Journal of Orthopaedic Surgery 2014;22(2):150-4

Enhanced recovery programme for total knee replacement to reduce the length of hospital stay

Amitabh J Dwyer, William Thomas, Simon Humphry, Paul Porter
Department of Trauma and Orthopaedic Surgery, Yeovil District Hospital, Somerset, United Kingdom

ABSTRACT

Purpose. To compare the length of hospital stay in patients undergoing primary total knee replacement (TKR) with or without enhanced recovery (ER) programme.
Methods. Medical records of 57 and 55 consecutive patients who underwent primary TKR with or without ER programme, respectively, were reviewed. 17 men and 40 women aged 43 to 87 (mean, 70) years with ER programme were compared with 22 men and 33 women aged 53 to 90 (mean, 73) years without ER programme in terms of the preoperative haemoglobin level, American Association of Anesthesiologists (ASA) physical status grading, body mass index (BMI), and length of hospital stay.
Results. The length of hospital stay was significantly shorter in the ER than non-ER groups in overall patients (6 vs. 7.8 days, p=0.0003), in patients with preoperative haemoglobin level of ≥14 g/dl (5.4 vs. 7.7 days, p=0.02), in patients with preoperative haemoglobin level of <14 g/dl (6.2 vs. 7.7 days, p=0.02), in patients with ASA grades 1 and 2 (5.6 vs. 7.6 days, p=0.01), in patients with ASA grade 3 (6.4 vs. 8.2 days, p=0.01), in patients with BMI of <30 kg/m^2 (6 vs. 8.1 days, p=0.0061), and in patients with BMI of ≥30 kg/m^2 (5.9 vs. 7.5 days, p=0.0006). Complications were noted in 4 ER patients and 5 non-ER patients.
Conclusion. ER programmes are readily transferable to patients undergoing TKR and significantly reduced the length of hospital stay.

Key words: *arthroplasty, replacement, knee; length of stay; postoperative care*

INTRODUCTION

Enhanced recovery (ER) programme refers to perioperative patient care pathways designed to reduce the time to functional recovery after surgery and the length of hospital stay.[1–3] The programme has been adopted for major gastrointestinal resections,[4,5] liver resections,[6] pancreatic tumour resections,[7] and gynaecological surgery.[8] To ensure success of the programme, patients and healthcare workers must

Address correspondence and reprint requests to: Mr Amitabh Dwyer, Department of Trauma and Orthopaedic Surgery, Yeovil District Hospital, Higher Kingston, Yeovil, BA21 4AT, United Kingdom. Email: amitabhdwyer@yahoo.com

adhere to its protocols, and patient expectations and attitude to surgery must be addressed. Therefore, educational programmes for staff and patients are essential. Combined implementation of several interventions improves outcomes.[9] Patient management has evolved considerably with developments in anaesthesia, analgesia, surgical methods, materials, and rehabilitation,[10] as well as economic pressure to improve efficiency.[5] This study compared the length of hospital stay in patients undergoing primary total knee replacement (TKR) with or without ER programme.

MATERIALS AND METHODS

The Department of Clinical Governance of our hospital approved this study. The hospital is state funded, and medical insurance companies have no influence in the management of patients or discharge policies. Medical records of 57 and 55 consecutive patients who underwent primary TKR with and without ER programme, respectively, were reviewed. 17 men and 40 women aged 43 to 87 (mean, 70; standard deviation [SD], 9) years who underwent primary TKR with ER programme between January 2007 and August 2008 were compared with 22 men and 33 women aged 53 to 90 (mean, 73; SD, 7) years who underwent primary TKR without ER programme between November 2004 and November 2006 in terms of the preoperative haemoglobin level, American Association of Anesthesiologists (ASA) physical status grading, body mass index (BMI), and length of hospital stay. The 2 groups were compared using paired Student's t test for independent means. A p value of <0.05 was considered statistically significant.

Enhanced recovery programme

The ER programme involved a multidisciplinary team of surgeons, nurses, physiotherapists, and occupational therapists; patients were active participants. The programme involved preadmission and pre-, intra-, and post-operative interventions in a stepwise manner (Table 1).

At the initial clinic visit, the programme was outlined to each patient using an information leaflet, and a mini pre-assessment check was carried out to identify those who needed to see an anaesthetist prior to surgery.

At the pre-assessment clinic visit, the key aspects of ER were explained again, and patients underwent the routine pre-assessment protocol. Patients were supplied with nutrition and vitamin supplement drinks (Build-up; Nestle Nutrition) to be taken in the morning of the 2 days prior to hospital admission. Patients were asked to take 3 sachets of Build-up dissolved in 150 ml of water 2 days before surgery, and 2 sachets one day before surgery.

At the pre-admission visit, patients attended a one-hour class about the ER programme run by the physiotherapists and occupational therapists, and were encouraged to bring a member of their family or a friend for support.

On the evening prior to surgery, patients were admitted and given a high carbohydrate drink consisting of 2 sachets of Preload (Vitaflo) dissolved in 400 ml of water. A further sachet of Preload dissolved in 400 ml of water was given 3 hours before surgery. The high-energy drinks were given irrespective of any comorbidities such as diabetes or high BMI. This high-energy drink minimises the adverse metabolic effects of starvation and reduces the risk of anaesthetic and starvation-induced diabetes, and maintains high energy levels following the operation.

The physiological benefits of managing the metabolic effects of starvation and the traumatic insult of surgery are essential to the ER programme but are new to orthopaedics.[11] The traditional fasting

Table 1
Enhanced recovery programme for total knee replacement

Enhanced recovery programme for total knee replacement
Preadmission interventions
Comprehensive education and involvement of patients, families, and carers from the time of listing for surgery to pre-admission, physiotherapy, and surgery
Complete assessment of patients' physical and social needs with planning of provision for the immediate postoperative convalescence and rehabilitation phase with focus on discharge arrangement
Preoperative interventions
Calorie loading from 48 hours before surgery
Long fasts (6 hours) substituted by preoperative carbohydrate loading and a short fast of only 2 hours
Avoidance of pre-medication
Intra-operative interventions
No urinary catheter
Short-acting anaesthetic agents
Emphasis on prevention of nausea, vomiting, and pain
Postoperative interventions
Non-opiate and non-steroidal analgesia, avoiding opiates where possible
Continued strong emphasis on prevention of nausea and vomiting
Early postoperative oral nutrition (starting on day of surgery)
Mobilisation pathways with agreed objectives

regimen for 6 hours aims to reduce the incidence of pulmonary aspiration, but there is no scientific support for this practice.[12] Recommendations now suggest fluid intake until 2 hours before the induction of anaesthesia and a 6-hour solid food fast. This reduces preoperative thirst, hunger, anxiety, and postoperative insulin resistance.[13] Preoperative oral intake of carbohydrates also reduces postoperative nausea and vomiting, which hinder postoperative recovery.[14]

Operations were performed under spinal or epidural anaesthesia and tourniquet use. Propofol was used for sedation and maintenance of light general anaesthesia to reduce postoperative nausea and vomiting. Short-acting opiates were delivered via a patient-controlled infusion pump to decrease the incidence of opiate toxicity. This was discontinued between days 1 and 2. Paracetamol, codeine, and anti-inflammatory analgesia were prescribed routinely. Specific pain scores were not recorded. Accurate fluid resuscitation avoided iatrogenic hyperchloremic acidosis and fluid overload.

Postoperatively, in the recovery room, patients were sat up in bed and allowed oral intake of fluids. Pneumatic intermittent calf compression was used to minimise the risk of deep vein thrombosis. On return to the ward, patients were encouraged to sit up and eat and drink protein- and carbohydrate-rich drinks. Intravenous fluid administration was not used unless absolutely necessary. Patients were given 2 sachets of Build-up drink for nutrition and vitamin supplements in the evening and 3 sachets for each of the next 3 days. This helps maintain normal gut flora, preserve immune function, and optimise wound healing and recovery.[15]

In the evening, dedicated physiotherapy was started, and patients were encouraged to sit out of bed in the chair. Enoxaparin (40 mg) was administered subcutaneously during in-patient stay. Early mobilisation reduces the incidence of thromboembolic events.[16]

On day 1, wound drains were removed, and urinary catheterisation was avoided. Patients were mobilised with the assistance of the physiotherapist and were encouraged to walk a distance of 50 metres. Patients were discharged when they could walk safely and the wound was deemed satisfactory. There was less insistence on the degree of knee bend and extension. When patients were unable to demonstrate adequate knee bend, an early outpatient therapy (typically one week after discharge) was scheduled.

At discharge, patients were escorted to the hospital exit by a physiotherapist or nurse and taught how to get in and out of a car safely. Wound care was undertaken by a nurse in the community. Patients were followed up by a physiotherapist for 3 weeks to assess early progress and identify any concerns. Patients could contact the hospital for any concerns.

Non–enhanced recovery programme

Patients were admitted on the evening before surgery and were instructed to fast for at least 6 hours before the operation. Spinal or general anaesthesia was used. Wound drains were removed on postoperative day 1. The analgesic regimen was the same as that in the ER programme. Physiotherapy did not start until day 1, and often patients did not mobilise until day 2. Patients were discharged when independent mobility was deemed satisfactory, wound was deemed dry, and 90° knee bend and a straight leg raise were achieved. There was no routine physiotherapy; the physiotherapist only saw patients if they had problems.

RESULTS

The ER and non-ER groups were similar in terms of patient age (70 vs. 73 years, p=0.7) and BMI (31.5 vs. 30.9 kg/m^2, p=0.6). The effects of the preoperative haemoglobin level, ASA physical status grading, and BMI on the length of hospital stay were examined. The length of hospital stay was significantly shorter in the ER than non-ER groups in overall patients (6 vs. 7.8 days, p=0.0003), in patients with a preoperative haemoglobin level of ≥14 g/dl (5.4 vs. 7.7 days, p=0.02), in patients with a preoperative haemoglobin level of <14 g/dl (6.2 vs. 7.7 days, p=0.02), in patients with ASA grades 1 and 2 (5.6 vs. 7.6 days, p=0.01), in patients with ASA grade 3 (6.4 vs. 8.2 days, p=0.01), in patients with BMI of <30 kg/m^2 (6 vs. 8.1 days, p=0.0061), and in patients with BMI of ≥30 kg/m^2 (5.9 vs. 7.5 days, p=0.0006) [Table 2]. The difference was also significant when comparing patients in the ER group with a preoperative haemoglobin level of <14 g/dl with patients in the non-ER group with a preoperative haemoglobin level of ≥14 g/dl (6.2 vs. 7.7 days, p=0.03), and when comparing patients in the ER group with BMI of ≥30 kg/m^2 with patients in the non-ER group with BMI of <30 kg/m^2 (5.9 vs. 8.1 days, p=0.0061). Patients with BMI of ≥30 kg/m^2 are deemed obese,[17] and have a higher morbidity from anaesthesia and surgery (e.g. airway management, postoperative mobilisation, increased wound problems, and infection).[18,19]

Complications were noted in 4 ER patients and 5

Table 2
Comparison of total knee replacement patients with or without enhanced recovery (ER)

Parameter	Mean±SD length of hospital stay (days)		p Value
	ER group (n=57)	Non-ER group (n=55)	
Preoperative haemoglobin level (g/dl)			
≥14	5.4±1.9 (n=20)	7.7±2.6 (n=30)	0.02
<14	6.2±2.4 (n=37)	7.7±2.9 (n=25)	0.02
p Value	0.68	1	
American Association of Anesthesiologists physical status grading			
1–2	5.6±1.7 (n=30)	7.6±2.7 (n=43)	0.01
3	6.4±2.9 (n=27)	8.2±2.6 (n=12)	0.01
p Value	0.09	0.23	
Body mass index (kg/m^2)			
<30	6±1.9 (n=19)	8.1±3.6 (n=22)	0.0061
≥30	5.9±2.5 (n=38)	7.5±1.9 (n=33)	0.0006
p Value	0.05	0.35	

non-ER patients. Of the 4 ER patients, one had deep vein thrombosis leading to pulmonary embolism on day 3; one had a leg blister on day 7; one patient had hallucinations after tramadol administration on day 9, which was resolved after discontinuation; and one required readmission for suturing of wound dehiscence after a fall at home 26 days after the operation. Of the 5 non-ER patients, one receiving warfarin had haematemesis on day 2; one had chest infection on day 3; one had cellulitis on day 3; one had superficial infection on day 4, which was resolved with oral antibiotics; and one had a small haematoma near the knee on day 5, which was resolved with aspiration.

DISCUSSION

ER programmes reduce the length of hospital stay by reducing the surgical stress response and metabolic insult and by optimising nutritional status and peri-operative pain.[4,20] Early mobilisation was also promoted. Increased length of hospital stay is often attributed to patient factors including increased BMI, co-morbidities, and age.[21]

In TKR patients aged over 75 years, those with a higher preoperative haemoglobin level had a shorter length of hospital stay.[22] The same is true when comparing patients with a haemoglobin level of ≥14 g/dl with those with a haemoglobin level of <12 g/dl (median, 5 [range, 4–7] vs. 6 [range, 4–10] days), but patients hospitalised for longer than 10 days (for any reason) were excluded.[23] Our study also suggested that ER programmes aided postoperative recovery and enabled earlier discharge.

The ASA grading is used to estimate operative risk and correlates well with surgical and anaesthetic mortality and morbidity.[21,24–28] According to the Hvidovre Fast Track Protocol in total hip and knee replacement surgery, patients with an ASA grade of 1 or 2 were more likely to stay in the hospital for <3 days than patients with an ASA grade 3.[20] Our study confirmed that the length of hospital stay for patients with ASA grade 3 in the ER group reduced by over 20% compared with patients with ASA grade 1 or 2 in the non-ER group.

BMI correlates with total body fat.[29] Obesity is defined as BMI of ≥30 kg/m^2.[17] Higher BMI correlates with longer length of hospital stay in TKR patients.[30] However, other studies have reported no significant difference.[31]

In our study, the ER programme resulted in a median of 29% reduction in the length of hospital stay in TKR patients. The ER programme also benefited less healthy or obese patients without affecting the complication or readmission rates. For the ER programme to be effective, patients should be actively involved throughout the perioperative period. In addition, the total demand on physiotherapy services by patients fell by 40%.

CONCLUSION

ER programmes are readily transferable to patients undergoing TKR and significantly reduced the length of hospital stay.

DISCLOSURE

No conflicts of interest were declared by the authors.

REFERENCES

1. Fearon KC, Ljungqvist O, Von Meyenfeldt M, Revhaug A, Dejong CH, Lassen K, et al. Enhanced recovery after surgery: a consensus review of clinical care for patients undergoing colonic resection. Clin Nutr 2005;24:466–77.
2. Kehlet H, Wilmore DW. Multimodal strategies to improve surgical outcome. Am J Surg 2002;183:630–41.
3. Easton J. Department of Health Communication, 2 March 2010. Available at: http://www.dh.gov.uk/en/Publicationsandstatistics/Lettersandcirculars/Dearcolleagueletters/DH_113362
4. Teeuwen PH, Bleichrodt RP, Strik C, Groenewoud JJ, Brinkert W, van Laarhoven CJ, et al. Enhanced recovery after surgery (ERAS) versus conventional postoperative care in colorectal surgery. J Gastrointest Surg 2010;14:88–95.
5. Eskicioglu C, Forbes SS, Aarts MA, Okrainec A, McLeod RS. Enhanced recovery after surgery (ERAS) programs for patients having colorectal surgery: a meta-analysis of randomized trials. J Gastrointest Surg 2009;13:2321–9.
6. van Dam RM, Hendry PO, Coolsen MM, Bemelmans MH, Lassen K, Revhaug A, et al. Initial experience with a multimodal enhanced recovery programme in patients undergoing liver resection. Br J Surg 2008;95:969–75.
7. Wichmann MW, Roth M, Jauch KW, Bruns CJ. A prospective clinical feasibility study for multimodal "fast track" rehabilitation in elective pancreatic cancer surgery. Rozhl Chir 2006;85:169–75.
8. Sjetne IS, Krogstad U, Ødegård S, Engh ME. Improving quality by introducing enhanced recovery after surgery in a gynaecological department: consequences for ward nursing practice. Qual Saf Health Care 2009;18:236–40.
9. Maessen J, Dejong CH, Hausel J, Nygren J, Lassen K, Andersen J, et al. A protocol is not enough to implement an enhanced recovery programme for colorectal resection. Br J Surg 2007;94:224–31.
10. Kehlet H. Multimodal approach to control postoperative pathophysiology and rehabilitation. Br J Anaesth 1997;78:606–17.
11. Fearon KC, Luff R. The nutritional management of surgical patients: enhanced recovery after surgery. Proc Nutr Soc 2003;62:807–11.
12. Ljungqvist O, Søreide E. Preoperative fasting. Br J Surg 2003;90:400–6.
13. Thorell A, Efendic S, Gutniak M, Häggmark T, Ljungqvist O. Insulin resistance after abdominal surgery. Br J Surg 1994;81:59–63.
14. Hausel J, Nygren J, Thorell A, Lagerkranser M, Ljungqvist O. Randomized clinical trial of the effects of oral preoperative carbohydrates on postoperative nausea and vomiting after laparoscopic cholecystectomy. Br J Surg 2005;92:415–21.
15. Soop M, Carlson GL, Hopkinson J, Clarke S, Thorell A, Nygren J, et al. Randomized clinical trial of the effects of immediate enteral nutrition on metabolic responses to major colorectal surgery in an enhanced recovery protocol. Br J Surg 2004;91:1138–45.
16. Pearse EO, Caldwell BF, Lockwood RJ, Hollard J. Early mobilisation after conventional knee replacement may reduce the risk of postoperative venous thromboembolism. J Bone Joint Surg Br 2007;89:316–22.
17. Spicer DD, Pomeroy DL, Badenhausen WE, Schaper LA Jr, Curry JI, Suthers KE, et al. Body mass index as a predictor of outcome in total knee replacement. Int Orthop 2001;25:246–9.
18. Amin AK, Clayton RA, Patton JT, Gaston M, Cook RE, Brenkel IJ. Total knee replacement in morbidly obese patients. Results of a prospective, matched study. J Bone Joint Surg Br 2006;88:1321–6.
19. Winiarsky R, Barth P, Lotke P. Total knee arthroplasty in morbidly obese patients. J Bone Joint Surg Am 1998;80:1770–4.
20. Husted H, Holm G, Jacobsen S. Predictors of length of stay and patient satisfaction after hip and knee replacement surgery: fast-track experience in 712 patients. Acta Orthop 2008;79:168–73.
21. Cullen DJ, Apolone G, Greenfield S, Guadagnoli E, Cleary P. ASA Physical Status and age predict morbidity after three surgical procedures. Ann Surg 1994;220:3–9.
22. Raut S, Mertes SC, Muniz-Terrera G, Khanduja V. Factors associated with prolonged length of stay following a total knee replacement in patients aged over 75. Int Orthop 2012;36:1601–8.
23. Jonas SC, Smith HK, Blair PS, Dacombe P, Weale AE. Factors influencing length of stay following primary total knee replacement in a UK specialist orthopaedic centre. Knee 2013;20:310–5.
24. Cullen DJ, Nemeskal AR, Cooper JB, Zaslavsky A, Dwyer MJ. The effect of pulse oximetry, age, and ASA physical status on the frequency of patients admitted unexpectedly to a postoperative intensive care unit and the severity of their anesthesia-related complications. Anesth Analg 1992;74:181–8.
25. Djokovic JL, Hedley-Whyte J. Prediction of outcome of surgery and anesthesia in patients over 80. JAMA 1979;242:2301–6.
26. Owens WD, Dykes MH, Gilbert JP, McPeek B, Ettling MB. Development of two indices of postoperative morbidity. Surgery 1975;77:586–92.
27. Tiret L, Desmonts JM, Hatton F, Vourc'h G. Complications associated with anaesthesia—a prospective study in France. Can Anaesth Soc J 1986;33:336–44.
28. Vacanti CJ, VanHouten RJ, Hill RC. A statistical analysis of the relationship of physical status to postoperative mortality in 68,388 cases. Anesth Analg 1970;49:564–6.
29. Bray GA. Overweight is risking fate. Definition, classification, prevalence, and risks. Ann N Y Acad Sci 1987;499:14–28.
30. Miric A, Lim M, Kahn B, Rozenthal T, Bombick D, Sculco TP. Perioperative morbidity following total knee arthroplasty among obese patients. J Knee Surg 2002;15:77–83.
31. Batsis JA, Naessens JM, Keegan MT, Huddleston PM, Wagie AE, Huddleston JM. Body mass index and the impact on hospital resource use in patients undergoing total knee arthroplasty. J Arthroplasty 2010;25:1250–7.