Orthopedic Surgery in Enhanced Recovery After Surgery

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Background and History of ERAS in Orthopedic Surgery

The systematic implementation of an evidence-based perioperative care pathway—an enhanced recovery after surgery (ERAS) pathway (also known as fast-track)—has demonstrated that hospital length of stay and complications can be reduced, without increasing readmissions [1]. The first orthopedic surgeries to use ERAS pathways were total hip arthroplasty (THA) and total knee arthroplasty (TKA). These surgeries were chosen as they were both high volume, had long hospital length of stays, and carried high costs. ERAS pathways were first widely adopted in countries such as Denmark and the United Kingdom (UK) [2–5] through the use of centrally organized improvement programs. Their success led to their spread internationally, and their use is now broadly accepted as best practice for hip and knee arthroplasty surgeries (Fig. 49.1).

ERAS pathways aim to reduce a patient's recovery time following surgery and improve patient outcomes. To do this, orthopedic ERAS pathways encourage the patient to be active in the process of their recovery. Multidisciplinary teams focus on combining the evidence-based clinical steps with the required process and system changes, so that care is consistent for each patient. Logistical processes as well as clinical steps are optimized for each patient, so that postoperative recovery is quickened and complications, adverse events, and morbidity are reduced.

The overarching principles of an orthopedic ERAS pathway can be divided into four stages. At the preoperative stage, the focus is on optimization of preoperative health (such as the management of anemia and the promotion of smoking cessation), preoperative education and counseling, and the preemptive organization of discharge arrangements. Intraoperatively, atraumatic surgical techniques are used; anesthesia and analgesia protocols are optimized; multimodal opioid-sparing analgesia regimes are adopted; blood loss is spared; normovolemia and normothermia are promoted; and hypoxia is prevented. Postoperatively, early ambulation is encouraged; effective analgesia is given, avoiding opioids where feasible; catheters, drains, and drips are not used or removed as soon as possible; and patients are encouraged to eat and drink early and wash, dress, and socialize as soon as possible. All patients are discharged home, using agreed criteria managed by the multidisciplinary team, with clear instructions and support on progressing independently. The details of effective ERAS programs have been previously reported [2].

ERAS pathways have been so successful in reducing length of stay that there is now growing evidence to suggest that outpatient surgery for THA and TKA is feasible for selected patients. A recent prospective study [6] found that of 557 unselected patients who were referred for surgery, actual discharge on the day of surgery occurred for 13–15%. Fifty-four percent had been identified as potentially being eligible for outpatient surgery. Twenty-eight percent of THA patients who had been identified as being eligible went on to have outpatient surgery, along with 24% of identified TKA patients. It was noted that 25% of those originally identified as being eligible for outpatient surgery could not be discharged on the same day as they had no adult available to stay with them for more than 24 hours following discharge. The most common reasons for not being discharged were lack of motivation, not fulfilling discharge criteria, and inability to mobilize safely.

Two recent systematic reviews [7, 8] also suggest that outpatient arthroplasty can be a safe and effective procedure for carefully selected patients; however, more research is required in order to critically examine its safety and potential cost savings.

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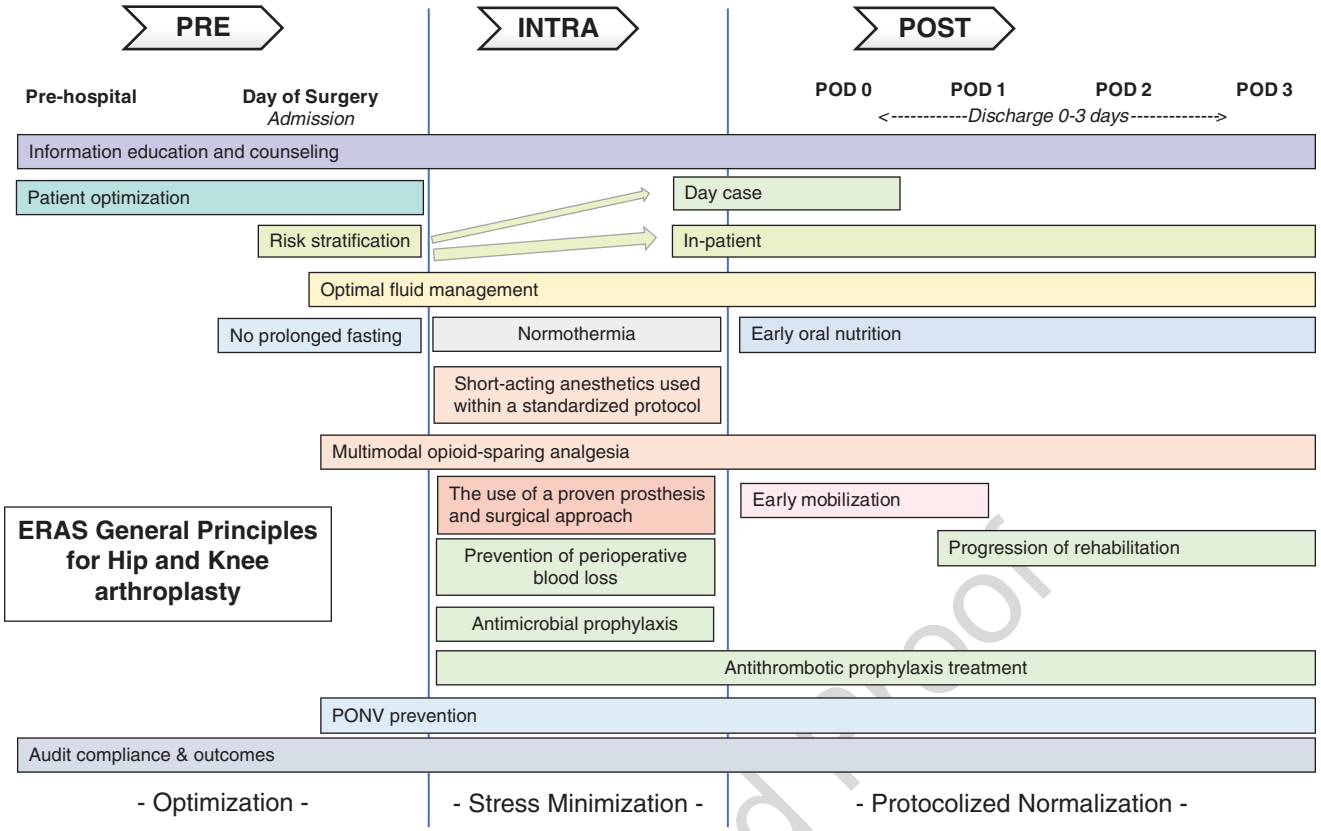

Fig. 49.1 ERAS general principles for hip and knee arthroplasty. PONV postoperative nausea and vomiting

ERAS in Total Hip Arthroplasty and Total Knee Arthroplasty

Clinical Outcomes

ERAS has been reported to improve the quality of care for patients in orthopedic surgery across a range of quality outcome measures, and it should be remembered that fast-track and ERAS protocols have always been based on the concept of "first better – then faster." Quality in healthcare is complex and multifaceted; however, the six dimensions through which the overall concept of quality is usually expressed (safety, effectiveness, patient-centeredness, timeliness, efficiency, and equity) can all be argued to have been improved through the implementation of ERAS within THA and TKA pathways.

Length of Stay, Readmissions, and Complications

Total hip arthroplasty (THA) and total knee arthroplasty (TKA) are common major surgical procedures often performed in older patients with complex comorbidities. ERAS has evolved during the past 20 years and has been shown to be effective in reducing length of hospital stay (LOS) from 4–12 days to 1–3 days [9, 10] without increasing complications or readmission rates or compromising patient safety [11]. In one of the most comprehensive reports of readmissions post ERAS in hip and knee arthroplasty, Husted et al. [2] found that in fast-track protocols, there was no increase in readmission rates and complications, such as dislocation after THA and reduced range of motion after TKA requiring manipulation.

The literature has been consistent in finding that readmissions do not increase following the implementation of ERAS; however, studies should be read carefully to ensure classification of readmissions is provided. In addition, the comparison of readmission rates after ERAS between different countries and institutions is difficult because readmissions may be classified differently. For example, a suspected deep vein thrombosis (DVT) patient may be admitted to hospital in some hospital systems or seen as an outpatient in others. Some patient groups are still more likely to be readmitted than others, even with ERAS; for example, a study of 2734 hip arthroplasty patients on a fast-track pathway found that patients aged 75 and over, and with pharmacologically treated psychiatric disease, were at an increased risk of dislocation [12]. In another study, the same research group concluded that surgery-related falls and subsequent readmission

after both hip and knee arthroplasty were related to patient characteristics rather than the fast-track pathway [13].

Mortality

Historically, mortality rates in hip and knee arthroplasty surgeries are relatively low, but the implementation of ERAS has been found to further reduce mortality rates. A large and well-conducted UK study comparing 3000 unselected ERAS patients with 3000 who had been on a traditional protocol reported reductions in mortality [10]. Mortality at 30 days and at 90 days was 0.1% and 0.5%, respectively, as compared to 0.5% and 0.8% when patients were on a traditional protocol ($p = 0.03$ and $p = 0.1$). A follow-up to this study [14] reported a mortality rate of 2.7% at 2 years, compared to 3.8% for those on the traditional protocol ($p = 0.05$). The authors suggest that a reduced stress response, shorter length of stay (LOS), and improved pain control for the ERAS cohort may have contributed to this lower rate. Importantly, in another large study of THA and TKA patients in Denmark, in which more than 17,000 on an ERAS pathway were compared to nearly 62,000 on a traditional pathway, no increase in mortality was found following ERAS, although this study fell short of proving a decrease in mortality within 90 days of surgery [11].

Patient-Reported Measures

Patient-reported outcome measures (PROMs) and patient-reported experience measures (PREMs) are considered an important patient-centered measure of quality within ERAS pathways [15, 16]. In the United Kingdom, hospitals are now required to collect PROMs for all primary total hip and knee arthroplasty patients as part of a national monitoring program. In the United Kingdom, the measures used comprise generic (e.g., EQ5D-5 L, EQ-VAS) and condition-specific measures (e.g., Oxford hip and knee scores).

A systematic review of patient-generated data following orthopedic surgery [17] for patients on an ERAS pathway found a lack of data. Their review included data on 2208 THR and TKR patients, from 8 papers. Six of the papers reported on patient satisfaction and found that scores were high and not affected by length of stay. Quality of life, reported in two papers, continued to increase following surgery for up to 12 months; however, one paper highlighted problems for patients in gaining necessary support post-discharge.

There are, however, issues in using PROMs as an outcome when assessing function. In a recent study of 80 patients [18], no correlation was found between objectively assessed function and improvements found using PROMs at 14 days post-surgery for THA patients and at 21 days post-surgery for TKA patients. While PROMs had improved following surgery, functional ability was decreased when objectively assessed using the 40 m paced walk test, a 30s chair stand test, and a 9-step stair-climb test and by an actigraphy recording of the level of activity. Consequently, in the future, objective functional data will be increasingly important from both a population and economic perspective, given the known increased healthcare costs and lower income levels of patients after THA and TKA [19], especially in light of recent research that has found little evidence that physical activity increases following TKA or THA [20–22].

Economics

Economic considerations are important when considering THA and TKA. They have been quoted to be two of the most successful operations and hence are being performed with increasing volume year-on-year around the world in order to reduce pain and improve function [23]. Although ERAS pathways have been shown to reduce LOS without increasing complications and readmissions, few studies have investigated the cost-effectiveness of implementing these protocols. A systematic review evaluating the cost-effectiveness of ERAS across a variety of surgical specialties concluded that ERAS protocols appeared to be cost-effective in the short term; however, data on costs post-discharge were lacking [24].

A study in Denmark [25] used a time-driven activity-based costing method to analyze time consumed by different staff members involved in the treatment of THA and TKA patients on ERAS pathways at two different hospitals. They found costs (excluding the prosthesis) of $2511 for THA and $2551 for TKA. Although these costs were not directly comparable to those published for more conventional pathways [26, 27] due to differences in process and logistics, importantly the ERAS pathways were cheaper.

Implementation

ERAS pathways have been shown to safely reduce length of stay to between 1 and 3 days, and outpatient surgery is now possible in unselected patients [6]. However, despite this there is evidence that only 40% of hospitals detail ERAS in patient information leaflets for THA and TKA [28], suggesting that adoption of the practice may not be complete. Therefore, in addition to further examine how to optimize the pathophysiological challenges that may affect early patient recovery, the present state of the implementation of ERAS in clinical practice should be considered. This is pertinent, because in order to achieve the goal of a "pain- and risk-free

surgery," we need to combine clinical evidence with implementation in order to do "the right things right" (Fig. 49.2). However, despite the established evidence-based and widespread acceptance of ERAS for THA and TKA principles over the last 20 years, mean LOS for both THA and TKA is still greater than 4 days in a socialized health system such as the National Health Service (NHS) in the United Kingdom [29]. The reasons that may underpin the slow adoption of ERAS have been previously described [30] and include a lack of understanding, a lack of acceptance, a lack of ability, no organizational will to change, deficient leadership, and poor audit mechanisms. Therefore, the immediate challenge for health systems such as the NHS to improve surgical outcomes is a quality improvement one, where efforts to implement what is already known should be prioritized given the improvement seen in clinical outcomes with ERAS.

The Development of ERAS® Society Guidelines for Hip and Knee Arthroplasty

Over the last 15 years, the systematic implementation of ERAS pathways has shown that hospital LOS and complications can be reduced [1] for a number of surgical procedures and ERAS protocols have been published for rectal, urological, pancreatic, gastric, breast and reconstructive, head and neck cancer, bariatric, and liver surgery [31–38].

For hip and knee arthroplasty, up until now there have only been narrative reviews on fast-track/enhanced recovery protocols [39–41], and a systematic and evidence-based guideline has not been produced. Therefore, the ERAS® Society has recently brought together a group of international ERAS experts, in order to produce ERAS® Society recommendations for hip and knee arthroplasty. These recommendations [42, 43] represent an extremely important document in summarizing the large volume of heterogeneous studies across all ERAS components within hip and knee arthroplasty surgery. The recommendations are detailed in Table 49.1 and are represented schematically in Fig. 49.2. Many of the principles are consistent with the core principles of ERAS in other surgical procedures.

These guidelines include a total of 17 topic areas. Best practice includes optimizing preoperative patient education, anesthetic technique, and transfusion strategy, in combination with an opioid-sparing multimodal analgesic approach and early ambulation. There is insufficient evidence to recommend that one surgical technique (type of approach, use of a minimally invasive technique, prosthesis choice, or use of computer-assisted surgery) over another will independently effect achievement of discharge criteria. The guidelines are consistent with other ERAS surgical procedures in recommending the limitation of fasting preoperatively, along with intraoperative optimization of fluid management, maintenance of normothermia, and prophylactic treatment for

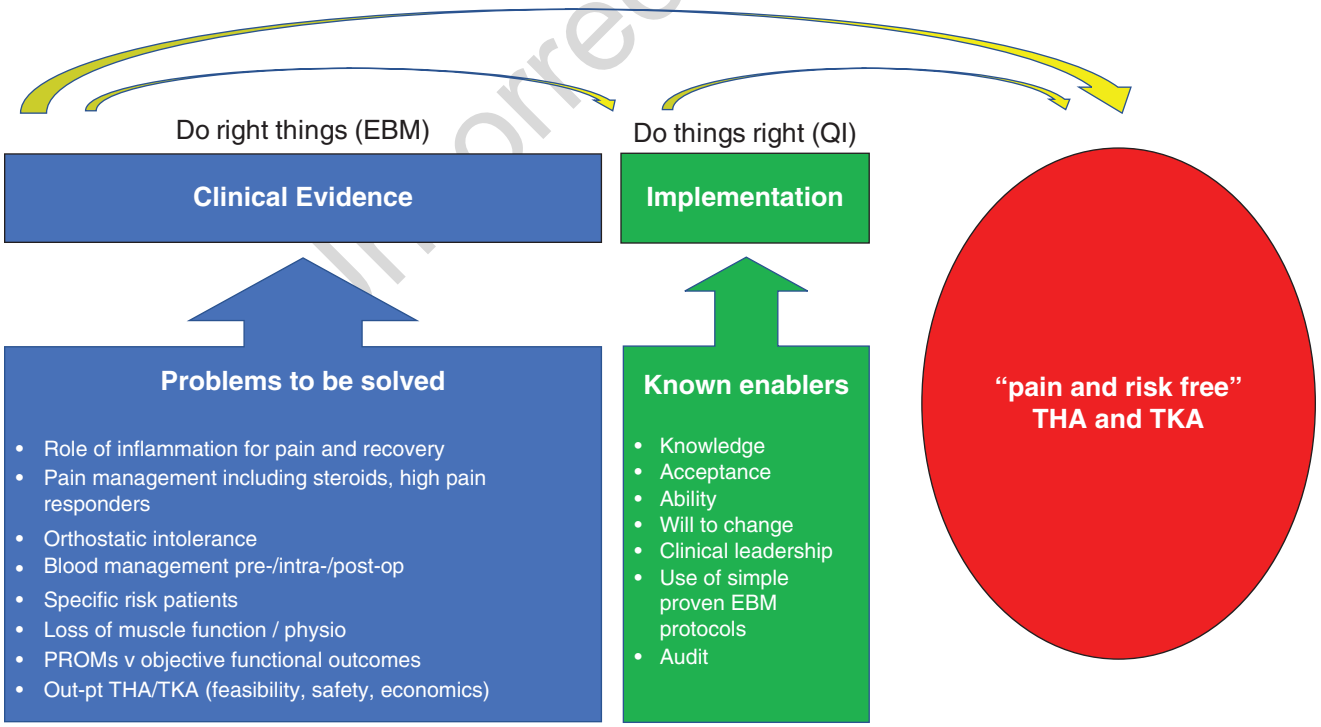

Fig. 49.2 ERAS in hip and knee replacement (THA and TKA): Recommendations for future development. EBM evidenced-based medicine, QI quality improvement, PROMs patient-reported outcome measures, Out-pt outpatient

Table 49.1 ERAS® Society recommendations for hip and knee arthroplasty

Number	Item	Recommendation	Evidence level	Recommendation grade
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	Smoking: high Alcohol: low	Strong
		Anemia should be actively identified, investigated, and corrected preoperatively	High	Strong
3	Preoperative fasting	Clear fluids should be allowed up to 2 h and solids up to 6 h hours prior to induction of anesthesia	Moderate	Strong
4	Standard anesthetic protocol	General anesthesia and neuroaxial techniques may both be used as part of multimodal anesthetic regimes	General anesthesia: moderate Neuroaxial techniques: moderate	Strong
5	Use of local anesthetics for infiltration analgesia and nerve blocks	Within a multimodal opioid-sparing analgesic regimen, the routine use of LIA is recommended for knee replacement but not for hip replacement. Nerve block techniques have not shown clinical superiority over LIA	LIA in knee replacement: high	Strong
6	Postoperative nausea and vomiting	Patients should be screened for and given multimodal PONV prophylaxis and treatment	Moderate	Strong
7	Prevention of perioperative blood loss	Tranexamic acid is recommended to reduce perioperative blood loss and the requirement for postoperative allogenic blood transfusion	High	Strong
8	Perioperative oral analgesia	A multimodal opioid-sparing approach to analgesia should be adopted. The routine use of paracetamol and NSAIDs is recommended for patients without contraindications		
			Paracetamol: Moderate	Strong
			NSAIDs: High	Strong
9	Maintaining normothermia	Normal body temperature should be maintained peri- and postoperatively	High	Strong
10	Antimicrobial prophylaxis	Patients should receive systemic antimicrobial prophylaxis	Moderate	Strong
11	Antithrombotic prophylaxis treatment	Patients are at increased risk of VTE and should undergo pharmacologic and mechanical prophylaxis in line with local policy	Moderate	Strong
12	Perioperative surgical factors	Surgeons are recommended to use a proven prosthesis and surgical approach	High	Strong
13	Perioperative fluid management	A fluid balance should be maintained to avoid over- and under-hydration	Moderate	Strong
14	Postoperative nutritional care	An early return to normal diet should be promoted	Low	Strong
15	Early mobilization	Patients should be mobilized as early as they are able in order to facilitate early achievement of discharge criteria	Moderate	Strong
16	Criteria-based discharge	A team-based functional discharge criteria should be used to facilitate patient discharge directly to their home	Low	Strong
17	Continuous improvement and audit	The routine audit of process measures, clinical outcomes, cost-effectiveness, patient satisfaction/experience, and changes to the pathway is recommended	Low	Strong

LIA local infiltration analgesia, *PONV* postoperative nausea and vomiting, *VTE* venous thromboembolism

infection and thrombosis. Postoperatively, in addition to early mobilization, early oral feeding is recommended. The published guidelines [43] will provide a detailed narrative review of all of the current literature and explain why certain components have been included and why other elements are not currently recommended.

The recommendations provide a starting point for implementation for teams new to ERAS and as a point of reflection for experienced ERAS teams to examine their current practice. These guidelines and the testing of their implementation, as has been performed in other ERAS procedures, will hopefully allow us to consolidate consensus within the evidence base, and generate new evidence, through systematic prospective data collection and through clinical trials.

Future Directions for Research

Future research for ERAS in hip and knee arthroplasty should focus on reaching the goal of the "pain- and risk-free"

hip and knee arthroplasty [44]. In order to do this, we need to better understand the pathophysiological mechanisms of recovery and the potential to optimize post-discharge functional outcomes [45]. This will be important because for some of the ERAS components, there is a strong need for properly designed randomized controlled studies that are sufficiently powered and performed in ERAS settings and that allow for discrimination between outcome parameters.

More specifically, it has been identified by Wainwright and Kehlet [45] that future trials should examine the preoperative prediction of high-inflammatory responders, with further dose-finding or repeat-dosing glucocorticoid or other anti-inflammatory agents in studies in high-inflammatory responders [46] as well as more specific studies on high-pain responders (preoperative opioid users, pain catastrophizers, sensitized patients, etc.) [47].

In addition, work is still required in order to understand how to reduce impairment of physical activity and improve function quicker postoperatively; how to better identify patients at high risk of complications owing to psychiatric disorders, chronic renal failure, and orthostatic intolerance; anemia and transfusion thresholds; postoperative urine retention and urinary bladder catheterization; and how to improve sleep. Intertwined with this will be the need for further research on the feasibility of same-day surgery and the type, timing, and duration of physiotherapy post-discharge [45, 48]. The future directions recommended for research are summarized within Fig. 49.2 along with the recognized implementation factors identified earlier in the chapter.

ERAS in Other Orthopedic Procedures

Given the excellent outcomes for ERAS in hip and knee arthroplasty patients, it would therefore seem prudent to apply ERAS to every orthopedic procedure so that all orthopedic patients may benefit from the approach. Given the high volumes of orthopedic procedures, there is significant scope to improve patient outcomes and also significantly increase hospital productivity if ERAS pathways are implemented more widely. The staff involved in treating and looking after joint arthroplasty patients are often the same teams that care for all other types of orthopedic patients. Therefore, it should be relatively straightforward to achieve strong commitment and "buy-in" from these people to change the pathway and improve patient outcomes for other procedures.

Fractured Neck of Femur

Despite the fact that fractured neck of femur (FNOF) is an emergency procedure, given the similarities to primary and revision hip arthroplasty and the substantial scope for improvement, the application of ERAS to this population demands attention. The National Hip Fracture Database reports that in 2016 more than 65,000 people were treated for hip fracture in England, Wales, and Northern Ireland. A study of NHS Trusts in England from November 2013 to October 2014 found that LOS for NHS Trusts ranged from 12.3 days to 33.7 days, even though predicted LOS for these NHS Trusts, when adjusted for case mix, only ranged from 21.5 to 24.4 days [49]. Other studies have also found significant variation in practice in the treatment and care of trauma patients [50, 51]. Wainwright et al. [49] contend that the introduction of an adapted and FNOF procedure-specific ERAS pathway could reduce variations in practice and therefore overall LOS.

As with other orthopedic procedures, pain is a major contributor to delayed mobilization and recovery in FNOF patients, and Wainwright et al. [49] highlighted the role that peripheral nerve blocks may have in this pathway. A recent Cochrane Review found that compared with other modes of analgesia, peripheral nerve blocks used to treat FNOF reduce pain on movement better within 30 minutes, the risk of postoperative pneumonia is reduced, there is a reduced time to first mobilization after hip fracture surgery (approximately 11 hours earlier), and the use of a peripheral nerve block given as a single injection leads to a reduced cost of analgesic drugs [52].

A further study in New Zealand [53] supports the implementation of ERAS for this patient cohort, showing that overall LOS reduced for FNOF patients by 4 days after the introduction of an ERAS pathway. Time in the emergency department was reduced by 30 minutes, and the overall time in rehabilitation reduced by 3–7 days depending on the type of facility, so that patients spent 95 hours less in hospital than a comparable group on a conventional pathway in the 3 years prior to the ERAS pathway introduction. The FNOF-specific ERAS pathway focused on full interdisciplinary involvement. Orthopedic assessment was encouraged on the orthopedic ward that specialized in FNOF management, rather than in the emergency department, and every possible attempt was made to operate on the patient either that day or the following morning. Outstanding investigations were prioritized so that patients could proceed to surgery quickly. It was agreed that all patients should be suitable for rehabilitation and weight bearing 48 hours following surgery. The rehabilitation team was multidisciplinary, comprising nurses, medical, occupational therapists, physiotherapists, and social workers. Electronic data on the management of the patients was available in real time and was analyzed by staff on a weekly basis so that cross-functional teams could explore process issues and agree on actions to continue to improve clinical outcomes. A second study by Haugan et al. [54] in Norway, comparing 1032 FNOF patients on an ERAS protocol to 788 on a conventional pathway, found no differences

between the groups in mortality and readmission within 365 days after the initial hospital admission. LOS was also reduced by 3.4 days in the ERAS group.

The findings of these initial studies on using ERAS pathways in FNOF are encouraging. If the success of implementing ERAS in elective pathways can be reproduced in FNOF pathways, this would have a big impact on health systems in terms of resources and cost economics and help to reduce some of the capacity and economic pressures on these systems.

Shoulder Arthroplasty

Total shoulder arthroplasty (TSA) is becoming increasingly popular, with the United States (US) reporting an increase in procedure rates of 319% between 1993 and 2007 [55]. As yet, there are few studies reporting on ERAS concepts being applied to TSA. An examination of Hospital Episode Statistics [56] from April 2015 to March 2016 found that NHS Trusts in England had LOS that varied from 1.0 to 6.4 days for TSA [57]. Expected case mix-adjusted LOS ranged from 10.0 to 3.9 days, thereby suggesting that there is scope to reduce LOS for TSA with the introduction of ERAS.

As with all types of surgery, procedure-specific guidance will be required for ERAS in TSA, whereby principles from THA/TKA are adapted and added to TSA. One such example is in the multimodal pain management strategies that have been successfully adapted and implemented in TSA pathways [58, 59]. Routman et al. [60] found that the addition of intravenous dexamethasone and liposomal bupivacaine injections to the surgical site intraoperatively in patients undergoing TSA under general anesthesia, with a single-injection interscalene block, reduced median LOS from 2 days to 1 day, with reductions in pain and the need for opioids. As with other orthopedic surgeries, conflicting results have been found on the most effective combination of regional blocks [61, 62] in total shoulder arthroplasty (TSA).

A US retrospective study [63] matched 136 TSA patients in a tertiary referral center (TRC) to 136 patients at an orthopedic specialty hospital (OSH) with protocols similar to ERAS. They found that although readmission rates were similar, the OSH had a lower LOS than the TRC (1.3 ± 0.5 days vs 1.9 ± 0.6 days, $p < 0.001$). Previously a study in Germany [64] had introduced ERAS concepts in areas such as pain management, drainage and catheter management, physiotherapy, and early mobilization and found improvements in LOS and patient and staff satisfaction.

Recent research, mostly retrospective, also indicates that outpatient TSA, implementing ERAS concepts such as multimodal pain strategies and minimizing blood loss, is feasible in appropriately selected patients [65, 66].

Ankle Arthroplasty

Until recently arthrodesis has been the routine treatment for end-stage osteoarthritis of the ankle. However total ankle arthroplasty (TAA) is now becoming more common with the introduction of better surgical techniques and training and a third generation of three-component mobile-bearing implants [67, 68]. Hospital Episodes Statistics (HES) data from NHS Trusts in England from April 2015 to March 2016 show that the mean LOS for TAA was 3.3 days, with a staggering range of 17.3 days between the hospitals with the minimum and maximum mean LOS [69]. The range of case mix-adjusted expected LOS was just 3.7 days, suggesting that those hospitals with a longer LOS were not outliers due to case mix but due to the pathway of care, and so therefore improvements may be possible with the introduction of ERAS.

There is little in the literature on the application of ERAS concepts to TAA. However, there is some evidence supporting the use of regional anesthesia and analgesia over systemic opioids [70–72], and pain management is a vital consideration in TAA patients. However, as yet there is limited evidence on multimodal pain management as part of ERAS pathways for TAA. One recent small study gave patients 30–50 ml of bupivacaine as local infiltration analgesia (LIA) intraoperatively as part of a newly introduced ERAS pathway. LOS reduced from 3.6 to 2.3 days, and there was a significant improvement in pain scores following the introduction of the new pathway [73]. There have been some small retrospective studies on outpatients undergoing TAA that have used a single-shot popliteal block with ropivacaine followed by periarticular liposomal bupivacaine at the end of the surgery [74] or a popliteal and saphenous nerve block prior to surgery [75]; however further research is required in this area.

These studies therefore provide evidence to suggest that outpatient TAA can be successful for selected patients, if teams are experienced and if there is a good postoperative support network [75, 76]. Further work is required, especially within rehabilitation where discharge can be delayed due to social/home circumstances, and post-discharge rehabilitation improvements are required in order to expedite return to functional activities.

Spinal Surgery

The demand for complex spinal surgery is increasing [77, 78] and may be undertaken within both orthopedic and neurosurgical settings. Wide variations in LOS, complications rates, postoperative pain, and functional recovery are reported [77, 79], and so, as for TSA and TAA surgeries, there are strong clinical and economics arguments to improve

outcomes for spinal surgery by implementing ERAS principles.

There is little evidence as yet published on the implementation of ERAS pathways in spinal surgery [80]. The introduction of a novel minimally invasive surgical approach with ERAS components [81] for 42 patients undergoing one- or two-level spinal fusion was found to be successful. A quality improvement study [82] examined the development of an ERAS pathway in an elective spinal service, in a hospital experienced in implementing ERAS for hip and knee arthroplasty patients. The service included more complex procedures, such as posterior scoliosis correction. ERAS components of the pathway included a leaflet describing what to expect following surgery, carbohydrate drinks, laxatives, minimally invasive surgical techniques, the use of tranexamic acid for longer operations, and an estimated discharge date. Standardized multimodal anesthetic and analgesic regimens were implemented, avoiding large doses of intraoperative opioids. The ERAS pathway was successful with overall mean LOS reduced by 3 days to 3 days and readmissions reduced to 3% from 7%. In addition, nearly all patients rated their satisfaction with the pathway as good or excellent. Studies have also shown that ERAS pathways can be successfully implemented for adolescent idiopathic scoliosis surgery [83, 84].

These initial successes indicate that ERAS pathways should be applicable to all spinal surgery patients, although there is a need for spinal-specific guidelines to enable more widespread adoption. These guidelines need to allow for adaptation to different procedures and the varying levels of preoperative disability and pain [42]. A dedicated chapter on spinal surgery and neurosurgery, providing more details of this patient group, can be found in this book.

Conclusion

This chapter has detailed that ERAS is a proven and widely adopted technique for improving outcomes in hip and knee arthroplasty. While outcomes have improved dramatically in the last 10 years, challenges remain in order to achieve widespread adoption and implementation of what is already known, and there are future research challenges in order to improve our understanding of the pathophysiology of factors effecting recovery, such as the inflammatory response and pain, and the most effective rehabilitation regimes. The new ERAS Guidelines will hopefully help to bridge both the implementation gap for those new to ERAS and help to consolidate the current heterogeneous evidence base, where direct comparison of ERAS components is difficult with so many differences to the ERAS pathways currently used. The application and development of ERAS in other elective and emergency orthopedic procedures is an exciting and emerging area that looks set to bring the benefits of ERAS to even more patients.

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