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Impact of an Enhanced Recovery Protocol on Postoperative Outcomes After Elective Arthroplasty

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The prevalence of osteoarthritis continues to increase, driven by our ageing population and the growing obesity epidemic, leading to a rise in arthroplasties. Enhanced recovery programmes have been developed to optimise perioperative care and reduce length of stay (LOS). Our aim was to investigate the effect of an enhanced perioperative protocol at a high-volume regional elective hospital on readmission rate, LOS and adverse events.

We compared elective arthroplasties from June to December 2022 (cycle 1, pre-protocol) to those from the same period in 2023 (cycle 2, post-protocol). Data included demographics, surgical procedures, and perioperative management, with a primary outcome of 30-day readmissions and secondary outcomes of revisions, LOS, and postoperative complications. Cycle 1 included 973 patients, mean age 69.9, standard deviation (SD 9.8), and cycle 2 included 1114 patients, mean age of 69.2 (SD 10). The mean LOS decreased from 2.26 days (SD 1.73) to 1.95 days (SD 2.67) ($p<0.01$), with 5.1% discharged on the day of surgery. Our 30-day readmission rate post intervention was 2.3% in cycle 2 compared to 0.6%, ($p<0.01$). There were no inpatient mortalities on first admission, however 1 reported death during readmission in cycle 2. There was no difference in surgical site infections (1.2% compared to 1.1%, $p=0.74$) and two cases of pulmonary embolism in cycle 2.

The 24-hour arthroplasty perioperative protocol effectively reduced LOS, there was a small increase in 30-day readmissions.

Keywords: Arthroplasty, Length of Stay, Enhanced Recovery.

INTRODUCTION

Osteoarthritis is becoming more prevalent in the Western World, primarily driven by an aging population and the growing obesity epidemic. These demographic shifts have contributed to a substantial rise in lower limb osteoarthritis, with the 2023 Swedish Arthroplasty Register reporting that 3.3% of individuals have received at least one hip or knee arthroplasty per 100,000 inhabitants[1]. In the United Kingdom (U.K.) 108,558 primary hip and 116,845 knee arthroplasties were performed in 2023[2]. Over 3.8 million hip and knee replacements have been recorded in the American Joint Replacement Registry (AJRR)[3]. The definitive treatment for end stage arthritic disease is a joint arthroplasty, with an average hospital LOS of 1.2 days after a total hip replacement (THR)[4].

Using the principles of the enhanced recovery programme founded by Kehlet et al. for colorectal surgery, postoperative care has advanced[5]. Through the utilisation of these principles, which entail more targeted perioperative care measures, there has been a decrease in postoperative LOS after an elective arthroplasty, with some achieving same day discharge[6]. Wainwright et al. reported LOS following hip and knee arthroplasties has been reduced from 4-10 days to 1-3 days as per data from 2013[7]. This multimodal pathway has enabled a higher turnover of lower limb arthroplasties to help tackle our osteoarthritis epidemic, whilst still maintaining good surgical outcomes and reducing pressures on the National Health Service (NHS).

Since 2023, our trust has implemented a protocol aimed at facilitating early discharge for lower-risk anaesthetic candidates due to undergo an elective

arthroplasty[8]. Our aim was to assess if our enhanced perioperative protocol can reduce LOS and achieve good surgical outcomes through assessing the number of recorded post operative complications, revision surgeries and 30-day re admissions.

MATERIALS AND METHODS

The study was conducted at a large regional elective surgical "hub".

Data collection

The inclusion criteria consisted of adults who had undergone an elective joint arthroplasty for arthritic disease by a sub-specialty arthroplasty surgeon during 2 study periods: June to December 2022 (cycle 1) and June to December 2023 (cycle 2). Patients who required arthroplasties due to trauma or pathology other than osteoarthritis were excluded. The decision for patients to undergo an enhanced recovery was made in the preassessment clinic after careful review of individual characteristics, clinical assessment and anaesthetic risks.

Data was extracted from our patient's electronic health records and then securely stored on an anonymised database. We gathered data on demographics, American Society of Anesthesiologists (ASA) score, the specific surgical procedure performed and details of individual perioperative management.

Our enhanced recovery protocol

In 2023, our trust designed and implemented an enhanced recovery protocol with a primary aim at facilitating early discharge for those undergoing an elective joint replacement (see Table I).

In the pre-operative phase this was initially achieved through early optimisation of any underlying medical co-morbidities reviewed during the pre-assessment clinic. Optimisation techniques consisted of tight glycaemic control, smoking cessation, alcohol consumption advice, and blood pressure reviews.

Patients were well informed of what to expect on the day of their procedure as well as the potential symptoms they may encounter post operatively such as pain, reduced range of movement (ROM) and swelling to help manage their expectations.

On the day of surgery stringent time keeping measures were put in place to ensure prompt theatre schedules. This was achieved through admitting morning listed patients at 7:00 am and afternoon listed patients at 11:00 am. Prior to the procedure patients were reviewed by a senior physiotherapist and post operative X-rays were scheduled in advance.

During the operative phase, specific surgical techniques were employed. Short acting prilocaine spinal anaesthesia was used and intraoperative motor nerve blocks were avoided to allow early mobilisation. Tourniquet use was avoided during total knee replacements (TKR) and both systematic and local tranexamic acid were administered. After the surgery, tight wound closure was achieved and negative pressure dressings were avoided.

Post operatively, patients were encouraged to eat and drink in the recovery unit and commence mobilisation with a senior physiotherapist on the day of their surgery where possible. On discharge, all patients were booked with a telephone consultation 72 hours post procedure.

Table I. — Enhanced recovery protocol implemented before cycle 2.

Preoperative	Operative	Postoperative
• **Preassessment** • Medical optimisation prior to surgery • Physiotherapy and occupational therapy preassessment • Patient education • Commence preoperative analgesia • Anaesthetic assessment for suitability of spinal anaesthesia • **Day of admission** • Morning list patients admitted at 7am. Afternoon list patients admitted at 11am. • Fluid balance • Physiotherapy assessment with senior physiotherapist • X-ray slot scheduled post surgery	• Prilocaine short acting spinal anaesthesia • No motor nerve blocks • Avoid tourniquet use • Injection of local anaesthetic into the posterior capsule of the knee during a TKR. • Systemic tranexamic acid on induction and local tranexamic acid before wound closure • No post operative antibiotics unless indicated after careful assessment •Avoid negative pressure dressings unless indicated	• Commence eating and drinking whilst in recovery • Mobilise early once anaesthesia worn off • Senior physiotherapist review for mobilisation • X-ray completed once mobile • Patient leaflet on discharge • Follow up phone call in 72 hours

Outcomes

The primary outcome was 30-day post-surgery readmissions. Secondary outcomes were LOS, post operative complications and revision surgeries. LOS was collected from inpatient notes. Complications included surgical site infections (SSI), dislocations, venous thromboembolism (VTE) and implant failure requiring revision surgery. Post-operative complications were identified from inpatient records, emergency department (ED) documentation and outpatient clinic reviews.

Two-sided student T-tests were used to compare continuous variables. The LOS data was skewed and so a non-parametric test, the Mann-Whitney U Test, was also employed. Categorical variables were compared using the Chi-squared test. The research and audit board at our institution granted approval for this observational study.

RESULTS

Pre intervention

Cycle 1 included 973 patients, 59.0% of which were women, age 20 to 94 years, mean age 69.9 (SD 9.8). Within our population, 8.5% were ASA 1, 69.6% ASA 2, 21.8% ASA 3 and 0.1% ASA 4. We included 562 knee arthroplasties, 356 hip arthroplasties, 18 shoulder arthroplasties and 1 ankle arthroplasty, of which 97.4% were primary and 2.6% revision.

All 973 patients underwent a successful surgery and there were no recorded inpatient mortalities. There were 6 (0.6%) 30-day hospital readmissions, of which 4 of these were SSI related to the index procedure, 75.0% of which required a joint washout. The mean LOS was 2.26 days (SD 1.73), and 2.9% achieved a same day discharge. The longest LOS was 24 days for 1 patient. The interquartile range (IQR) and median valve were both 2 days. During the post operative phase there were 98 (10.1%) recorded presentations to the ED, with 52.0% related to common post operative complications, such as leg swelling, ROM and pain. There was one case of new atrial fibrillation (AF) and one dislocation of a THR, which was successfully reduced under anaesthesia in the ED. (see Table II and III).

Post intervention

Cycle 2 included 1114 patients, 61.0% of whom were women. We had an older demographic ranging from 30 to 94 years, mean age 69.2 years (SD 10), see Table II. In cycle 2, 6.6% were ASA 1, 63.5% ASA 2, 29.7% ASA 3 and 0.2% were ASA 4. We included 661 knee arthroplasties, 408 hip arthroplasties, 32 shoulder arthroplasties and 3 ankle arthroplasties, 97.0% were primary arthroplasties and 3.0% revision.

There were no significant intraoperative complications and all 1114 patients made a successful recovery and were discharged back into the community. There were no reported inpatient mortalities during the primary admission. Following discharge, there were 26

Table II. — Patient demographics.

Variable	Cycle 1	Cycle 2	p value
Sample size	973	1114	
Female, n (%)	532 (59.0%)	675 (61.0%)	
Male, n (%)	367 (41.0%)	439 (39.0%)	
Mean age in years (SD)	69.9 (9.8)	69.2 (10)	0.1153
ASA classification			
ASA I	8.5%	6.6%	
ASA II	69.6%	63.5%	
ASA III	21.8%	29.7%	
ASA IV	0.1%	0.2%	
Arthroplasty type			
Hip	356	408	
Knee	562	661	
Shoulder	18	32	
Ankle	1	3	

Table III. — Patient outcomes.

Variable	Cycle 1	Cycle 2	p value
Mean LOS in days (SD)	2.26 (1.73)	1.95 (2.67)	<0.01
SSI	10	13	0.74
30- day readmissions (%)	6 (0.6%)	26 (2.3%)	<0.01

(2.3%) 30-day hospital readmissions (p<0.01). The mean LOS reduced to 1.95 days (SD 2.67, p<0.01), with 5.1% achieving same-day discharge. One patient stayed for the longest LOS at 43 days. The median LOS was 2 days and the IQR was calculated at 1 day. Given that LOS demonstrated a right-skewed distribution the Mann–Whitney U test, a non-parametric method, was employed to overcome this variable. The difference remained statistically significant (Mann–Whitney U = 415,262, p<0.001).

During the recovery period there were 139 (12.5%) recorded presentations to the ED, 58.3% of which were related to commonly encountered post operative symptoms, such as pain, ROM and swelling. Of the 139 ED presentations, 26 were subsequently admitted within 30 days of their initial discharge following arthroplasty.

Of the 26 (2.3%) 30- day hospital readmissions, 13 (1.2%) of these were SSI, with one case of wound dehiscence (p=0.78). 9 of the 13 SSI underwent a joint washout (69.0%). There were two cases of pulmonary embolism (PE), both of which were discharged on a treatment dose of an anticoagulant. There were 2 hip dislocations, both of whom underwent a closed reduction under anaesthesia in the ED. One patient underwent a revision of their THR. Finally, there was one reported mortality 1 month after a TKR following an aspiration pneumonia during second admission. Overall, in cycle 2 there was a total of 51 complications, compared to 50 in cycle 1 (p=0.6). (See table II, III, Figure 1-2).

A reduced LOS can lead to significant cost savings. To calculate our cost saving for cycle 2 we multiplied the difference in mean LOS (0.31) by our total sample size for cycle 2 (1114 patients) and our nightly reimbursement cost of £320, which equated to a saving of approximately £110,508.80, minus the cost of the small additional number of readmissions[8]. Hospitals are reimbursed for the services they provide and the nightly reimbursement cost provides an estimate of the cost for inpatient care. It is the amount paid to hospitals when patients stay beyond the standard duration which varies according to the complexity of the case[8].

DISCUSSION

After the introduction of our protocol in 2023 all 1114 patients within cycle 2 underwent a successful arthroplasty. They were all safely discharged back into the community, LOS was reduced by a mean of 0.31 days (SD 0.94, p<0.01), with no recorded inpatient mortalities during first admission.

Early recovery is associated with numerous physiological benefits, such as reduced incidence of VTE and improved musculoskeletal function[9,10]. There is also a psychological link between early ambulation and empowering patients to take responsibility for their own health, which will indirectly help support their recovery. This aspect was incorporated within our protocol, in which patients were encouraged to mobilise as early as 2-4 hours post surgery[10], reducing the risk of immobility complications.

Following the principles of a rapid discharge after an arthroplasty there has been conflicting literature into whether reduced LOS is correlated with an increase in hospital reattendance, with some studies noting a rise of 13.0% in 30-day readmissions[11]. Within our study, 30 day-readmissions increased

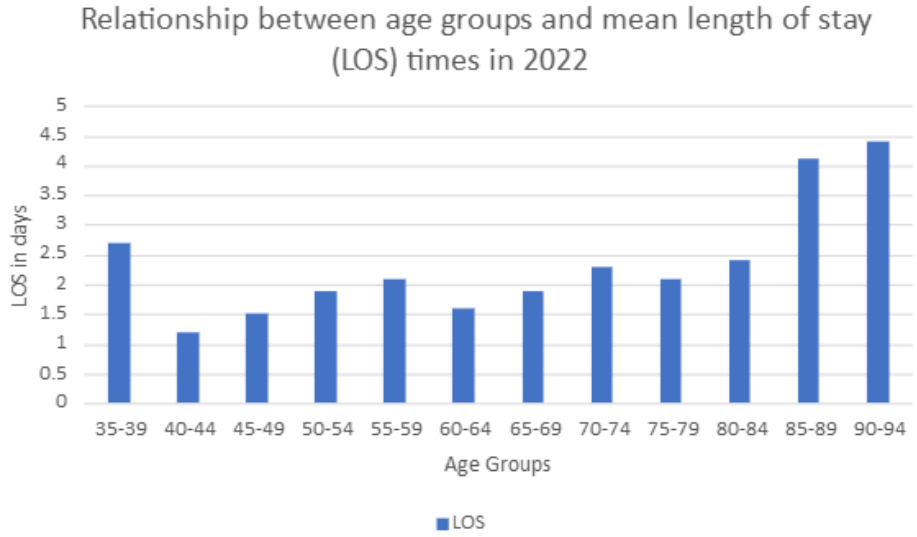

Fig. 1 — Relationship between age and mean LOS in cycle 1.

from 0.6% in cycle 1 to 2.3% post intervention. Despite this, we have reviewed opposing literature as to whether reduced LOS is correlated to an increase in readmissions. A retrospective study carried out by Sibia et al. further explored this concept of a 1-day LOS discharge following a total hip or knee replacement on readmission rate. No significant difference was seen between the 30- day re admission rate in those with 1 day LOS vs 2 day LOS (2.3% vs 2.5%, p=0.591) and the 90-day wound related admissions remained as 1.1% across both groups, concluding that early discharge is not always correlated with higher readmissions[12].

Alongside the difference in 30- day re admission rates (p<0.01), there was also an increase in ED attendance in cycle 2. The majority of the post operative complications encountered within 30 days requiring medical attention were due to an underlying infection.

Evolving literature has suggested that patients who have undergone an arthroplasty, specifically total knee arthroplasty (TKA), without the use of a tourniquet have been associated with a faster recovery[13]. Ejaz et al. confirmed that patients whom had undergone a TKA without the use of a tourniquet had less thromboembolic events, hospital re attendance and improved knee range of motion in the first 6 months compared to those with a tourniquet.

Although data supports no tourniquet use within our second cycle 2 patients developed a PE during their post operative phase. In Ludwick's retrospective study of 16,972 patients with an aim of investigating where tourniquet use or cementation is associated with an increased risk of VTE in TKA, the regression analysis confirmed that there was no significant difference in the incidence of VTE in those managed with or without a tourniquet[14]. In those managed without a tourniquet, it was noted that they were more likely to have been administered tranexamic acid intraoperatively and receive a cementless implant, with overall lower surgical times. In the cohort that received a cementless TKA they were more likely to develop a post operative PE, at 0.9% compared to 0.4% in the cemented group[8].

In cycle 2 there was also an increase in SSI. There are numerous factors which increase one's risk of developing a prosthetic joint infection, ranging from modifiable factors such as obesity and malnutrition through to methicillin sensitive (MSSA) and resistant staphylococcus aureus colonisation (MRSA), which can be identified during pre-operative screening[15]. The majority of these risk factors for SSI are more prevalent in an older demographic from 64 years and above, where this population have a 5 times greater mortality risk. Saucedo et al. confirmed that age less than (<)50 years, or greater than (>)80 years, body mass index (BMI) of <18.5, or ≥30, diabetes and coronary artery disease can be correlated with an increased risk of re admission[16].

Despite an increase in recorded SSI in cycle 2 from our data, the majority of these patients were the more co-morbid individuals, with 29.7% ASA 3, an increase of 7.9% from cycle 1. One patient deemed ASA 3 had a BMI of 37.1, illustrating that this particular group were more vulnerable to developing complications, irrespective of their reduced LOS[18]. Further work is needed to identify patients at highest risk of complications when an enhanced recovery programme is applied.

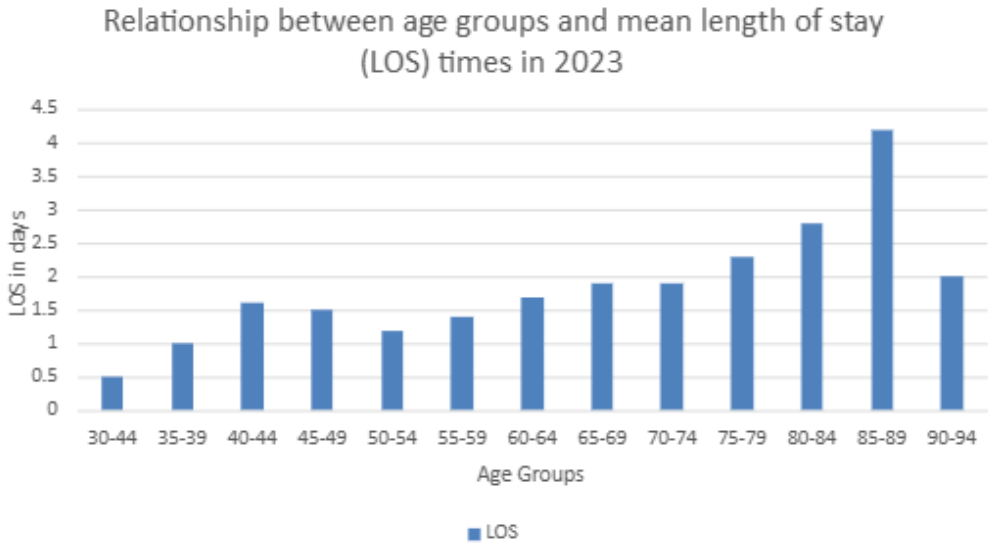

Fig. 2 — Relationship between age and mean LOS in cycle 2.

The cost of each night in hospital was estimated based on the 2023/2025 NHS Payment Scheme where elective arthroplasty procedures have a reimbursement value of £320 per additional night stay once they go over their "trim point" which varies by complexity of the case[8]. An enhanced recovery programme is strongly correlated with a reduction in costs, lessening the financial burden on the NHS. This is reflected through Milligan et al.'s study in which they were able to achieve a mean saving of £757.26 per patient after implementation of an enhanced recovery[5].

We included a total of 2,051 patients in both cycles, increasing the statistical power of our results. Our broad study population increases the generalisability of the results.

Limitations

This study was conducted in a high-volume low complexity (HVLC) hub across a broad geographical region with patients referred from multiple hospitals. Despite this the characteristics of wider populations may vary.

Although we included a large demographic, our study was retrospective and therefore relied on adequate documentation onto the electronic patient record system.

Between our 2 study periods there was a variation in morbidity with 21.8% being graded ASA 3 in cycle 1 compared to 29.7% in cycle 2. Due to this confounding variable, the results obtained from our post operative outcomes may not be a true representative of our protocol, as co-morbid patients are more vulnerable to developing surgical complications, thereby reducing the internal validity of this study.

We did not stratify cases by primary hip, knee, ankle, shoulder, or revision arthroplasty. The primary aim of our study was to evaluate whether an enhanced recovery can successfully reduce length of stay across all joint replacements in general. Our data is to be applied broadly to arthroplasty and cannot be generalised to individual joint replacements as outcomes may differ.

Our follow-up period was relatively short, limiting our ability to detect long-term complications. However, for the purposes of evaluating the enhanced recovery protocol, immediate complications were of greatest concern and would have been captured within our timeframe.

During our readmission period in cycle 2, one patient passed away after having undergone a TKR in 2023. This elderly patient had multiple comorbidities, including diabetes, which increased their risk of mortality. Although they were only one-month post-operation, they were reviewed by the orthopaedic team and showed no concerns following their arthroplasty, and so it was unlikely that the surgery contributed to their death.

Despite our significant cost saving from cycle 2 this calculation does not take into account the financial impact from ED attendance and readmissions requiring overnight hospital stay. Therefore, our estimated cost saving of £110,508.80 is likely to have been an overestimate.

We did not specify the implants used; however, the same implants were employed for both cohorts, ensuring the consistency of our results.

CONCLUSION

Reduced LOS can safely be achieved in lower-risk anaesthetic candidates undergoing an elective arthroplasty. Rapid discharge is associated with an array of benefits such as alleviating financial pressures, decreasing the incidence of hospital acquired infections and promoting early mobilisation, which will all support a rapid recovery. Caution should be exercised with more co-morbid patients and further research is necessary to identify patients at highest risk of complications when enrolled on enhanced recovery programmes.

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