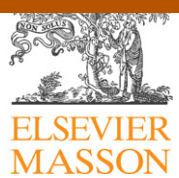
Orthopaedics & Traumatology: Surgery & Research (2012) **98**, 499—505



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ORIGINAL ARTICLE

Rehabilitation implications during the development of the Norwich Enhanced Recovery Programme (NERP) for patients following total knee and total hip arthroplasty☆

T.O. Smith[a,*], C. McCabe[b], S. Lister[b], S.P. Christie[b], J. Cross[a]

[a] *Queen's Building, Faculty of Medicine and Health Sciences, University of East Anglia, Norwich, NR4 7TJ, UK*
[b] *Physiotherapy Department, Norfolk and Norwich University Hospital, Colney Lane, Norwich, NR4 7UY, UK*

Accepted: 6 March 2012

KEYWORDS
Rehabilitation;
Post-operative recovery;
Wound catheter infiltration;
Accelerated;
Joint replacement

Summary
Background/hypothesis: To report the analysis of the initial rehabilitation results of the Norwich Enhanced Recovery Programme (NERP), regime with increased post-operative physiotherapy input following total hip arthroplasty (THA) and total knee arthroplasty (TKA) performed under spinal anaesthetic with wound catheter infiltration.
Materials and methods: A secondary analysis of a service improvement programme was undertaken from an acute National Health Service Hospital in the United Kingdom. Ninety-five patients listed for THA ($n = 67$) or TKA ($n = 28$) were reviewed during the first six post-operative weeks. All received an enhanced post-operative programme including commencement of mobilisation four hours post-operatively and physiotherapy interventions a minimum of twice daily during hospital admission. The primary outcome measure was the Iowa Level of Assistance Score at discharge. Secondary outcomes included length of hospital stay (LOS), visual analogue scale pain at discharge and complications during the initial six post-operative weeks.
Results: The NERP is a successful rehabilitation regime for patients following THA and TKA, facilitating early safe discharge (mean LOS = 3.5 days) with minimal complications. Patients who commenced mobilisation on the day of the operation reported significantly reduced pain score ($p = 0.02$) and length of stay ($p < 0.01$) compared to those who did not. Thirty-four percent of patients were discharged with rollator frames.

☆ Study performed at the Norfolk and Norwich University NHS Hospital Foundation Trust and University of East Anglia, UK.

* Corresponding author. Tel.: +01603 593087; fax: +01603 289357.
E-mail addresses: toby.smith@uea.ac.uk (T.O. Smith), catherineimccabe@nnuh.nhs.uk (C. McCabe), sarah.lister@nnuh.nhs.uk (S. Lister), sue.christie@nnuh.nhs.uk (S.P. Christie), j.cross@uea.ac.uk (J. Cross).

1877-0568/$ - see front matter
doi:10.1016/j.otsr.2012.03.005

Conclusions: Whilst the early results of the NERP allow patients who have undergone THA or TKA surgery a short hospital length of stay, its demand on out-reach physiotherapy suggests that the availability of such community services is imperative to ensure the appropriate progression of rehabilitation.
Level of evidence: Level IV — retrospective series.

Introduction

Total hip arthroplasty (THA) and total knee arthroplasty (TKA) are two of the most common elective orthopaedic procedures performed worldwide [1]. In the UK alone, approximately 157,500 THA and TKA were performed in England and Wales in 2010 [2].

Rehabilitation and physiotherapy is vital for the optimal recovery of patients following THA and TKA [3]. Physiotherapy comprises of pre-operative advice, gait re-education, exercise prescription and the assessment of a safe discharge home [3—5]. Given the number of patients seen following joint arthroplasty, the costs associated and the major role physiotherapy has in the post-operative management of this patient group, it is important that clinicians are aware of the most effective means of treating this population. Over the past 10 years, research has begun to investigate whether accelerated or enhanced recovery programmes can reduce hospital length of stay whilst maintaining clinical outcomes [4,6,7]. This has reported mixed findings regarding the benefit of pre-operative exercises and educational classes [8], but improved outcomes for patients who commenced early mobilisation, and received a greater intensity of rehabilitation [9,10].

With these potential advantages in mind, our institution began an enhanced recovery programme for patients following THA and TKA. This combined a modified post-operative analgesic regime with earlier, more intensive rehabilitation. In order to assess the advantages and disadvantages of this change in practice, we investigated the introduction of this new service. The purpose of this paper is therefore to report the early findings of the initial 95 patients who followed the developing Norwich Enhanced Recovery Programme (NERP) in terms of function and pain at discharge, length of stay, need for outreach physiotherapy services and complications during the initial six post-operative weeks.

Materials and methods

We undertook a secondary analysis of this change in routine clinical practice. An anonymous database was constructed for the first 95 patients (consecutive) who underwent primary THA or TKA using the NERP regime. Surgeries were performed between April 2010 and June 2010 at the participating hospital.

Participants

Patients were selected for THA or TKA on the basis of: significant pain limiting their activities of daily living, radiological evidence of degenerative joint pathology, and were medically fit for surgery. Patients who underwent isolated patellofemoral joint replacement, unicompartmental knee joint replacement or hip resurfacing were not included in this review. All patients followed the NERP regime irrespective of demographic characteristics such as age, past medical history or social circumstance.

Of the 95 patients, 67 underwent THA and 28 TKA. The demographic characteristics of this cohort are presented in Table 1. The median age of the cohort was 72.0 years, with a greater proportion of females to males. Twenty six percent of the cohort had previously undergone THA or TKA. While the majority of patients mobilised with some walking aids (68.4%), 17% were still able to walk without (Table 1).

The majority (53%) of patients lived in houses with stairs, with 27% reporting that they lived alone. As expected for the participating site, patients came from a wide geographical area, with 38% living 31 miles or over from the hospital. As Table 2 demonstrates, patients presented with a number of co-morbidities.

Pre-operative physiotherapy

All patients attended a standard pre-operative educational session approximately two weeks before their admission. This comprised of information regarding the typical patient pathway, post-operative exercises and advice on their expected post-operative physical capabilities. Those awaiting a THA were also taught the standard hip precautions of extreme flexion, adduction and rotation [11].

Operative procedure

Operations were performed by four different senior surgeons at consultant level. All surgical procedures were undertaken under a spinal anaesthetic of Bupivacine and sedation. All TKA were performed with a midline incision. One surgeon performed an anterior THA approach, and three surgeons performed a posterior approach to THA surgery. All implants were cemented. Before closing the wound, 200 mL of ropivacaine local anaesthetic was injected into the wound. A wound catheter was placed in the wound to provide a local anaesthetic infiltration for the initial 12 post-operative hours. No wound drains were used for either TKA or THA.

Post-operative rehabilitation

Approximately four hours post-operatively, with the local anaesthetic still effective, each patient was assessed by a physiotherapist with the intention of commencing full

Table 1 Patient demographics.

	Total cohort	THA	TKA
Patients (joints)	95 (95)	67 (67)	28 (28)
Median age (IQR)	72 (66.0—77.0)	71 (66.0—77.0)	73 (64.5—78.0)
Gender			
Male	42	28	14
Female	53	39	14
Side of operation			
Left	46	32	14
Right	49	35	14
Previous LL arthroplasty (Yes — %)	25 (26.3)	15 (22.4)	10 (35.7)
Median BMI (IQR)	29.4 (27.4—32.3)	28.4 (26.7—31.2)	32.1 (29.3—36.5)
Median Weight (IQR)	82 (72.3—93.9)	81.2 (69.9—90.0)	82.9 (76.6—102.5)
Median ASA (IQR)	2 (2—2)	2 (2—2)	2 (2—2)
Pre-operative mobility (%)			
Unaided	15 (16.8)	13 (19.4)	2 (7.1)
1 stick	65 (68.4)	43 (64.2)	22 (78.6)
2 sticks/2 crutches	14 (14.7)	10 (14.9)	4 (14.3)
Walking frame	1 (1.1)	1 (1.5)	0 (0.0)
Unable	0 (0.0)	0 (0.0)	0 (0.0)
Lives alone (Yes — %)	26 (27.4)	19 (28.4)	7 (25.0)
Type of dwelling (%)			
House	50 (52.6)	33 (49.3)	17 (60.7)
Bungalow	36 (37.9)	29 (43.3)	7 (25.0)
1st floor flat	3 (3.2)	3 (4.5)	0 (0.0)
Boat	1 (1.1)	0 (0.0)	1 (3.6)
Ground floor flat	4 (4.2)	1 (1.5)	3 (10.7)
Residential home	1 (1.1)	1 (1.5)	0 (0.0)
Distance from institution (miles)			
0—10	30 (31.6)	19 (28.4)	11 (39.3)
11—20	9 (9.5)	8 (11.9)	1 (3.6)
21—30	30 (31.6)	21 (31.3)	9 (32.1)
31 and over	36 (37.9)	19 (28.4)	7 (25.0)

ASA: American Society of Anesthesiologists' physical status classification; BMI: body mass index; IQR: inter-quartile range; LL: lower limb; THA: total hip arthroplasty; TKA: total knee arthroplasty.

weight-bearing exercises using walking aids, and gait re-education. If a patient returned late (after 17.00) from theatre, ward nurses were instructed to commence mobilisation. Additionally patients who had undergone a TKA were instructed to perform gentle knee flexion and extension exercises, as well as isometric quadriceps contractions. The following day, the exercises were reviewed, and patients continued with gait re-education, and, when able, were instructed on negotiating steps and stairs independently and safely for discharge. Each patient was seen a minimum of twice a day during their in-patient hospital stay. Patients were discharged once they were fit from a medical and nursing perspective. No specific haematocrit or knee range of motion parameters were placed as discharge criteria. It was only required that the patients were safe and independent mobilising after being reviewed by the ward physiotherapist, and that the patient felt comfortable regarding their discharge home. On discharge, patients were advised to progress their exercises and gait re-education as pain and swelling allowed during the first six post-operative weeks. Community rehabilitation was not routinely accessed unless indicated by the patient's clinical presentation for profession of joint range of motion, strength or gait re-education.

Data collection

Data were collected by one physiotherapist (SL) from a retrospective review of the medical notes on each patient's discharge. This was verified by a second physiotherapist (TS) through a second retrospective review of the medical notes six months later. Using these sources, data collected comprised of patient characteristics including age, gender, weight, body mass index (BMI), American Society of Anesthesiologists' physical status classification (ASA) grade, side of operation, whether the patient had undergone

Table 2 Past medical histories for the reviewed cohort.

Condition	Frequency Exhibited		
	Total Cohort	THA	TKA
None	28	19	9
Cardiovascular/respiratory			
Hypertension	6	4	2
MI	5	5	0
Cardiac surgery	4	4	0
COPD	3	2	1
Asthma	2	2	0
Pacemaker	2	2	0
Sleep apeona	2	1	1
Atrial fibrillation	1	1	0
Emphysema	1	1	0
Angina	1	1	0
Lung metastasis	1	1	0
Pulmonary embolism	1	0	1
Orthopaedic/musculoskeletal			
Low back pain	6	6	0
Meniscectomy	5	2	3
Polymyalgia	3	3	0
Rheumatoid arthritis	2	2	0
Fractured wrist	2	2	0
THR	2	2	0
Spinal surgery	2	2	0
Multi-joint Osteoarthrits	2	2	0
Clubfoot	1	0	1
Fractured NOF	1	0	0
Surgical			
Hernia repair	2	0	2
Lap Chole	2	1	1
Barrettes esophagetomy	1	1	0
Colectomy	1	1	0
Hysterectomy	1	1	0
Cancer bowel	1	1	0
Cancer breast	1	1	0
Below knee amputation	1	1	0
Nephrectomy	1	0	1
General Medical			
NIDDM	7	5	2
Hyperthyroidism	6	2	4
Hepatitis A	1	1	0
Deep vein thrombosis	1	1	0
Tuberculosis	1	1	0
Diverticulitis	1	0	1
Gout	1	0	1
Neurological			
TIA	2	2	0
CVA	1	1	0

COPD: chronic obstructive pulmonary disease; CVA: cerebral vascular accident; Lap Chole: laparoscopic cholecystectomy; MI: myocardiac infarct; NIDDM: non-insulin-dependent diabetes mellitus; NOF: neck of femur; THA: total hip arthroplasty; TIA: transient ischaemic attack; TKA: total knee arthroplasty.

previous lower limb joint arthroplasty, whether the patient lived alone, the type of dwelling they lived in, and the distance between the hospital to their home.

Primary outcome measures

The Iowa Level of Assistance (ILOA) score and visual analogue scale (VAS) pain scores patients reported at discharge were collected from the medical notes. The ILOA score has been demonstrated to be a valid and reliable measure for patients following THA and TKA [12]. It is a five-item functional outcome measure which assesses a patient's ability to transfer from supine lying to sitting on the edge of the bed, sitting to standing, walking 4.57 m, climbing up and down three stairs, and walking speed over 13.4 m/h [12]. Each task is scored according to the level of assistance required and use of assistive devices, such as a walking frame, used to complete the task. The ILOA scale is scored out of a maximum of 56, where higher scores represent greater disability. A standard VAS for pain was constructed using a horizontal 10-cm line on a piece of A4 paper. This has also been shown to be reliable and valid for this population [13].

Secondary outcome measures

Additional data also collected from the medical notes included length of stay, time of operation, time the patient commenced mobilisation, whether a social care package was required, number of physiotherapy treatments, type of walking aid prescribed on discharge, and whether any complications arose during the first six post-operative weeks. The reasons why patients were not discharged at 24 hours were also determined.

Data analysis

Descriptive statistics assessing frequencies, median and inter-quartile ranges for cohort characteristics were calculated. All data collected were analysed using these descriptive statistics.

To assess the relationship between patient characteristics and post-operative management, inferential statistical tests were undertaken. Histogram analyses indicated that the data were not normally distributed. Accordingly, non-parametric statistical tests were employed. A Spearman's rank correlation coefficient was performed assessing the relationship between ILOA score, length of hospital stay, and VAS pain score with patient age, weight, BMI, the number of times physiotherapists treated these patients. A Mann-Whitney U test was adopted to assess whether there was a difference in ILOA score, length of hospital stay, or VAS pain score for those who had undergone previous lower limb arthroplasty compared to those who had not, lived alone or did not live alone, and finally mobilisation on the day of surgery compared to those who did not. A Kruskall-Wallis Test was conducted to investigate differences in ILOA score, length of hospital stay, and VAS pain score when compared to the different ASA grades, type of dwelling lived in, and distance lived from the hospital.

Table 3 Operative and post-operative outcomes.

	Total cohort	THA	TKA
Median LOS (IQR)	3 (2.8—5.0)	3 (2.0—5.0)	3.5 (3.5—5.8)
Operation time (%)			
08.00—10.30	39 (41.1)	26 (38.8)	13 (46.4)
10.30—13.00	26 (27.4)	21 (31.3)	5 (17.9)
13.00—15.30	10 (10.5)	6 (9.0)	4 (14.3)
15.30—onwards	20 (21.1)	14 (20.9)	6 (21.4)
Package of care required (Yes—%)	0 (0.0)	0 (0.0)	0 (0.0)
Commenced mobility on the day of operation (Yes—%)	44 (46.3)	33 (49.3)	12 (42.9)
Median Physiotherapy contact per patient (IQR)	5 (3—7)	5 (3—7)	5 (4—8)
Walking aid discharged with patient (%)			
Rollator frame	32 (33.6)	24 (35.8)	8 (28.6)
Elbow crutched	58 (61.1)	39 (58.2)	19 (67.9)
Two sticks	5 (5.3)	4 (6.0)	1 (3.6)
Median ILOA on discharge (IQR)	25 (18.5—35.5)	25 (21.0—35.0)	23 (14.5—37.0)
Median VAS Pain on discharge (IQR)	3 (1.0—5.0)	2.7 (1.0—4.0)	5 (2.0—6.0)
Complications during first 6 weeks			
Knee stiffness requiring MUA	1	0	1
THR dislocation	4	4	0
Required blood transfusion (%)	1 (1.1)	1 (1.5)	0 (0.0)

ILOA: Iowa Level of Assistance score; IQR: inter-quartile range; MUA: manipulation under anaesthetic; THR: total hip arthroplasty; TKA: total knee arthroplasty; VAS: visual analogue scale.

A probability value of $p < 0.05$ was determined as statistically significant. All analyses were performed on SPSS version 18.0 (IBM, New York, USA).

Results

Primary outcome measures

On discharge, the median ILOA score was 25.0 for THA patients and 23.0 for TKA patients, whilst the median VAS pain score was 2.7 for the THA and 5.3 for TKA patients.

Secondary outcome measures

The median length of hospital stay was three days for THA patients and 3.5 days for TKA patients. Whilst there was a trend for more procedures to be performed in the morning, less than half of the cohort (46%) commenced mobilisation on the day of the operation due to factors such as reduced sensory-motor output, dizziness, nausea and insufficient pain control. The median number of times physiotherapists saw each patient was five for both THA and TKA patients. Whilst the majority of patients (61%) were discharged home with two elbow crutches, 34% were discharged home with rollator frames.

No patient required a social services package of care (Table 3). The reasons for why patients were not discharged at 24 hours post-operatively are presented in Table 4. The most frequently cited reasons were vaso-vagal episodes during the early post-operative period, pain and dizziness. When reviewed after the first six weeks, one TKA patient required MUA (mobilisation under anaesthesia) due to a flexion deficit, and four THA patients had dislocated (two anterior approach; two posterior approach). The duration from surgery to first dislocation ranged from three days to three weeks following primary THA.

Table 4 In-patient complications.

Condition	Frequency exhibited		
	Total cohort	THA	TKA
None	21	17	4
Vaso-vagal episode	14	12	2
Pain	13	4	9
Dizziness	12	10	2
Nausea and dizziness	8	5	3
Low blood pressure	7	5	2
Nausea	6	6	0
Poor gait	3	3	0
Pain and dizziness	3	1	2
Decreased sensory-motor output	3	2	1
Chest infection	2	1	1
THA dislocation	1	1	0
Urinary incontinence	1	0	1
Anxiety	1	0	1

THA: total hip arthroplasty; TKA: total knee arthroplasty.

Table 5 The statistical relationship between pre-operative/post-operative variables and clinical outcomes.

	LOS (p)	ILOA score (p)	VAS Pain (p)
Age	< **0.01**	**0.01**	**0.02**
Weight	0.88	0.08	**0.03**
BMI	< **0.01**	**0.05**	0.35
ASA grade	0.79	0.30	0.48
Previous LL arthroplasty	0.48	0.26	0.96
Lives alone	< **0.01**	0.95	0.28
Type of dwelling	0.26	0.15	0.26
Residential area	0.45	0.38	0.24
Commenced mobility on the day of operation	< **0.01**	0.43	0.02
Physiotherapy contacts	< **0.01**	**0.01**	**0.04**

ASA: American Society of Anesthesiologists' physical status classification; BMI: body mass index; ILOA: Iowa Level of Assistance score; LL: lower limb; LOS: length of stay: VAS: visual analogue scale.
Bold signified statistical significance where p = less than or equal to 0.05.

The results of the inferential statistical analyses are presented in Table 5. These indicate that there was no statistical association between ASA grade and ILOA or VAS pain scores at discharge ($p > 0.05$; Table 5). There was also no statistical association between whether patients had previously undergone THA or TKA, the type of dwelling patients lived in or distance from hospital, in relation to length of hospital stay or with ILOA or VAS pain scores at discharge ($p > 0.05$). There was however a significant correlation between patient's age and outcome, where older patients required longer hospital stays (Rho = 0.48; $p < 0.01$), had lower functional outcomes (Rho = 0.28; $p = 0.01$) and higher pain scores at discharge (Rho = 0.27; $p = 0.02$) compared to younger patients. Patients with a higher BMI also reported longer length of stays (Rho = 0.02; $p < 0.01$) and lower functional ILOA scores (Rho = 0.66; $p = 0.05$), whilst those weighed more reported higher pain scores at discharge (Rho = 0.24; $p = 0.03$). Patients who lived alone required a significantly longer length of stay compared to those who did not (median = 4.0 days versus 3.0 days; $p < 0.01$).

Although there was no statistical difference between those who commenced mobilisation on the day of operation and those who did not for functional ILOA outcomes ($p = 0.43$), those who commenced mobilisation on Day 0 reported significantly lower pain scores (median = 2.0 versus 3.0; $p = 0.02$) and shortened length of stay (median = 3.0 days versus 4.0 days; $p < 0.01$), compared to those who did not. Finally, there was a statistically significant correlation between the number of physiotherapy treatment sessions and each outcome, where those who received the highest number of physiotherapy contacts reported unsurprisingly, the longest length of stay (Rho = 0.41; $p < 0.01$) and better functional outcomes (Rho = 0.26; $p = 0.01$), with lower pain scores (Rho = 0.31; $p = 0.04$).

Discussion

The findings of this review indicate that the developing Norwich Enhanced Recovery Programme (NERP) has been a successful rehabilitation regime for patients following THA and TKA, facilitating early safe discharge with minimal complications.

It suggests that commencing mobilisation on the day of the operation was important in improving early functional outcomes and reducing length of stay, like in other enhanced recovery programmes [7,14,15]. However, not all patients achieved this. Reasons for not mobilising at 24 hours included low blood pressure, limited pain control, dizziness and reduced sensory-motor outcome. Thus, there appears to be a reduction in the functional status within the early post-operative period. This was been attributed to the anaesthetic regime and has been subsequently reviewed to address these initial shortcomings. Following these findings, these issues have improved. The change in anaesthetic protocol from our institution's previous use of spinal epidural has been attributed as a key factor in facilitating early mobilisation, particularly during the initial 12 hours. Further development of the analgesic programme has been successfully started, to further minimise the effects of hypotensive symptomatology, whilst reducing nausea and minimising pain to allow early mobilisation. Furthermore, greater familiarity of this new post-operative analgesic regime may also facilitate the reduction of these unwanted early post-operative complications.

The median ILOA score for this cohort was 25. This equated to being safe to transfer, slowly mobilise requiring two elbow crutches, and the ability to negotiate stairs with some difficulty [12]. Furthermore, anemization due to surgery could affect the functional outcome. Whilst one patient required blood transfusion, since only function was assessed during in-patient stay, further longer-term assessment to evaluate patient function with typical haematocrit levels six months to one year post-operatively may be warranted.

Whilst function was evaluated, specific measurement of range of motion was not assessed for those following TKA. Although the study indicated that the enhanced programme provided good early functional outcomes, it remains unknown whether this enhanced recovery program affects the functional outcome of TKA in term of range of motion in comparison with classical rehabilitation programmes. Further study is therefore recommended to compare these domains between different regimes.

All patients attended a pre-operative educational class. Previous literature has suggested that the addition of a pre-operative educational or exercise programme offers little advantages [16]. For instance, whilst patients were routinely instructed regarding precautions following THA, four experienced a THA dislocation. We did not formally assess why THA dislocation occurred. However, with good pain control and the facilitation of greater post-operative activity, the programme may have inadvertently affected patient's perceptions of protecting their THA and their caution in activity undertaken during the initial six weeks. This is nonetheless a hypothesis and therefore further study is required to determine what level of information and pre-operative interventions should be given to patients

awaiting a joint arthroplasty procedure with an accelerated rehabilitation programme.

Previous studies of enhanced recovery programmes have selected those patients with less co-morbidities to participate, on the basis that they will be physiologically 'better able' to cope with the increased intensity of physiotherapy [14,15]. This was not the case with the NERP regime where patients presented with a number of co-morbidities (Tables 1 and 2). This enhanced the generalisability of this programme to all patients listed for THA and TKA surgery.

This survey of normal practice presented a number of methodological limitations. No control group or comparison group was included in the survey. Thus, it is not possible to determine the significance of the changes reported in this paper compared to a more conventional rehabilitation programme. Secondly, baseline functional data on this patient group is not routinely collected thus it was not possible to assess how clinical outcomes changed following their surgical programme. Finally, only 95 patients were included in this audit, which may be subject to type 2 statistical errors.

Conclusion

This review indicated that the developing NERP allows patients who have undergone THA or TKA surgery to experience a short hospital length of stay. The addition of commencement of mobilisation within four hours significantly reduced hospital length of stay and pain scores compared to not initiating this within a rehabilitation programme. The initial limitations in respect to immediately post-operative complications and analgesic regime have subsequently been addressed. We now intend to assess the clinical and health economic results of the modified NERP with a sufficiently powerful sample size, to evaluate these against a conventional post-operative lower limb arthroplasty programme.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

Funding: None.

Acknowledgements

We would like to thank Mrs. Leigh Smith, Norfolk and Norwich University Hospital, for her assistance in the final preparation of this paper.

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