traction in high-volume centers with experienced orthopaedic surgeons since the early 2000s,[5-7] and projections indicate continued growth in OJA adoption over the next decades,[8-12] as the majority of the evidence – including this thesis – is supporting its feasibility and safety, and outcomes appear non-inferior to traditional inpatient pathways.[13-17] From the patients' perspective, OJA also offers the opportunity to gain greater autonomy – fostering a sense of independence and control over their health journey – and allowing individuals to manage their recovery at their own pace, while still having access to support from healthcare providers when needed. By returning home the same day, patients can heal in a more familiar, comfortable and private home environment, which may reduce the psychological stress associated with hospital stays, enhance their overall well-being and potentially improve their satisfaction with the treatment received.[18-22]

Although outcomes regarding feasibility, efficacy, safety, and patient satisfaction have been encouraging, healthcare providers in established multidisciplinary teams (MDTs) should regularly review their perioperative protocols and outcomes. It is also crucial to recognize that care pathways are dynamic and should evolve in response to emerging evidence.[23-26] The findings of this thesis highlight the importance of optimizing key elements in the OJA pathways to enhance these outcomes in a multidisciplinary general hospital setting. This includes preoperative patient selection, where factors like surgical procedure (THA versus TKA), sex and comorbidities should be considered alongside intrinsic motivation, coping mechanisms, resilience and social safety net. Comprehensive patient education and expectation management are also essential, especially given the shorter hospital stay, where healthcare providers have limited time to support and reassure patients. Perioperative care should be focused on expedited recovery and promoting early ambulation (e.g., multimodal opioid-sparing pain management, local infiltration analgesia techniques which prevents transient peroneal nerve palsy in TKA, tranexamic acid strategies to minimize blood loss, reduce orthostatic hypotension

and postoperative nausea and vomiting). Comprehensive postoperative care should include clear instructions for patients and caregivers, scheduled check-ups, and easy access to medical support for addressing uncertainties or complications.[27-30] Although high satisfaction rates are reported,[20] engaging with patients – as one of the key stakeholders – revealed that they place significant value on the entire pathway experience. Improving this experience is a critical next step in further enhancing patient satisfaction. Key areas of improvement include optimizing logistical elements to reduce inconveniences – such as long waiting times, taking postoperative X-rays in the post anesthesia care unit (PACU), and by dispensing discharge medications directly on the ward – enhancing communication consistency between healthcare providers and patients, and reassuring patients with available intra- and extramural safety nets.

2. COST-EFFECTIVE IN A SYSTEM FACING INCREASING RESOURCE STRAIN

The impact of OJA, however, is multifaceted, alleviating strain on healthcare systems faced with growing demand for lower extremity arthroplasty.[31-34] Shifting to outpatient procedures can incentivize more efficient use of resources and yield substantial cost savings, as inpatient stays contribute significantly to the overall cost of joint arthroplasty.[31, 32] This assumes that complication rates associated with OJA are comparable to traditional inpatient stays, and that the multidisciplinary team (MDT), emergency departments, or primary care providers are not unexpectedly burdened by additional healthcare visits, as highlighted by existing literature.[13, 15-17, 34] Maybe ambulatory surgical centers (ASCs; known as "Zelfstandige behandelcentra" [ZBC] in Dutch) and specialized clinics within existing healthcare institutions (e.g., "focusklinieken") could play an even more prominent role in reducing overall healthcare costs for these specific (i.e., healthy) patient populations requiring lower extremity arthroplasty, as they often benefit from lower overhead costs compared to multidisciplinary general or academic hospitals.[35, 36]

By reducing hospital stays, OJA frees up beds, enabling healthcare institutions to accommodate more patients and reduce waiting times for elective surgery.[37] However, contingency plans are essential, such as ensuring the availability of backup hospital beds in general hospitals or establishing transfer policies for ASCs without overnight stay options, to manage the 15% to 25% of patients who may not be discharged the same day.[13, 38, 39]

3. IMPACT, CHALLENGES AND CLOSING THE KNOWING-DOING GAP

The potential impact of OJA largely depends on its applicability to the general arthroplasty population and the extent to which healthcare providers adopt it. While both healthcare providers and patients must recognize that OJA is not suitable for everyone,[18, 30] feasibility studies suggest that about half of the population may be eligible for same-day discharge (SDD).[6, 40, 41] The growing demand for lower extremity arthroplasty, combined with the trend of performing these procedures in younger, otherwise healthy patients with symptomatic osteoarthritis, may further expand the pool of candidates eligible for OJA. These younger patients often have distinct post-surgical needs that could benefit from tailored approaches in the outpatient setting.[42, 43] However, as shown in this thesis, OJA is currently relatively underutilized in the Netherlands and probably limited to a few specific healthcare institutions, suggesting that its broader adoption will require a cultural shift among both healthcare providers and patients.[28, 40] This shift starts with raising awareness, increasing familiarity with OJA, and enhancing patient education and expectation management. The findings presented in this thesis provide a solid foundation for institutions and MDTs aiming to integrate this approach into their practices. Despite growing evidence, concerns from both providers and patients may persist. The transition from inpatient care to home without professional support can be daunting. A more gradual approach, involving collaboration with home care providers and peripheral physical therapists, potentially supplemented by telemonitoring and remote specialist guidance, could ease this transition and reduce apprehension. By enabling recovery at home with appropriate professional oversight, costly hospital-based care can be minimized.

However, the adoption of OJA is not only driven by evidence of feasibility, safety and cost-effectiveness, but also by factors like healthcare accessibility and coverage, the infrastructure and culture of healthcare systems, and reimbursement models, which differ greatly across countries.[28, 44, 45] As a result, the adoption of OJA has largely been limited to developed healthcare systems that have experience with implementing clinical pathways and reimbursement models that incentivize its use. In the Netherlands, the transition to OJA may be more feasible than initially anticipated, given the relatively short average LOS of two to three days in most healthcare institutions – which is significantly shorter than in some other European countries – and the minimal differences in perioperative protocols between existing outpatient and inpatient pathways, as demonstrated in this thesis.[3, 45-47] This suggests that optimizing logistics and fostering a cohesive MDT with well-organized, goal-

aligned services may be as important, or even more so, in transitioning to OJA as refining perioperative protocols within an already established fast-track pathway.[24, 27]

Surgeons may face barriers to adopting OJA, such as time constraints and increased workload, driven by a culture of "noblesse oblige" within healthcare institutions, where physicians are expected to take on leadership and administrative responsibilities without additional compensation.[39, 48, 49] Meanwhile, healthcare institutions may encounter logistical challenges that contribute to the knowing-doing gap. For example, a lack of expertise in key departments responsible for developing the medical framework and managing the care pathway (CP) (e.g., orthopaedic surgery or anesthesia), or resource constraints, such as limited budgets for supportive services like physical therapy, can result in staff shortages and hinder the establishment of an effective OJA pathway. Healthcare institutions and providers should critically assess their strengths, limitations, and comfort levels when planning to implement OJA. Adhering to the principle of "first better – then faster" is crucial, as ensuring patient safety remains the foundation of successful outpatient TJA.[18, 27, 29] To address these challenges, healthcare institutions should consider allocating budget to hire personnel, such as a physician assistant or nurse practitioner for 'perioperative care'. This role can serve as a hub within the team, coordinating the CP, fostering collaboration across medical disciplines, mediating between medical specialists who develop the pathway and the bedside paramedical staff, exploring the different interests within specialties, and organizing frequent team meetings and educational sessions to align these interests.[24] ASCs and 'focusklinieken' likely face fewer logistical challenges in fostering an infrastructure and environment conducive to implementing these CPs, as they are specifically designed to deliver protocolized care, such as lower extremity joint arthroplasty, more efficiently. Additionally, orthopaedic surgeons tend to have greater ownership and decision-making authority in these settings compared to multidisciplinary general or academic hospitals, enabling them to better prioritize and streamline the CP.[38, 39, 50]

In the current Dutch healthcare system, however, the lack of incentives within the reimbursement structure is likely one of the primary barriers to the adoption of OJA. Diagnosis-related groups (DRGs) for inpatient procedures (requiring at least one overnight stay) typically provide higher reimbursement than outpatient lower extremity joint arthroplasty (without an overnight stay). As a result, healthcare institutions with efficient care pathways may delay SDD, opting to keep patients overnight and discharge them the next day. This generates more revenue while allowing the bed to be reused. To foster the adoption of cost-effective approaches like OJA and reshape the healthcare landscape for lower extremity joint arthroplasty,

health insurers could play a pivotal role by developing reimbursement models that incentivize outpatient procedures. Additionally, insurers might negotiate outcome-based contracts with healthcare providers, considering casemix and the proportion of successful outpatient procedures performed.[28]

4. FUTURE RESEARCH

Although some high-quality studies have shown that, in carefully selected patients at high-performing institutions, OJA yields comparable or even superior functional outcomes to inpatient procedures – demonstrating similar rates of adverse events and high patient satisfaction – further high-quality studies are needed to strengthen the evidence base and improve generalizability for broader adoption.

In the Dutch context, it would also be valuable to assess the proportion of the arthroplasty population both medically eligible and willing to participate in an OJA pathway, and to conduct a cost-effectiveness analysis, as current evidence is limited. Such research could better evaluate OJA's potential to reduce the economic burden on healthcare.

Future research should focus on the continued development of the OJA concept, including:

- Establishing widely accepted, standardized screening tools to predict OJA's success or mitigate risk.
- Exploring the feasibility of expanding eligibility criteria to a broader population.[51]
- Refining perioperative protocols, especially those yielding inconclusive results due to insufficient modulation of the surgical stress response, such as advanced pain management for "high-risk pain responders" and strategies to address orthostatic intolerance.
- Mapping the post-discharge burden on patients and caregivers to enhance support systems.
- Investigating the role of remote monitoring and telemedicine to improve post-discharge care, patient education, and communication.
- Assessing the perspective of health insurers on OJA implementation and exploring their potential role in incentivizing its adoption.

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CHAPTER 11

ENGLISH SUMMARY

As outpatient joint arthroplasty (OJA) of the hip and knee is gaining popularity worldwide, this thesis aims to evaluate the evidence on the safety and efficacy of its implementation (part II). In addition, the research within this thesis focuses on identifying clinical barriers to successful same-day discharge, optimizing risk stratification and patient selection, and understanding factors contributing to complications and readmissions (part III). Moreover, analyses of both surgeon and patient perspectives on OJA (parts IV and V, respectively) were conducted to provide a comprehensive understanding of the opportunities and challenges associated with this evolving approach.

The *second part* of this thesis presents the findings of a systematic review and meta-analysis comparing outpatient (both true-outpatient and semi-outpatient, based on specific definitions) and inpatient hip and knee arthroplasty **(chapter 2)**. "True-outpatient" was defined as patients being discharged home on the day of surgery, while "semi-outpatient" included all other definitions of outpatient surgery. A total of 41 studies met the inclusion criteria, underwent methodological assessment, and were analyzed for outcomes related to safety (e.g., serious adverse events and readmissions) and efficacy (e.g., success rates, PROMs, and cost reduction).

Patients in the outpatient group were generally younger, had a lower BMI, and a lower ASA classification compared to those in the inpatient group. Overall, no statistically significant differences were found between the two groups in terms of complications, readmission rates, or improvements in PROMs. However, OJA resulted in an average cost reduction of $6,797.02. Therefore, OJA appears to be as safe and effective as inpatient procedures for selected patient populations, with the added benefit of potential cost savings. It is important to note that a considerable risk of selection bias was present in the majority of studies, which should be considered when interpreting these results.

The *third part* of this thesis presents the clinical outcomes from a cohort of 525 patients scheduled for outpatient total hip arthroplasty (THA), total knee arthroplasty (TKA), or unicompartmental knee arthroplasty (UKA) at a multidisciplinary general hospital in the Netherlands. Although all patients were scheduled for same-day discharge, 79% were successfully discharged on the day of surgery. This underscores the need for continuous optimization of the patient selection process and the care pathway (CP), as well as the importance of having a contingency plan, such as a short-stay option, for patients unable to be discharged as planned.

Chapter 3 identifies the reasons for unsuccessful same-day discharge (SDD), including transient reductions in motor function and sensory disturbances that hindered early postoperative ambulation. Although this finding is rarely reported in the current literature, it was primarily observed in patients undergoing TKA and is hypothesized to be a side effect of local anesthetic analgesics (LIA) diffusing near the peroneal nerve. Other common barriers to SDD included dizziness and/or orthostatic hypotension, wound discharge, pain and/or patient anxiety, which align with observations reported in similar studies in the literature.

Multivariable logistic regression analysis in **Chapter 4** demonstrates that a history of contralateral joint arthroplasty is independently associated with successful SDD. This association may arise from patients benefiting from their prior knowledge and experiences with the early rehabilitation process, which can lead to more effective coping strategies, increased resilience, and improved expectation management. Conversely, being female and undergoing TKA were identified as risk factors for unsuccessful SDD, suggesting that these patients may be less eligible or require additional preoperative counseling.

Chapter 5 demonstrates a 90-day complication rate of 15% and a readmission rate of 4.2%, with no significant differences between patients who were successfully discharged on the same day of surgery and those who required an overnight stay. Most surgical complications occurred within the first postoperative week, with the majority being non-infected wound discharge, which was typically managed with simple wound care and observation. No major medical complications requiring emergency intervention – such as cardiopulmonary issues, venous thromboembolism, stroke, or renal failure – were observed. Patients undergoing TKA, as well as those classified as ASA III or Charnley C (multiple joints affected with osteoarthritis), were at higher risk of developing complications.

The *fourth part* of this thesis presents the utilization of OJA in Dutch practice, identifying current rates, comparing outpatient and inpatient pathways, and exploring surgeons' perspectives on OJA. These insights were gathered through a survey conducted among orthopaedic surgeons who are active members of the Dutch Hip Society and Dutch Knee Society.

Chapter 6 demonstrates that only 18% of respondents currently offer an outpatient pathway for hip and/or knee arthroplasty, while around half of those who do not yet offer OJA expressed interest in implementing it in the future. Most respondents considered THA feasible for outpatient settings (91%), followed by UKA (81%) and

TKA (68%). Although opinions on safety and the added value of OJA varied between proponents and opponents, surgeons who had positive personal experiences with OJA or received patient requests were more likely to offer it. Common barriers to implementation included challenges in patient selection, current reimbursement models, and a lack of organizational support, whether from direct colleagues, the multidisciplinary team, or the healthcare institution.

Chapter 7 highlights only minor intra- and postoperative differences between current outpatient and inpatient pathways, as reported by orthopaedic surgeons. Many of these differences likely resulted from logistical factors. Outpatient pathways, however, tended to be more up to date, e.g., often utilizing combined administration methods of tranexamic acid to minimize intraoperative blood loss. Despite emphasis on early ambulation and opioid-sparing multimodal pain management, interestingly, about 25% of current inpatient pathways did not incorporate same-day ambulation, particularly when surgery took place later in the day. Additionally, around 40% of current inpatient pathways included scheduled opioids, or even patient-controlled analgesia (PCA), as part of their multimodal pain management strategies.

The *fifth part* of this thesis presents the perspectives of patients and their informal caregivers on OJA, focusing on satisfaction, key benefits and challenges of its pathway, and the burden on caregivers. Insights were gathered from 12 semi-structured interviews with patients – who underwent outpatient THA or TKA – and their caregivers.

Chapter 8 shows that OJA was well accepted by most patients and their informal caregivers, but the decision should be mutual, as OJA may not suit everyone. Key reasons for choosing OJA included the surgeon's advice, patient fitness, availability of a vital caregiver, increased privacy and a faster recovery at home. Only one caregiver (8.3%) reported discomfort due to the patient's high pain levels in the early postoperative days. Overall satisfaction was high, with over 92% of patients preferring outpatient over inpatient joint arthroplasty and 100% willing to recommend it to others. However, interviews highlighted areas for improvement, such as better preoperative education and patient expectation management, and optimizing pathway logistics to reduce patient burden and enhance the overall experience.

CHAPTER 12

DUTCH SUMMARY

Dagbehandeling voor heup- en knieprothesiologie wint wereldwijd aan populariteit. Een doel van dit proefschrift is om de bestaande literatuur over de veiligheid en effectiviteit van de implementatie hiervan te evalueren (deel II). Daarnaast richten diverse onderzoeken binnen dit proefschrift zich op het identificeren van klinische barrières voor een succesvolle dagbehandeling – gedefinieerd als ontslag naar huis op de dag van de operatie, evenals het in kaart brengen van complicaties en redenen voor heropnames, en het beter begrijpen van factoren die bijdragen aan een onsuccesvolle dagbehandeling of het optreden van complicaties en heropnames (deel III). Ook het perspectief van de orthopaedisch chirurg (deel IV) en de patiënt (deel V) wordt belicht in dit proefschrift om een volledig inzicht te bieden in de kansen en uitdagingen binnen dit zorgpad voor heup- en knieprothesiologie.

In het *tweede deel* van dit proefschrift worden de resultaten van een systematische review met meta-analyse gepresenteerd waarin de resultaten van heup- en knieprothesiologie in dagbehandeling (zowel 'true-outpatient' als 'semi-outpatient', afhankelijk van de gehanteerde definitie om het desbetreffende zorgpad te beschrijven) worden vergeleken met heup- en knieprothesiologie gevolgd door een klinische opname (**hoofdstuk 2**). 'True-outpatient' werd gedefinieerd als patiënten die dezelfde dag nog naar huis werden ontslagen, terwijl 'semi-outpatient' alle andere definities van dagbehandeling omvatte. Alle 41 studies die voldeden aan de inclusiecriteria zijn methodologisch beoordeeld en geanalyseerd op uitkomsten met betrekking tot veiligheid (bijv. complicaties en heropnames) en effectiviteit (bijv. succespercentages, "patient reported outcome measures" [PROMs] en kostenreductie). Dagbehandeling was succesvol in 91% van alle gevallen en de patiënten die dagbehandeling ondergingen waren over het algemeen jonger, hadden een lager BMI en een lagere ASA-classificatie vergeleken met patiënten die na een heup- of knieprotheseoperatie klinisch werden opgenomen. Hoewel er geen statistisch significante verschillen werden gevonden tussen de twee groepen met betrekking tot complicatie- of heropnamepercentages of verbeteringen in PROMs, leidde dagbehandeling wel tot een gemiddelde kostenbesparing van US$6,797.02. Op basis van de geïncludeerde studies lijkt dagbehandeling dus net zo veilig en effectief als een klinische opname, met een mogelijke kostenbesparing als bijkomend voordeel. Bij de interpretatie van deze resultaten is het echter belangrijk op te merken dat de meeste studies een aanzienlijk risico op bias vertoonden.

In het *derde deel* van dit proefschrift worden de klinische resultaten van een cohort van 525 patiënten die preoperatief geselecteerd waren voor een heup- of knieprotheseoperatie in dagbehandeling in een perifeer opleidingsziekenhuis met een topklinische zorgstatus (STZ) op het gebied van heup- en knieprothesiologie.

Hoewel voor alle patiënten ontslag op de dag van de operatie gepland was, was de dagbehandeling slechts in 79% van de gevallen succesvol. Dit benadrukt het belang van voortdurende optimalisatie van het zorgpad (waaronder het patiënten selectieproces), evenals de noodzaak van een back-upplan – zoals een klinische overnachting of opname – voor patiënten die niet zoals gepland met ontslag kunnen gaan.

Hoofdstuk 3 onderzocht de klinische redenen voor een 'onsuccesvolle' dagbehandeling en vond onder andere dat een tijdelijke parese een veelvoorkomende postoperatieve belemmering was voor vroegtijdige mobilisatie en oefeningen met de fysiotherapeut, waardoor het ontslag moest worden uitgesteld. Deze bevinding werd voornamelijk waargenomen bij patiënten die een totale knieprothese (TKP) kregen en wordt hypothetisch toegeschreven aan de infiltratie met een lokaal anestheticum (LIA) dat diffundeert in het posterolaterale kapsel nabij de nervus peroneus. Andere veel voorkomende obstakels voor ontslag op de dag van de operatie waren duizeligheid en/of orthostatische hypotensie, wondlekkage, pijn en/of angst, wat overeenkomt met bevindingen uit andere studies.

Een multivariabele logistische regressieanalyse in **hoofdstuk 4** toont aan dat een eerder succesvolle gewrichtsvervanging aan de contralaterale zijde onafhankelijk geassocieerd is met een succesvolle dagbehandeling. Dit zou kunnen komen doordat patiënten profiteren van hun eerdere kennis en ervaring met het vroege postoperatieve herstel, wat kan leiden tot effectievere coping strategieën, verwachtingsmanagement en verhoogde veerkracht. Het vrouwelijk geslacht en het ondergaan van een TKP bleken daarentegen risicofactoren voor een onsuccesvolle dagbehandeling. Dit suggereert dat bij deze patiënten extra aandacht nodig is voor preoperatieve selectie, voorlichting en verwachtingsmanagement.

Hoofdstuk 5 rapporteert een complicatiepercentage van 15% en een heropnamepercentage van 4,2% binnen 90 dagen. Er werden geen statistisch significante verschillen gevonden tussen patiënten met een succesvolle en een onsuccesvolle dagbehandeling. De meeste chirurgische complicaties deden zich voor in de eerste postoperatieve week, waarbij het merendeel bestond uit niet-geïnfecteerde wondlekkage, die doorgaans werd behandeld met eenvoudige wondzorg en/of observatie. Patiënten die een TKP ondergingen, evenals ASA III en Charnley C patiënten (meerdere gewrichten aangedaan door artrose), hadden een hoger risico op complicaties.

In het *vierde deel* van dit proefschrift wordt de toepassing van dagbehandeling in de Nederlandse praktijk in kaart gebracht. Hierbij worden de huidige gebruikspercentages beschreven, het klinische zorgpad vergeleken met het zorgpad voor dagbehandeling, en het perspectief van de orthopaedisch chirurg met betrekking tot de implementatie van dagbehandeling voor heup- en knieprothesiologie belicht. Deze inzichten werden verzameld via een enquête die werd verspreid onder actieve leden van de “Dutch Hip Society” en “Dutch Knee Society”.

In **hoofdstuk 6** wordt beschreven dat 18% van de respondenten het dagbehandeling zorgpad reeds gebruikt voor heup- en/of knieprothesiologie, terwijl circa de helft van de overige respondenten aangeeft dit in de toekomst te willen implementeren. Ondanks uiteenlopende meningen over de veiligheid en toegevoegde waarde van dagbehandeling, vormden positieve ervaringen en verzoeken van patiënten om vroegtijdig ontslag belangrijke redenen voor orthopaedisch chirurgen om dit zorgpad aan te bieden. Veelvoorkomende barrières voor implementatie waren een ongeschikte patiëntenpopulatie en een gebrek aan organisatorische ondersteuning vanuit collega’s, het multidisciplinaire team of de zorginstelling.

Hoofdstuk 7 beschrijft slechts kleine intra- en postoperatieve verschillen tussen de huidige dagbehandelings- en klinische zorgpaden in Nederland. Desondanks bleken de dagbehandelingszorgpaden over het algemeen meer up-to-date, bijvoorbeeld door het gebruik van gecombineerde toedieningsmethoden van tranexaminezuur om intra-operatief bloedverlies te minimaliseren. Hoewel een ‘rapid recovery’-protocol nadruk legt op vroege postoperatieve mobilisatie, werd één op de vier patiënten die klinisch een heup- of knieprotheseoperatie onderging niet altijd op de dag van de operatie nog gemobiliseerd, vooral wanneer de operatie later op de dag plaatsvond. Veel van deze kleine verschillen tussen de zorgpaden lijken vooral toe te schrijven aan logistieke factoren.

Het *vijfde deel* van dit proefschrift onderzoekt de perspectieven van zowel patiënten als mantelzorgers op dagbehandeling. Hierbij worden tevredenheidspercentages, belangrijke voordelen en tekortkomingen van het dagbehandeling zorgpad, evenals de zorglast voor mantelzorgers in kaart gebracht. Deze inzichten zijn gebaseerd op een kwalitatief onderzoek, waarbij 12 semigestructureerde interviews zijn afgenomen met patiënten – die een totale heup- (THP) of knieprothese (TKP) operatie in dagbehandeling hebben ondergaan – en hun mantelzorgers.

Hoofdstuk 8 laat zien dat dagbehandeling door de meeste patiënten en hun mantelzorgers goed werd geaccepteerd. Wel wordt aanbevolen dat de keuze

om een dergelijke operatie in dagbehandeling te ondergaan gezamenlijk moet worden gemaakt door patiënt/mantelzorger en orthopaedisch chirurg, aangezien dagbehandeling niet voor iedereen geschikt is. Patiënten kozen onder meer voor dagbehandeling op advies van hun chirurg, vanwege hun eigen fitheidsniveau en de aanwezigheid van een vitale mantelzorger, het voordeel van snellere en betere revalidatie thuis, meer privacy, en het comfort van hun eigen omgeving. Dit benadrukt dat dagbehandeling ook een patiënt gedreven keuze kan zijn.

Slechts één mantelzorger (8,3%) ervaarde enige ongemak door de hoge pijnniveaus van de patiënt in de eerste postoperatieve dagen. Hoewel de algemene patiënttevredenheid zeer hoog was – meer dan 92% zou opnieuw voor dagbehandeling kiezen bij een eventuele operatie aan het andere been en 100% zou het aanraden aan familie en vrienden – brachten de semigestructureerde interviews ook verbeterpunten aan het licht voor het zorgtraject en de patiëntervaring bij dagbehandeling. Belangrijke aandachtspunten waren onder andere uitgebreidere preoperatieve voorlichting en verwachtingsmanagement, het benadrukken van de aanwezigheid van intra- en extramurale veiligheidsnetten om de patiënt gerust te stellen, en het optimaliseren van de logistiek binnen het zorgpad om de belasting voor de patiënt te verminderen.

PART VII

Appendices

CHAPTER 13

LIST OF PUBLICATIONS

Keulen MHF, Boonen B, Leenders AM, van Haaren EH, Schotanus MGM, Bemelmans YFL. Patients' Perceptions of and Experiences with Outpatient Hip and Knee Arthroplasty: A Qualitative Study**.** Cureus 2025 Feb 9;17(2):e78781.

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CHAPTER 14

ABOUT THE AUTHOR

Mark Keulen was born on July 30th, 1992, in Brunssum, the Netherlands. He grew up in a Dutch-German family, with a Dutch mother and a German father, spending his childhood first in the Netherlands and later in Germany alongside his older and twin brother.

After completing secondary school in 2010, he began studying Biomedical Engineering at Eindhoven University of Technology. One year later, he decided to follow his passion and started his medical training at Maastricht University, Faculty of Health, Medicine and Life Sciences. During his studies, his interest in the biomechanics and pathophysiology of the musculoskeletal system became increasingly clear. He pursued clinical electives in both orthopaedics and trauma surgery at Zuyderland Medical Centre and further solidified his ambition by completing a voluntary extracurricular internship at the department of "Unfallchirurgie, Orthopädie und Sporttraumatologie" at the Landeskrankenhaus Hall in Tirol, Austria, under the supervision of Prim. Dr. Genelin.

At the final stage of medical school, Mark completed a six-month research fellowship under the supervision of Prof. Dr. Ring at the Dell Medical School, University of Texas at Austin. There, he initiated and conducted several research projects, coordinated patient inclusion, performed data analyses, and successfully published his first scientific papers in peer-reviewed journals. In 2017, he obtained his medical degree with distinction (cum laude).

Upon returning to the Netherlands, Mark started working as a resident in orthopaedic surgery (non-training position) at Zuyderland Medical Centre under the supervision of Prof. Dr. Heyligers and Dr. Jansen. After a period of clinical adaptation, he rekindled his academic aspirations and, together with Dr. Schotanus, revitalized the local research line on outpatient hip and knee arthroplasty. This initiative ultimately laid the foundation for his PhD project, conducted under the supervision of Prof. Dr. Heyligers, Dr. Schotanus, and Dr. Boonen.

In 2020, Mark officially started his orthopaedic surgery residency. He completed his general surgery rotations at Zuyderland Medical Centre under the guidance of Dr. Sosef and Dr. de Loos. His orthopaedic training then took him through several hospitals in Limburg, including Zuyderland (Dr. Jansen and Dr. van Haaren), VieCuri Medical Centre (Drs. Nieuwenhuis and Dr. Lambers Heerspink), and Maastricht

University Medical Centre+ (Dr. Staal and Dr. Feczko). He is currently completing the final stage of his orthopaedic training at Zuyderland Medical Centre.

In his free time, Mark enjoys outdoor activities such as road cycling, mountain biking, padel and hiking. He lives with his partner Kirsten and together they have two beautiful children, Otis and Lauren, as well as their loyal four-legged friend Seb.

CHAPTER 15

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zoals zo vaak, gebruik kon maken van jouw kennis en je altijd aanwezige bereidheid om anderen te helpen. Ook tijdens mijn PhD-traject stond je klaar om af en toe iets voor mij door te lezen en je mening te geven. En als kers op de taart was jij degene die mijn eindeloze streven naar perfectie een halt toeriep, door simpelweg op de verzendknop te drukken toen ik de mail aan de beoordelingscommissie klaar had staan. Zonder jou was dat manuscript er waarschijnlijk nóg niet uit geweest. De dank van Kirsten is dus waarschijnlijk nog groter!

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CHAPTER 16

LIST OF ABBREVIATIONS

(S)AE	(Serous) adverse events
(S)OS	(Semi-) outpatient surgery
AB	Antibiotic
ACL	Anterior cruciate ligament
ACS	American College of Surgeons
ADH	Antidiuretic hormone
ANOVA	Analysis of Variance
APC	Ambulatory Payment Classification
ASA	American Society of Anesthesiologists
ASC	Ambulatory surgical center
AV	Atrioventricular
BMI	Body mass index
BPCI	Bundled Payments for Care Improvement
CA	Canada
CCI	Charlson Comorbidity Index
CI	Confidence interval
CINAHL	Cumulative Index to Nursing and Allied Health Literature
CJR	Comprehensive Care for Joint Replacement
CMS	Centers for Medicare and Medicaid Services'
CNS	Central nervous system
COVID-19	Coronavirus disease 2019
COX	Cyclooxygenase
CP	Care pathway
CPM	Continuous passive motion
DAA	Direct anterior approach
DHS	Dutch Hip Society
DK	Denmark
DKS	Dutch Knee Society
DOAC	Direct Oral Anticoagulant
DOS	Day of surgery
DRG	Diagnosis-Related Group
DVT	Deep vein thrombosis
e.g.	Exempli gratia ("for example")
eHealth	Electronic health
EQ-5D	EuroQol - 5 dimensions
ERAS	Enhanced recovery after surgery
et al.	Et alia ("and others")
etc.	Et cetera
FFS	Fee-for-service

FNB	Femoral nerve block
FR	France
g	Gram
GA	General anesthesia
GBD	Global Burden of Disease
GP	General practictioner
h	Hour
Hb	Hemoglobin
HOOS	Hip Disability and Osteoarthritis Outcome Score
HPA	Hypothalamic-pituitary-adrenal
HS-PDPR	Humana subset of the PearlDiver Patient Record
i.e.	Id est ("in other words")
IBM Corp.	International Business Machines Corporation
IC(U)	Intensive care (unit)
IL	Interleukin
IN	Indiana
IQR	Interquartile range
IRB	Institutional Review Board
IV	Intravenous
KOOS	Knee Injury and Osteoarthritis Outcome Score
KSS	Knee Society Score
L	Liter
LA	Local anesthetic
LIA	Local infiltration analgesia
LMWH	Low-molecular-weight heparin
LOS	Length of stay
LROI	Landelijke Registratie Orthopedische Interventies
m	Meter
MDT	Multidisciplinary team
MIS	Minimally invasive surgery
MPP	Medial parapatellar
N	Number
NA	Neuraxial anesthesia
NA	Not applicable
NJ	New Jersey
NL	Netherlands
NOAC	Novel Oral Anticoagulant
NP	Nurse practitioner
NSAID	Non-Steroidal Anti-Inflammatory Drug

NSQIP	National Surgical Quality Improvement Program
NY	New York
NYHA	New York Heart Association
OA	Osteoarthritis
OARA	Outpatient Arthroplasty Risk Assessment
OHS	Oxford Hip Score
OJA	Outpatient joint arthroplasty
OKS	Oxford Knee Score
OR	Odds ratio
PA	Physician assistant
PACU	Post-anesthesia care unit
PCM	Paracetamol
PE	Pulmory embolism
PERT	Program Evaluation and Review Technique
PFA	Patellofemoral arthroplasty
PL	Posterolateral
PNB	Peripheral nerve block
PONV	Postoperative nausea and vomiting
PRISMA	Preferred Items for Reporting Systematic Reviews and Meta-Analysis
PROM	Patient-reported outcome measure
PROMIS®	Patient-Reported Outcomes Measurement Information System
PT	Physical therapy
QALY	Quality-adjusted life year
QoL	Quality of life
RAAS	Renin-angiotensin-aldosterone system
RCT	Randomized controlled trial
RHA	Resurfacing hip arthroplasty
ROBINS-I	Risk Of Bias In Non-randomized Studies – of Interventions
RRAT	Readmission Risk Assessment Tool
SD	Standard deviation
SDD	Same-day discharge
SE	Standard error
SNS	Sympathetic nervous system
SPSS	Statistical Package for the Social Sciences
SSI	Surgical site infection
THA	Total hip arthroplasty
THAMCR	Truven Health Analytics Marketscan Commercial Research
TJA	Total joint arthroplasty

TJR	Total joint replacement
TKA	Total knee arthroplasty
TNF-α	Tumor necrosis factor-alpha
TXA	Tranexamic acid
UK	United Kingdom
UKA	Unicompartmental knee arthroplasty
USA	United States of America
VAS	Visual Analogue Scale
VTE	Venous thromboembolism
WHO	World Health Organization
WOMAC	Western Ontario and McMaster Universities Osteoarthritis Index
YLD	Years lived with disability
ZBC	Zelfstandig behandelcentrum

Statements relating to the thesis entitled

OUTPATIENT HIP AND KNEE ARTHROPLASTY

Advancing the optimization of care pathways

Mark H.F. Keulen

1. The majority of patients undergoing total hip or knee arthroplasty are limited primarily by disability rather than acute illness, and may not require extended inpatient hospitalization *(Boonen, n.d.; this thesis)*.

2. Outpatient hip and knee arthroplasty is feasible and safe; however, its success depends on strict patient selection and well-structured care pathways, as not all patients are suitable for this approach *(this thesis)*.

3. Fast-track and outpatient protocols are dynamic entities that must continuously adapt to emerging evidence *(Schotanus, n.d.; this thesis)*.

4. Uniform definitions and standardized registration of outcomes such as complications, readmissions, and reoperations are essential for international comparability *(this thesis)*.

5. With an aging population, orthopedic care must move beyond treatment to emphasize prevention and the maintenance of mobility.

6. If you don't have data, you cannot manage it *(Kehlet, 2017)*.

7. The word is sharper than a surgeon's knife *(Heyligers, n.d.)*.

8. Broad implementation of outpatient arthroplasty has the potential to reduce healthcare costs and optimize hospital capacity, without compromising the quality of care *(this thesis)*.

9. In the Netherlands, current reimbursement systems provide greater financial incentives for overnight hospital stays than for same-day discharge, which may hinder the broader adoption of outpatient joint arthroplasty pathways *(this thesis)*.

10. The key question in our understanding of the pathogenesis of postoperative morbidity is related to the pathophysiological role of the various components of the surgical stress response and whether or not a modification of such responses may improve surgical outcome (*Kehlet, 1997)*.

11. Innovations in orthopaedics often fail to reach their full potential due to the knowledge-practice gap and clinicians' reliance on established habits rather than evidence-based practices.