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## Enhanced recovery programmes for lower limb arthroplasty in the UK

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### ABSTRACT

**INTRODUCTION** Enhanced recovery programmes (ERPs) reduce patient morbidity and mortality, and provide significant cost savings by reducing length of stay. Currently, no uniform ERP guidelines exist for lower limb arthroplasty in the UK. The aim of this study was to identify variations in ERPs and determine adherence to local policy.

**METHODS** Hospitals offering elective total knee arthroplasty (TKA) and total hip arthroplasty (THA) (23 and 22 centres respectively) contributed details of their ERPs, and performed an audit (15 patients per centre) to assess compliance.

**RESULTS** Contrasting content and detail of ERPs was noted across centres. Adherence to ERPs varied significantly (40–100% for TKA, 17–94% for THA). Analysis identified perioperative use of dexamethasone, tranexamic acid and early mobilisation for TKA, and procedures performed in teaching hospitals for THA as being associated with a reduced length of stay.

**CONCLUSIONS** This study highlights variation in practice and poor compliance with local ERPs. Given the proven benefits of ERPs, evidence-based guidelines in the context of local skillsets should be established to optimise the patient care pathway.

### KEYWORDS

Enhanced recovery programme – Total knee arthroplasty – Total hip arthroplasty – Length of stay

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Total knee and hip arthroplasty (TKA and THA respectively) are widely recognised as being among the most clinically effective and cost-effective procedures for end-stage, symptomatic osteoarthritis. Over 145,000 National Health Service (NHS) knee and hip arthroplasty procedures are performed annually in the UK.<sup>1</sup> There has been significant interest in factors that the surgeon and healthcare provider can optimise to improve patient outcomes and reduce length of stay (LOS).<sup>2,3</sup>

Enhanced recovery programmes (ERPs) were first proposed in 1997 by Kehlet as a means to reduce the surgical stress response.<sup>4</sup> By using multimodal techniques, ERPs can reduce patient morbidity and mortality; they are therefore associated with significant cost savings through reduced LOS and healthcare associated costs.<sup>5–10</sup> Furthermore, there is emerging evidence that in addition to the short-term benefits, ERPs may be associated with reduced mortality in the

longer term as well as superior long-term functional outcomes.<sup>4,11</sup> Two decades on, the complexity of ERPs has increased, with interventions implemented pre, intra and postoperatively.<sup>2,5</sup> While there is strong evidence behind certain components of ERPs, the evidence behind others is lacking and as such, what constitutes the gold standard ERP has yet to be defined.<sup>2,5</sup>

This study had two aims. The first was to assess the variation in current practice in the NHS with regard to local ERPs. The second was to determine compliance with these protocols within individual trusts.

### Methods

A national, multicentre audit of ERPs in knee and hip arthroplasty was conducted between October 2014 and April 2015 at 37 NHS hospitals. The study was conceived and led by the

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Nuffield Department of Orthopaedics, Rheumatology and Musculoskeletal Sciences, and coordinated through the British Orthopaedic Network Environment (BONE), an online orthopaedic research group (organised by the British Orthopaedic Trainees Association), where collaborators were recruited and coordinated.<sup>12</sup> Ethical approval was not required as assessed using the Health Research Authority online decision tool (<http://www.hra-decisiontools.org.uk/research/>). All collaborators registered the study with their respective base hospitals.

Each participating centre provided details of their local ERP policy as well as data on compliance with their policy for a consecutive series of 15 patients. Patients were included in the study if they were aged over 18 years, undergoing elective primary total knee or hip arthroplasty, suitable for an ERP and had single joint surgery.

**Data collection**

A proforma containing the core elements of an ERP<sup>2</sup> was designed and circulated to all participating centres. Collaborators entered the details of their centre’s ERP and were free to expand the proforma if their ERP contained additional components. Patients’ age and sex were recorded on the proforma in addition to whether the described element of that centre’s ERP had been completed. The proformas can be accessed via: <http://bone.ac.uk/audit/project/9> (login required).

**Statistical analysis**

The mean LOS of patients attending for joint replacement in the UK is 5 days, with a reduction by 1 day being considered clinically significant.<sup>15</sup> Assuming a standard deviation of 1.5 days,<sup>14</sup> a sample size of 74 patients (37 per arm) is required to detect a clinically relevant difference with 90% power and 1% two-sided significance.

All analysis was performed using SPSS® version 20.0 (IBM, New York, US). Mann–Whitney U tests were used to determine statistical significance when establishing whether any given element of an ERP caused a significant reduction in patient LOS, with a *p*-value of <0.05 considered statistically significant.

**Results**

During the study period, 25 centres provided information regarding their TKA ERPs and 22 centres did so for THA ERPs. Of these, 18 and 16 contributed compliance data for their hospital for TKA and THA respectively. The recruitment process is summarised in Figure 1. Participating centres varied in terms of size of hospital (number of beds), type of hospital (district general or teaching hospital) and geography across the UK.

Compliance with local policy was assessed in 510 patients (270 TKA and 240 THA procedures). The mean age for the TKA patients was 70.4 years (range: 48–90 years), with just

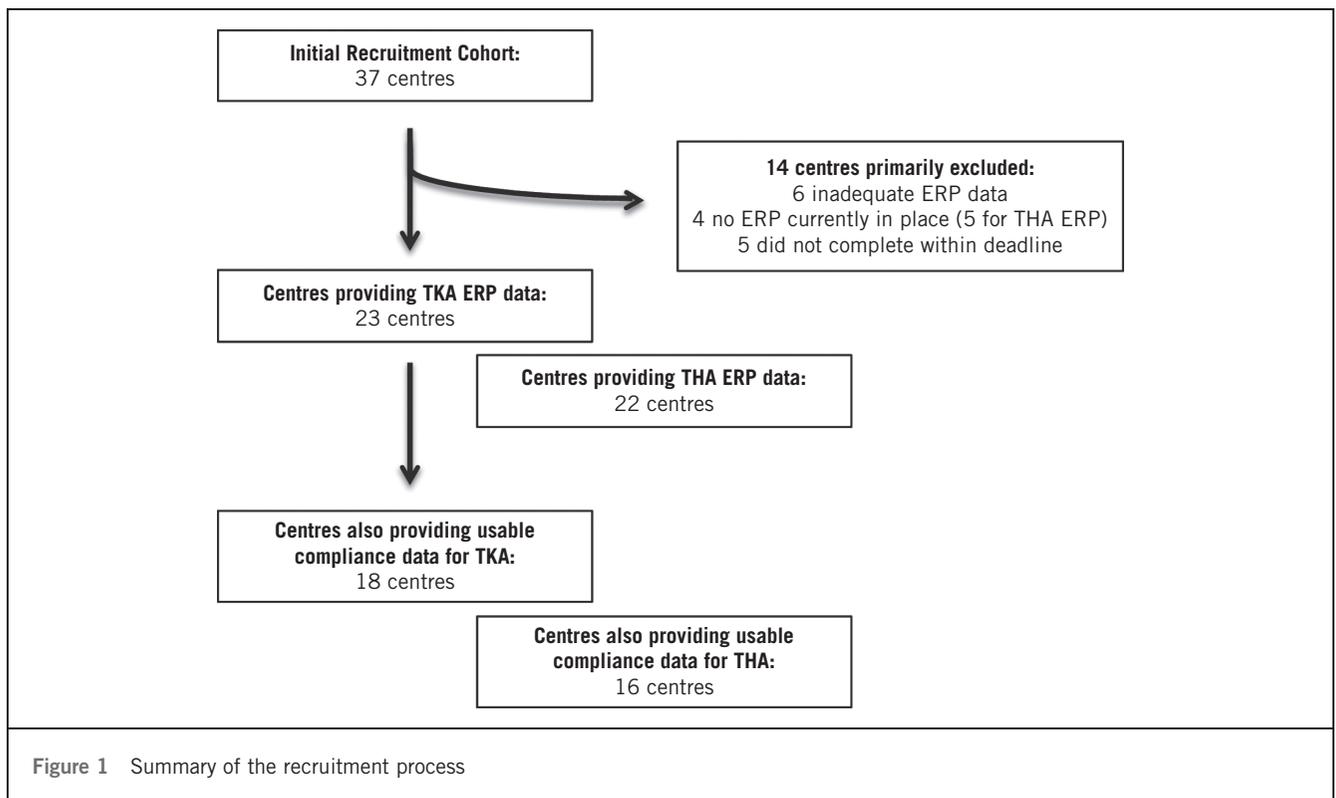


Figure 1 Summary of the recruitment process

**Table 1** A summary of the most frequently recommended ERP components (present in at least half of audited centres) and the respective adherence to these elements

ERP element	Knee ERPs		Hip ERPs	
	Proportion of centres that recommend	Proportion of centres that adhere where offered	Proportion of centres that recommend	Proportion of centres that adhere where offered
Patient education	76%	90%	90%	81%
Assessment of body habitus	81%	87%	82%	88%
Same day admission to surgery	71%	98%	90%	93%
Preoperative gabapentinoid	62%	46%	73%	45%
Wound local anaesthetic	50%	78%	73%	89%
Tranexamic acid	67%	73%	77%	82%
Early mobilisation and physiotherapy	76%	47%	82%	51%
Postoperative paracetamol	81%	85%	82%	100%
Postoperative NSAIDs	57%	76%	82%	54%
Postoperative opioids	67%	61%	82%	87%
Postoperative gabapentinoid	52%	17%	77%	72%
Postoperative antiemetic	67%	52%	77%	85%
Postoperative laxatives	52%	48%	64%	79%
Specific postoperative ward	67%	88%	82%	99%

ERP = Enhanced recovery programme; NSAIDs = non-steroidal anti-inflammatory drugs

over half (55%) being female. For the THA cohort, the mean age was 70.0 years (range: 64–77 years) and almost two-thirds (61%) were female. Table 1 shows the proportion of centres that recommended different ERP elements as well as the proportion of centres that followed these suggestions.

### Patient education

For TKA ERPs, there was wide variation with regard to delivery of patient education, ranging from simple written advice (booklets) to ‘joint schools’ (run by multidisciplinary teams consisting of physiotherapists, occupational therapists, pain specialist nurses and anaesthetists), with joint schools being offered in two centres. Patient education was delivered by a surgeon in 38% of occasions.

Where preoperative education was provided for THA ERPs, this was delivered in person in all centres and supported by written material in two centres.

### Body habitus

Patient body habitus was assessed in 17 centres using predominantly the body mass index (BMI). In one centre, the patient’s weight alone was used. Despite the inconsistency in how body habitus is gauged, it appears to be of importance to clinicians as it is assessed in over 80% of centres for both TKA and THA patients. Currently, there is no consensus

regarding the appropriate point at which BMI should be acted on. Often this is a nominal threshold (varying from BMI >35kg/m<sup>2</sup> to >50kg/m<sup>2</sup>) and once this threshold has been crossed, the appropriate management is considered to be either referral to bariatric services or referral back to the patient’s primary care physician.

### Physiology

Minimum acceptable preoperative haemoglobin values were defined in 30% of ERPs. The thresholds varied significantly between centres, from >10g/dl to >13g/dl. In addition, two centres provided guidance regarding preoperative blood transfusions if haemoglobin was low.

### Interventions after admission prior to surgery

Patients were offered carbohydrate loading before surgery in 30% of ERPs for TKA and 56% of ERPs for THA. This varied in terms of volume (from 400ml to 800ml) and timing (from the night before surgery to 2–3 hours before commencing surgery). Preoperative fasting otherwise was either stated to be for a minimum of six hours, or specific instructions were given to patients who were attending for morning or afternoon lists.

In all centres, fasting was advised for six hours prior to the start time of the operating list, with clear fluid permitted

until two hours before the start time. In 87% of centres, the time of fasting varied depending on whether the operation was on a morning or afternoon list.

### Venous thromboembolism prophylaxis

Eleven centres specified chemical prophylaxis with low molecular weight heparin (LMWH) such as enoxaparin or dalteparin, depending on renal function. Use of oral anticoagulants (factor Xa inhibitors) such as apixaban and rivaroxaban was also mentioned in 10% of TKA ERPs.

For THA, LMWH was recommended in 45% of ERPs and factor Xa inhibitors in 25%. Venous thromboembolism prophylaxis was not mentioned in 32% of ERPs.

### Analgesia

Pre-emptive analgesia included paracetamol, opioids (controlled release oxycodone, fentanyl patch) and gabapentinoids. Other medications prescribed included antiemetics, proton pump inhibitors (omeprazole and lansoprazole) and the histamine antagonist ranitidine. There was no consensus on the dose, timing or frequency of analgesics.

### Anaesthetic considerations

Of the centres that provided anaesthetic advice for TKA, the majority (9 centres) recommended spinal anaesthetic, with some specifying anaesthetic agents (isobaric bupivacaine commonly recommended). Alternatives included combinations of general and spinal anaesthetics, and use of short acting anaesthetics, with two centres suggesting intravenous propofol.

For THA, anaesthetic type was specified in 14 ERPs. Spinal or epidural anaesthesia (with or without sedation) was recommended in 12 ERPs and general anaesthesia in 2 ERPs.

### Intraoperative analgesics

A combination of intraoperative drugs were prescribed for ERPs. Most commonly these were paracetamol, dexamethasone, antiemetics (particularly ondansetron) and opioids. Timing of administration and dosages varied or was not specified.

Local anaesthetics were administered periarticularly during surgery. Ten centres recommended local anaesthetics, with six suggesting ropivacaine of varying concentrations (either 0.2% or 0.25% at volumes between 80ml and 200ml), two suggesting 30ml of 0.5% levobupivacaine in 100ml of 0.9% saline with 1:1,000 adrenaline and two recommending unspecified regional anaesthesia.

### Tranexamic acid

Tranexamic acid was advised in 13 centres for TKA (at doses varying from 15mg/kg to 1g/kg in the majority of centres) and in 17 centres for THA (at doses from 1g/kg to 2g/kg).

### Early mobilisation

Sixteen TKA ERPs and twelve THA ERPs mentioned early mobilisation. This was inconsistent in that certain centres stated mobilisation should occur within two hours or four hours of the operation (with a further caveat of mobilisation

only being allowed if the blood pressure was within 10% of the preoperative value) whereas others specified that patients should be exercising in bed on 'postoperative day 0'.

### Postoperative analgesia

Three centres with TKA ERPs recommended postoperative analgesia by intra-articular catheter. Ropivacaine was the analgesic of choice; however, different regimens of administration were apparent, with either boluses or regular volumes suggested. Paracetamol and non-steroidal anti-inflammatory drugs were also recommended postoperatively, with ibuprofen and diclofenac mentioned specifically. Finally, opioids of varying formulation were suggested in 14 centres and gabapentinoids in 11.

### Other postoperative medications

Antiemetics were prescribed in 14 centres for TKA and 22 centres for THA. Combinations of cyclizine and ondansetron were used most often. Ephedrine (indicated for unsteadiness when attempting to mobilise postoperatively or postural hypotension) and lansoprazole were advised in three ERPs. Varying laxative regimens were suggested postoperatively such as osmotic, stimulant and polyethylene glycol-based laxatives and stool softeners, with combinations of these laxative types prescribed.

### Patient discharge

Specific postoperative wards were recommended in 14 TKA ERPs while regular physiotherapy and occupational therapy input was suggested in 11 centres. Twelve ERPs had target discharge times (range: 2–5 days, mean: 3.2 days). In ten centres, patients were provided with information on precautions to take to avoid damaging the knee postoperatively. Seven of these centres also provided raised seats. Advice was given about sleeping positions in four centres.

For THA, 20 ERPs had target discharge times. These ranged from 2 to 5 days (mean: 3.5 days).

### Length of stay

For 2014–2015 the national mean for LOS for TKA in the NHS was 4.9 days<sup>15</sup> whereas our audited centres (all with an ERP in place) had a mean LOS of 3.9 days (range: 2–20 days). Intraoperative administration of dexamethasone (-1.4 days,  $p<0.001$ ), tranexamic acid (-2.6 days,  $p<0.001$ ), and early mobilisation and physiotherapy input (defined as occurring <24 hours postoperatively) (-2.4 days,  $p=0.019$ ) were associated with a reduced LOS. Patient education (+1.1 days,  $p=0.21$ ,  $p=0.21$ ) and prescribing gabapentinoids during patient admission (-1.4 days,  $p=0.14$ ) had no significant impact on LOS.

The mean LOS for patients undergoing THA in centres with an ERP in place was 4.2 days (range: 2–23 days). The national mean in 2014–2015 was 5.4 days.<sup>15</sup> Patients undergoing primary THA at a teaching hospital rather than a district general hospital had a shorter LOS (-1.2 days,  $p=0.002$ ). Preoperative education (+0.9 days,  $p=0.09$ ) and use of gabapentinoids (-0.3 days,  $p=0.79$ ) had no significant impact on LOS.

## Discussion

This is the first study of its kind to highlight the variation in both ERP elements and compliance for lower limb arthroplasty across the NHS. The study also confirmed widespread uptake of some ERP components with limited evidence regarding their effectiveness at the expense of other interventions with a much stronger evidence base.<sup>2,5</sup>

Our study found that patients undergoing TKA who received dexamethasone and tranexamic acid and who attempted early mobilisation had a significantly reduced LOS. For THA, the type of hospital in which patients underwent their procedure had the greatest impact on LOS. Patient education and use of gabapentinoids had no influence on LOS in either of the cohorts.

Tranexamic acid has been found in a number of studies to reduce postoperative bleeding and the incidence of blood transfusion while not increasing the propensity for patients to develop thrombosis in the postoperative period.<sup>16–18</sup> This has also been shown to translate to a reduced LOS for patients.<sup>19</sup>

Similarly, in studies where patients have received dexamethasone, shorter stays in hospital have been noted.<sup>20</sup> This reflects the data obtained in our study, where the significant difference can be explained in part by the antiemetic and opioid-sparing effects of dexamethasone.<sup>21</sup>

Furthermore, there is evidence that postoperative mobilisation of patients on the same day as their TKA procedure reduces LOS by an average of 69 hours compared with patients mobilised on the first postoperative day.<sup>22</sup> This highlights the importance of increasing adherence to early mobilisation after surgery.

Pre-emptive analgesia is another preoperative mechanism that has been demonstrated to reduce LOS as it helps to manage pain, thereby increasing patient mobility while reducing analgesic requirements. Hebl *et al* compared patients managed with multimodal analgesia with historical controls undergoing identical surgical procedures using traditional anaesthetic techniques.<sup>23</sup> Multimodal analgesia discouraged use of intravenous opioids and emphasised regional nerve blocks. The LOS of patients receiving multimodal analgesia was 1.2 days less, with improved range of motion by 5° of flexion as well as a lower rate of adverse reactions such as urinary retention and ileus formation. Our study suggests that most centres are not yet fully utilising the multimodal analgesic strategies that have been shown to improve perioperative outcomes and reduce adverse events.

The route of administration and type of analgesics used intraoperatively have also been noted to have a significant impact on perioperative outcomes, with peripheral nerve block analgesic regimes leading to fewer adverse events than traditional oral analgesics.<sup>23</sup> Another widely used and increasingly popular technique is local infiltration anaesthesia, whereby a mixture of anaesthetic agents (often ropivacaine, ketorolac and adrenaline)<sup>24</sup> are administered intraoperatively into the surgical site.<sup>25</sup> This was used in the majority of audited centres. This method has been found to reduce time to mobilisation after surgery by 4–6 hours and

has facilitated discharging hip arthroplasty patients after one night's hospital stay.<sup>24</sup>

Gabapentinoids have been associated with antiemetic effects as well as reducing postoperative nausea and vomiting, and urinary retention however the weight of evidence suggests that this does not translate to decreased LOS.<sup>26,27</sup> Lunn *et al* have stated that gabapentin should not be recommended as a standard of care in TKA as it has limited analgesic effects in opioid-naïve patients,<sup>28</sup> with a similar conclusion drawn by Paul *et al* for THA patients.<sup>29</sup>

Patient education sessions, conducted by phone or in person, have been employed to manage patient expectations as well as encourage preoperative exercise, nutritional changes and weight management.<sup>30,31</sup> Patient education was heralded as the reason for reducing LOS by one day on average for patients undergoing arthroplasty of the knee or hip in a study by Yoon *et al*<sup>30</sup> but a Cochrane review from 2014 suggests that patient education may particularly benefit certain patients, such as those with 'depression, anxiety or unrealistic expectations'.<sup>32</sup>

Having considered traditional forms of pharmacological analgesia, it is important to discuss Kehlet's call for use of multimodal techniques to improve patient recovery, for instance with methods such as cryotherapy. Since a Cochrane review published in 2012 stated that the potential benefits of cryotherapy may be too small to justify use while also highlighting the need for further studies,<sup>33</sup> a number of randomised trials have been published.<sup>34–37</sup> Leegwater *et al* demonstrated that patients receiving cryotherapy during recovery from THA had shorter hospital stays, decreased analgesic use and improved pain scores at six weeks after surgery compared with controls.<sup>34</sup> Despite this, others have shown that there is no further benefit in providing cryotherapy by means of expensive kits compared with treatment using crushed ice packs.<sup>36,37</sup> Examining the evidence, simple cryotherapy is a relatively inexpensive method that is worth considering for TKA/THS ERPs at the very least.

This study does have certain limitations. Although the total sample size of 510 was adequate, given the high variation in clinical practice with regard to ERP components, it did not permit regression analysis. Moreover, LOS was employed as a surrogate measure of an 'enhanced recovery' and no account was made for readmissions or long-term morbidity or mortality. Further studies should therefore use larger patient cohorts to permit logistic regression and collect holistic outcome measures that are more representative of improved patient care.

This study has highlighted the great variation between centres in the NHS as well as discrepancies in practice within centres themselves. There are indications that patients are receiving varying degrees of preoperative optimisation, analgesia, antiemetics and postoperative care, and that this is causing longer hospital stays with the ensuing financial burden. With over 145,000 knee and hip procedures performed annually in NHS hospitals<sup>1</sup> (and an additional night in hospital costing approximately £300 on average),<sup>58</sup> if the NHS were to routinely implement some of the interventions suggested in this paper, it could save over

£43 million per year just for these two procedures. Evidence-based practice should be considered by all elective orthopaedic hospitals in the context of enhanced recovery and guidelines should be put in place to provide optimum patient care.

## Conclusions

There is overwhelming evidence to show the benefits of ERPs, and in particular, use of multimodal analgesia, tranexamic acid and early mobilisation. There is a large variation in perioperative practice in the NHS for both TKA and THA, with only a minority of hospitals currently implementing a complete ERP. Adherence to ERPs varies significantly within hospitals between patients but also on a national level. Clinicians and institutions must recognise the importance of ERPs on patient outcomes and improve implementation of these programmes while considering the available skillsets.

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