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Introduction of an enhanced recovery programme for total shoulder arthroplasty: report of a novel pathway

Marie L Morgan,[1] Gareth R Davies-Jones ,[1] Edward F Ibrahim,[2] Simon J Booker,[3] Marcus Bateman,[1] Amol A Tambe,[1] David I Clark[1]

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[1]Derby Shoulder Unit, University Hospitals of Derby and Burton NHS Foundation Trust, Derby, UK
[2]Trauma & Orthopaedics, Chelsea and Westminster Hospital NHS Foundation Trust, London, UK
[3]Trauma & Orthopaedics, Sheffield Teaching Hospitals NHS Foundation Trust, Sheffield, UK

Correspondence to
Gareth R Davies-Jones;
gareth.davies-jones@nhs.net

Marie L Morgan;
marie.morgan2@nhs.net

ABSTRACT

Background Enhanced recovery (ER) programmes are well established in hip and knee arthroplasty, but are not yet commonplace for total shoulder arthroplasty (TSA). This study analyses the effect of implementing an ER programme with TSA, on length of stay (LOS), functional outcome and patient satisfaction.

Local problem No established programme applying ER to the specifics of upper-limb arthroplasty existed at our unit.

Methods A three-cycle plan–do–study–act quality improvement methodology was applied, involving development of our multifactorial programme, a pilot phase and wider roll-out. A consecutive series of patients who underwent TSA and were enrolled in an ER programme were compared with a matched control group of consecutive patients who underwent TSA in the year before the programme started. For all patients, LOS as well as mean Oxford Shoulder Score (OSS) and Constant Score (CS) were quantified and patient satisfaction assessed.

Interventions A dedicated multidisciplinary team led preoperative class involving patient education, advice and occupational therapy assessment. A standardised perioperative anaesthetic regime based on regional anaesthetic techniques with preoperative analgesic and nutritional loading was introduced. Postoperative rehabilitation was also standardised with slings for comfort only and early safe-zone mobilisation. New patient information was developed.

Results 71 patients were included in matched cohorts. Mean LOS was reduced from 2.4 nights to 1.9 nights. The single night stay rate improved from 40% to 49%. Across the ER cohort, 15 less nights were required to complete same volume of surgeries as in the non-ER cohort.
Parity in OSS and CS measured at 3 and 12 months after surgery were observed in both cohorts.
Satisfaction was already high before ER but scores stayed the same or improved across all areas surveyed.
Absolute complication rates of 9.9% in the non-ER group and 7% in the ER group were recorded.

Conclusion Our ER programme benefited patients and the Trust by reducing time in hospital and improving patient satisfaction without an adverse effect on complication rate.

PROBLEM

Enhanced recovery (ER) is well established in hip and knee arthroplasty. No programmes using ER in total shoulder arthroplasty (TSA) were identified in the literature at the time of conception, though Wainwright *et al*[1] have discussed the concepts of applying ER to TSA since.

Our unit is performing increasing numbers of TSAs, with an average of 108 per year over the last 5 years. Good clinical outcomes with high patient satisfaction were established, but patients' varied preparedness for surgery was noted during routine arthroplasty review. This prompted an interest in developing a process to improve consistency of patient experience. A steering group was formed including senior upper-limb (U/L) arthroplasty consultants, registrars and specialist physiotherapists to define the problem and plan a TSA ER programme.

Variability in patients' understanding and expectations of surgery was confirmed by a small-cohort (n=17) qualitative study. A questionnaire consisting of nine questions using a Likert scale with room for comments was administered via convenience sampling of consecutive patients attending for arthroplasty review. Patients rated their level of agreement with statements regarding their experience, for example, 'pain postsurgery settled within an expected timeframe'. Overall satisfaction was good but pain levels and function were identified as areas where patients' pre-conception and actual experiences differed. Variability in preoperative analgesia and nutrition, quality and quantity of therapy and anaesthetic were noted. A time delay between listing and surgery was also identified as an opportunity for proactive management.

We aimed to introduce an evidence-based holistic and sustainable programme with investment from the whole multidisciplinary team (MDT). This would use applicable aspects of our lower-limb (L/L) ER programme, but also introduce new resources such as a class, educational literature and multimedia, anaesthetic and analgesia protocols and therapy assessment tools and

protocols. We aimed for a fully functional programme within a year from first class.

We would measure the service's effect at a number of defined checkpoints. Data were collected prospectively on length of stay (LOS), functional outcome and complication rates and would be audited at 2, 6 and 12 months. A number of cohort studies would also be introduced to measure more specific aims, including improvements in patient understanding and the effects of a protocoled anaesthetic regime on postoperative pain.

A service analysis would be carried out after 12 months comparing matched non-ER and ER patients to deduce impact on LOS and to ensure there were no detrimental effects.

BACKGROUND

TSA numbers in the UK are increasing, with the 2019 National Joint Registry (NJR) report detailing a total of 7677 procedures in 2018, compared with 6769 procedures in 2016.[2] ER was first established in general surgical practice in the late 1990s[3] but was soon adopted by L/L arthroplasty. It is now commonplace, evidence consistently highlighting associated reduced LOS, better patient experience and improved morbidity outcomes.[4 5] A 2016 systematic review and meta-analysis of ER in total hip arthroplasty (THA) and total knee arthroplasty (TKA) showed significantly reduced LOS without significantly impacting 30-day readmission rates or complication rates.[6] A more recent systematic review and narrative synthesis in 2021[7] of THA and TKA also found that adherence to ER protocols consistently reduced LOS. Moderate confidence in the results of these reviews is suggested using AMSTAR-2 (A MeaSurement Tool to Assess systematic Reviews-2).[8]

Common ER principles include using multimodal analgesia to limit opioid use, regional or local infiltration anaesthesia techniques over general anaesthetic, blood loss reduction protocols and early postoperative mobilisation.[3 5] Patients being informed partners in their own care is key and is promoted by prehabilitation, patient education, expectation management, nutritional optimisation and comorbidity control. Prehabilitation has been recommended with THA and TKA in recent NICE (The National Institute for Health and Care Excellence) guidelines.[9] While evidence to support ER with TSA is sparse, further research in this area has been suggested[9] and our view is that the benefits seen in THA and TKA may be cautiously extrapolated to TSA.

At the time of conception, no ER programmes had been described for TSA. Wainwright *et al*[1] did subsequently discuss an application of ER to TSA and their analysis of Hospital Episode Statistics data in England, suggested scope for improving LOS in TSA.

Baseline measurement

A retrospective analysis was undertaken to understand existing the TSA treatment pathway. The pathway is detailed in figure 1. Data were collected prospectively at clinic attendances by a dedicated U/L arthroplasty practitioner and compiled on an Excel database.

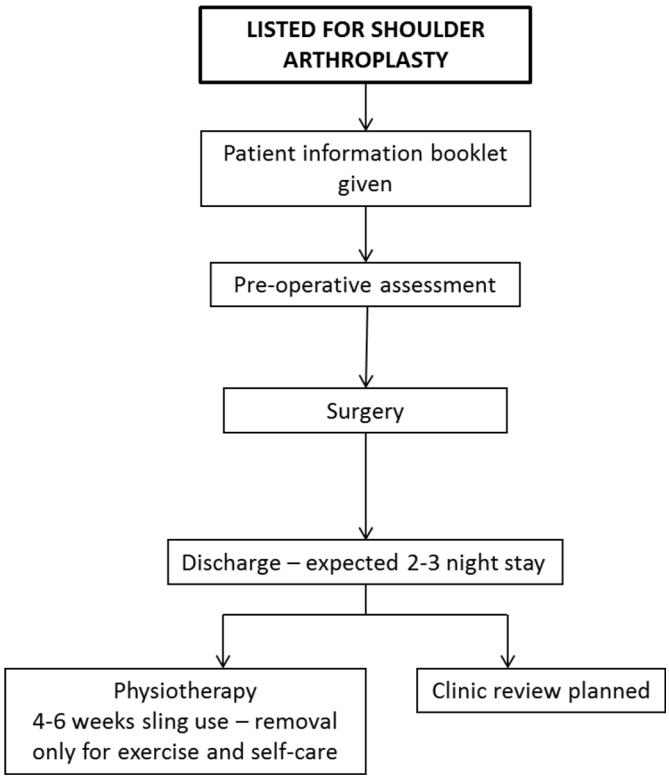

Figure 1 Arthroplasty pathway pre-ER

Seventy-one consecutive patients who underwent TSA between 1 September 2016 and 1 September 2017 were identified. The average preoperative Oxford Shoulder Score (OSS) was 16.8. The average preoperative Constant Score (CS) was 21.7.

The mean LOS was 2.38 nights, the median LOS was 2 nights and the single night stay rate was 40.2%.

Table 4 details these results (non-ER group).

Design

An initial concept TSA ER was created based on an established L/L ER pathway within our hospital. The MDT involved in design of the L/L pathway was consulted and lessons/limitations from their experience shared. This paved the way for focused development of our own intervention with attention to specific differences of shorter LOS and rehabilitation goals around sling use and self-care rather than mobility and transfers.

The steering group was tasked with reviewing and adapting existing resources and developing new programme components. Cross-disciplinary working involved anaesthetists, arthroplasty practitioners, physiotherapists, occupational therapists (OTs), ward nurses, preoperative assessment team, outpatient nurses, pain services, clerical support and divisional management. A number of novel interventions were agreed (figure 2). Our first plan–do–study–act (PDSA) cycle was dedicated

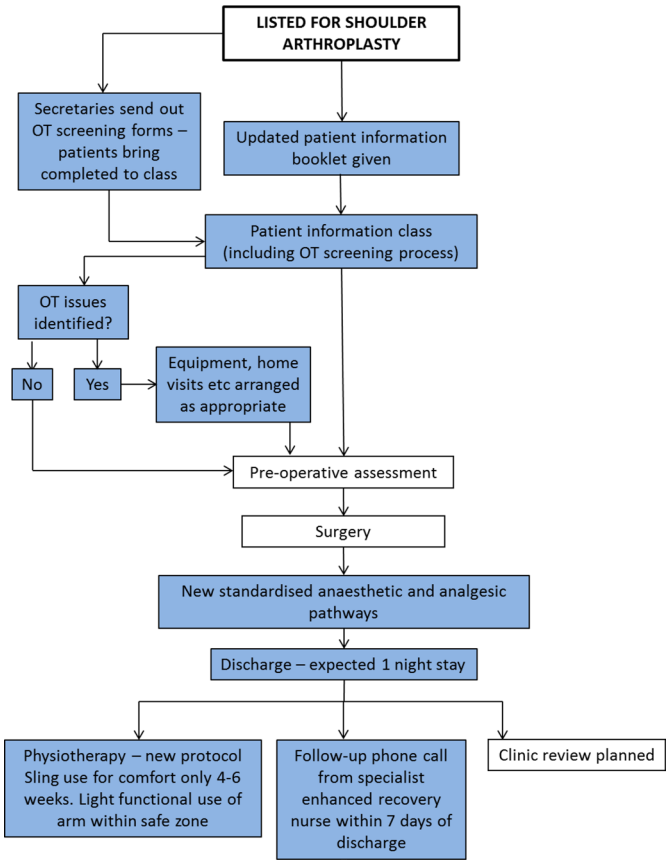

Figure 2 ER patient pathway - changes shown in blue. OT, occupational therapist.

to this thorough planning process of several integrated salient components and is described below.

Strategy

We planned for multiple PDSA cycles that would provide a robust and responsive tool for shaping the programme. A three-cycle programme was designed. Cycle-1 involved in depth development of our multifactorial intervention. Cycle-2 involved a 2-month pilot period and Cycle-3 involved roll-out of the programme to all eligible patients with TSA.

PDSA Cycle-1

The aim of Cycle-1 was to plan, develop and analyse the components that would make up our core ER programme. An overview of this is presented in tabular form for ease of differentiation (table 1).

It was agreed that all patients with TSA would be eligible for the programme unless 'opted out' by the consultant in charge. ER became our standard approach for all primary TSA. Some revision or complex cases were not included, due to more stringent precautions that were imposed.

A comprehensive patient information booklet was produced to be given to patients on listing. Clinicians included counselling patients on expected short stays and engagement in the programme in the consent process from the time of listing.

The patient information class was designed with a focus on pro-active patient involvement and prehabilitation concepts. Preoperative and postoperative exercises and functional techniques within a safe mobilisation zone would be demonstrated. A home assessment form was developed by OT which patients would bring completed to the class to allow early identification of concerns and provision of equipment before admission.

Consensus on a universal anaesthetic regime was challenging due to acknowledged clinical nuances and personal preferences in practice. Use of dexamethasone in regional blocks, local anaesthetic agent and use of indwelling nerve catheters were areas of perceived inconsistency. However, provision of preoperative carbohydrate drinks and a loading dose of 100 mg gabapentin, both on the evening before and morning of surgery, were agreed. A postoperative regime including continuation of gabapentin for 5 days and early postoperative oxycodone use was also agreed on. These measures were already well established in L/L arthroplasty practice and computerised prescribing order sets made regime consistency more convenient.

On drafting the overall pathway, a business case was presented and approved. Both OT and nursing involvement in running the class was agreed within existing staffing levels. As programme benefits were predicted to save human-resources during the inpatient portion of the patient journey, re-assigning these resources to class provision was possible with no extra staffing costs. Additional time of a specialist physiotherapist to lead the group was required at 3 hours per month, but was deemed an acceptable expense.

While there was no formal public and patient involvement (PPI) in our project, informal patient feedback from routine U/L arthroplasty follow-up was the initial stimulus for the project. This informal patient feedback, advocated by the specialists involved, continued to shape our programme throughout. Our initial scoping questionnaire did also highlight some inconsistencies and areas of concern for patients and helped in shaping the educational package.

The final programme is shown in figure 3.

PDSA Cycle-2 is detailed in table 2.

Due to conscientious planning in Cycle-1, very few adjustments to the format of the programme were required during Cycle-2. Improved LOS, without a detrimental effect on functional outcomes or complication rates was promising and allowed transition to Cycle-3.

PDSA Cycle-3

Cycle-3 increased throughput, with all eligible patients with TSA being part of the programme (table 3).

The average LOS in this group was 1.88 days. Average 3-month postoperative OSS and CS were 34.7 and 48.9, respectively. Four complications were observed; a superficial wound infection, a neuropraxia, a superficial haematoma and one prosthetic dissociation requiring further surgery.

Table 1 PDSA analysis of four salient components of the programme during Cycle-1

	Patient information	Preoperative class	Physiotherapy protocol	Anaesthetic/analgesic protocols
Plan	Update existing patient information booklet and exercise sheets.	Develop MDT led class to provide education, reassurance, explain patient journey and teach exercises, sling use and so on.	Update existing physiotherapy protocol.	Review, update and streamline anaesthetic and analgesic protocol for TSA.
Do	Changes agreed with consultants. New documents drafted, using arthroplasty messages from L/L materials. Focus on expectation management.	Structure of class proposed, involving physio, OT and nurses. Meetings to discuss content, logistics, staffing, capacity and creation of informative DVD.	MDT agreement of a new protocol allowing 'safe-zone' mobilisation of shoulder immediately post-op and sling use 'for comfort' only.	MDT agreement of new draft protocol based on existing L/L ER principles.
Study	New documents circulated for comments from MDT. Second drafts created and agreed. Language and readability reviewed with patient information team.	Existing L/L ER group and DVD observed. Administrative pathways analysed and adapted. Feasibility of staffing assessed. Demand and capacity estimated.	No published evidence of adverse events from safe-zone mobilisation (limited external rotation and elevation). Patient reports of inconvenience of sling reinforced change.	Protocol shared with wider team for comments. Attempts to reach consensus made, but universal agreement on one protocol not possible.
Act	Final drafts agreed and ordered to replace existing stocks.	DVD filmed and edited with AudioVisual department, and MDT. Final structure of group agreed (figure 3), including location, timings and administrative processes.	Protocol changed as above. Meetings held with inpatient and outpatient teams to explain changes and communicated with community partners. New protocol uploaded to website and start-date agreed.	New protocol agreed allowing some flexibility in anaesthetic regime. Cohort study planned for initial stages of roll-out to determine the most effective practices.

ER, enhanced recovery; L/L, lower-limb; MDT, multidisciplinary team; OT, occupational therapist; PDSA, plan–do–study–act; TSA, total shoulder arthroplasty.

Within Cycle-3, two cohort studies were organised. The first investigated satisfaction among patients undergoing TSA in and outside of the ER programme. This study found comparable outcomes with 98% of ER patients answering yes to the question 'would you recommend the service to others?' compared with 97% of the no-ER group. Other positive qualitative outcomes were identified including patients feeling better prepared physically and psychologically for their operations and having more realistic expectations of pain and recovery outcomes.

The second cohort study investigated anaesthetic outcomes among patients, to allow us to finalise an accepted anaesthetic regime. Sixty-three consecutive patients who were enrolled in the ER programme from February 2017 to October 2018 were identified. The primary outcome of this retrospective audit was to evaluate pain scores post-TSA. A secondary outcome was to assess adherence to the ER analgesic regime and anaesthetic techniques used.

Pain scores were observed throughout the 36-hour immediate postoperative period. The mean score was under 0.9, meaning most patients had no or mild pain. Only 6% and 8% of patients had moderate to severe pain (2–3) at the time of their 6-hour and 12-hour postoperative observations, respectively. This is relevant as it means that early mobilisation first occurred while patients had controlled pain. One hundred per cent of patients received regional blocks during their procedures. Sixty-seven per cent had a general anaesthetic and regional block, 30% had regional block with sedation and 3% had regional block alone. Pain scores and morphine consumption were also lower in patients receiving dexamethasone as part of their anaesthetic regime. A final important lesson was that analgesia lasted longer when levobupivacaine was used over lidocaine.

A group of 17 patients also completed the same Likert questionnaire used pre-ER to gain insight into expectations and understanding of TSA. Overall satisfaction and preparedness remained high. Positive free text comments specifically regarding the usefulness of the education group in reassuring and aiding preparation for surgery were noted.

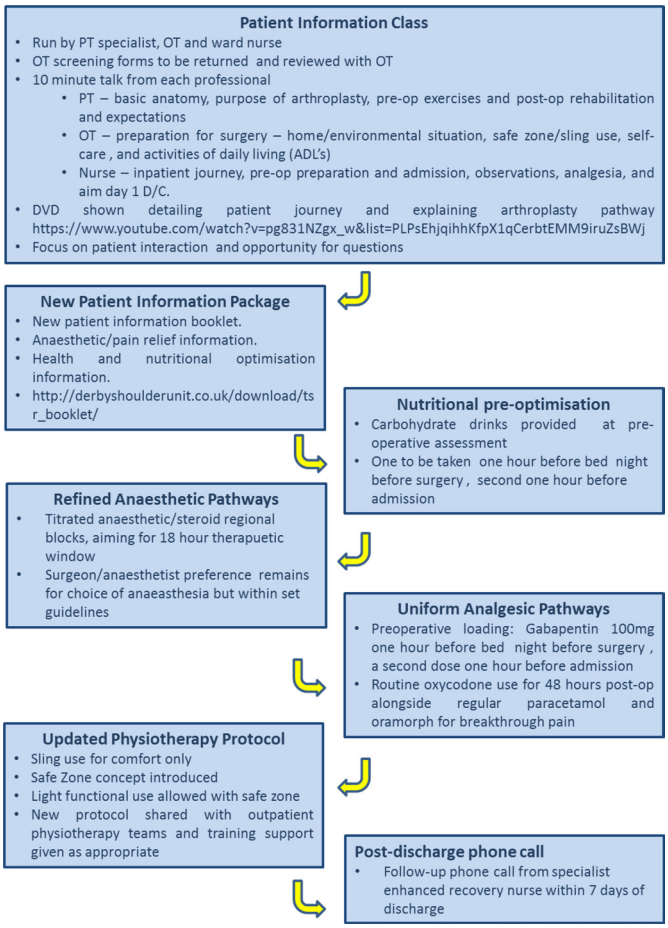

Figure 3 Components of shoulder ER programme. OT, occupational therapist DVD, digital video disc, PT, physiotherapist

RESULTS

A total of 148 patients were enrolled in the ER programme. One hundred and twenty-two went on to have surgery during the study period. Seventeen classes were delivered. Eight patients failed to attend classes but otherwise underwent other aspects of the programme.

Seventy-one patients subject to the complete ER programme were matched by age, gender, procedure and indication to the cohort of patients undergoing TSA prior to ER. Twenty-four patients underwent anatomical TSA and 47 patients underwent reverse TSA. Twenty male patients and 51 female patients were identified with an average age of 73.1 years. Indications for surgery were osteoarthritis (n=34), cuff tear arthropathy (CTA) (n=34) and inflammatory arthropathy (n=3). The average preoperative OSS was 16.81 and the average preoperative CS was 19.05. A summary of results is presented (table 4).

Mean LOS was reduced from 2.38 nights to 1.89 nights. Median LOS remained at 2 nights. However, single night stay rate improved from 40.2% to 49.2%. Across the ER cohort, 15 less nights were required to complete same volume of surgeries as in the non-ER cohort.

Parity in OSS measured 3 months after surgery was observed in both cohorts. Scores improved by an average of 17.43 points in the non-ER group and by 17.11 points in the ER group. Improvements were also observed in 12-month OSS. Patients not enrolled in ER saw a 21.49 mean point improvement compared with 24.76 mean point improvement in the ER group.

Similar parity was observed in CS between cohorts at 3 and 12 months postoperatively. The mean CS for the non-ER cohort 3 months after surgery was 25.72 compared with 28.37 observed in the ER group. After 12 months, the mean CS in the non-ER cohort was 37.97, compared with 41.13 in the ER group.

Absolute complication rates of 9.9% in the non-ER, group and 7% in the ER group were recorded. In the non-ER group, these consisted of 1 dislocation, 1 wound dehiscence, 1 haematoma, 1 peri-prosthetic fracture and

Table 2 PDSA analysis of four salient components of the programme during Cycle-2

Plan	Deliver the first three patient education classes and roll-out all aspects of the programme as a pilot, before full roll-out of the programme with all eligible patients.
Do	The first ER class was on the 6/10/2017. Recruitment monitored until 6/12/2017.
Study	Class attendance, drop-out rate and short-term outcomes were primary quantitative measures. Twenty-two patients were recruited and attended ER classes. Of these, 6 patients developed problems that precluded surgery, leaving 16 who proceeded to surgery. Two patients failed to attend the class, but were subject to all other aspects of the programme. Average LOS was 1.75 days. Average 3-month postoperative OSS and CS were 35.1 and 52.9, respectively, suggesting no early adverse effects of the programme on functional outcomes. One complication was observed in this 3-month period, a haematoma. Regular updates between the project lead (arthroplasty practitioner) and MDT identified problems which could be shared for potential solutions. Informal feedback was gained from the early class attendees and comments invited. In response areas for improvements in terms of the class set-up and 'meet and greet' for patients were identified.
Act	Application made to appoint a volunteer to assist in class set-up, and provide a 'meet and greet' service for patients. Fine-tuning of class content between professionals also undertaken. No adverse responses to any aspect of the programme were noted. Progression to full roll-out of the service to all patients with TSA therefore agreed, with further monitoring.

CS, Constant Score; ER, enhanced recovery; LOS, length of stay; MDT, multidisciplinary team; OSS, Oxford Shoulder Score; PDSA, plan–do–study–act; TSA, total shoulder arthroplasty.

Table 3	PDSA analysis of four salient components of the programme during Cycle-3
Plan	Continuation of ER programme incorporating minor modifications from Cycle-2 to 1 year period.
Do	From 07/12/2017 to 8/10/2018, 14 ER classes were delivered and data collected.
Study	Class attendance, LOS, complication rates and patient outcomes (standard arthroplasty review process) were monitored. One hundred and six patients were recruited and underwent surgery. Six patients failed to attend the ER class but were subject to all other aspects of the programme. Twelve patients attended classes but surgery was delayed or cancelled. Complication rates were not adversely effected by introduction of ER, LOS was reduced and patient outcomes were maintained (see below). A convenience sample of 17 patients completed the same initial questionnaire used pre-ER to gauge effects on preparedness and expectations of recovery.
Act	The benefits of the ER programme were assessed to be worthwhile when balanced against costs of running the programme. Long-term continuation was agreed.

ER, enhanced recovery; LOS, length of stay; PDSA, plan–do–study–act.

3 neuropraxias. In the ER group, these consisted of 1 case of prosthesis loosening, 1 neuropraxia, 1 superficial wound infection and 2 haematomas.

While the comprehensive impact on all MDT members involved was beyond the scope of this study, no significant dissatisfaction was reported. Through effective MDT communication, the programme was successfully introduced without any issues and all staff involved could see the benefits for patients and invested parties.

Table 4	Results summary	
	Non-ER (n=71)	**ER (n=71)**
Gender	Male 27 Female 44	Male 20 Female 51
Average age (years)	70.5	73.1
TSA indication	OA 38 CTA 29 Inflammatory arthropathy 3 Osteomyelitis 1	OA 34 CTA 34 Inflammatory arthropathy 3
Arthroplasty type	Anatomical TSA 22 Reverse TSA 49	Anatomical TSA 24 Reverse TSA 47
Mean OSS	Pre-op 16.80 3/12 post-op 34.23 12/12 post-op 38.29	Pre-op 16.81 3/12 post-op 33.92 12/12 post-op 41.54
Mean CS	Pre-op 21.7 3/12 post-op 25.72 12/12 post-op 37.97	Pre-op 19.05 3/12 post-op 28.37 12/12 post-op 41.13
Mean LOS (nights)	2.38	1.89
Single night stay rate	40.2%	49.2%
Absolute complication rate	9.9%	7%

CS, Constant Score; CTA, cuff tear arthropathy; ER, enhanced recovery; LOS, length of stay; OA, osteoarthritis; OSS, Oxford Shoulder Score; TSA, total shoulder arthroplasty.

Lessons and limitations

Using PDSA cycles provided a robust system to guide continuous improvement. PDSA cycles were selected as the most appropriate methodology based on our knowledge of existing L/L pathways. We already had ideas about key components of the programme to adapt for TSA and wished to test and refine these. An alternative method such as experience based co-design[10] would have allowed a much richer collaborative approach using PPI. However, given the already well-established local hip and knee pathways, we sought to use existing knowledge and refine it relative to TSA rather than re-conceptualise the entire process.

Patient-reported outcomes and satisfaction were already high before ER, therefore improving these aspects was always going to be difficult. Feedback from patients in their experience has been very positive but was only collected from a relatively small cohort (n=34, 17 non-ER, 17 ER). It is acknowledged that this aspect of the project was underdeveloped and that a more robust qualitative investigation, with open-ended questioning could have given more meaning and context to the value of the programme and effects on patient experience. The Likert scores used for this research are acknowledged to have limitations. The programme aims to promote patients as champions for their own care and PPI in the planning phase would have undoubtedly added value.

Complication rates in both groups were comparable with those reported in the literature for TSA[11] and introduction of the programme did not adversely affect this. In addition, of the seven total complications in the non-ER group and five in the ER group, 2 and 3, respectively, were more minor complications that were not listed within the Bohsali *et al*[11] study.

While difficult to measure, the proactive approach to pain relief, early safe-zone mobilisation and reduced sling use does seem to infer earlier return to function, which patients value greatly. Use of patient-reported outcome measures earlier than 3 months may have confirmed this objectively.

Comparatively low numbers of TSA are performed compared with TKA and THA. Demand for classes is less.

Classes occur monthly on Friday mornings. This inflexibility is a limitation and some patients have difficulty attending. The ER educational resources are also only available in English. Our hospital serves a population with rich language and ethnic diversity. While non-English speaking patients do attend classes with interpreters, in a group situation this is challenging and does inevitably introduce some inequality.

Although matched our cohorts are not homogenous groups. Differences exist in consultant, specific arthroplasty type, anaesthetic and comorbidities. The validity of generalising could therefore be challenged. However, the results are purposefully presented in a pragmatic way to represent the real changes observed in a diverse patient group, illustrating the programmes impact as a whole.

Maximising adherence to agreed analgesic and anaesthetic regimes was challenging, as was auditing the process. Our findings, however, have led to more universal application. Dexamethasone use, for example, was associated with improved postoperative pain scores and reduced morphine use. In the cohort audited, adherence to using dexamethasone was only 36% but a more recent re-audit of 15 patients shows increased adherence to 80%. In April 2019, gabapentin was re-classified as a controlled drug. As such it could not be provided in preoperative assessment and would need to be dispensed by a pharmacist and this led to its protocolled use being unviable. However, a study showed our compliance with gabapentin provision within the ER programme was only 24% due to local supply issues even before re-classification, limiting the impact of this forced change.

OT screening preoperatively reassures patients that environmental or functional difficulties will be assessed prior to surgery. While benefiting patients, this also allows more efficient use of OT time as workload can be planned prospectively, meaning less 'surprises' postsurgery and less delays in discharge. Local social services policy, however, does not allow referral prior to admission, and a small cohort of patients (n=12) had prolonged delays in discharge for this reason.

A formal cost–benefit analysis was not within the remit of this study. However, based on standard National Health Service reference costs, 3 hours per month of specialist physiotherapy time for 8 months equates to £516.96. Based on £290 per night (inpatient stay–current Trust estimates), 15 nights saved equate to £4350. So within our cohort we estimate minimum savings of £4000. No other significant costs were generated as the programme involved modification of existing pathways. Findings are in keeping with the results of a recent systematic review in to the cost effectiveness of ER programmes with TKA and THA.[12] On the whole, ER programmes were regarded to be cost-effective, with the AMSTAR tool[8] suggesting moderate confidence in these results. This has justified the programme's sustainability long term.

CONCLUSION

ER as a concept is extremely compatible with TSA. Most trusts performing elective THA and TKA have forms of ER programmes, and thus the blueprint for their own TSA ER programmes. To our knowledge, this is the first description of such a project from a quality improvement perspective and our experiences will hopefully aid others to use good quality improvement practices as they set up their own programmes.

We used applicable aspects of our L/L ER programme while introducing new resources and protocols. Through effective MDT involvement, new aspects of ER could be introduced quickly and no single individual was overwhelmed. Overall leadership from two lead developers, a therapist and a registrar with an interest in quality improvement allowed for dovetailing of skills, knowledge and contacts, engaging more parties in the project.

Comparison of matched cohorts suggests a quantitative benefit of ER on LOS with associated cost and bed-occupancy benefits. Seventy-one patients undergoing TSA in the ER cohort required 15 fewer overnight stays than 71 patients undergoing the same procedures outside of the programme. There were no significant detrimental effects of the programme such as increased complication rates or reduced functional outcomes.

We continue to run a holistic and sustainable programme, based on well-established ER practices[4 6] and guided by the lessons of PDSA cycles and ongoing audits. We hope dissemination of our project will encourage others to share their own solutions and successes in this area.

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Contributors MLM, the project lead, planned the overall project. Planned, organised and delivered enhanced recovery classes. Produced updated patient information and patient information DVD. Collected data for baseline and active study measurements. Authorship of the study and guarantor. GRD-J contributed to the planning of quality improvement measurement. Additional data collection and analysis. Co-authorship and submission of the study. EFI contributed to the analysis of patient satisfaction data. Production of patient information DVD. Planned PDSA cycle 1 and performed data collection and analysis of this cycle. SJB contributed to procurement and production of patient information. Planned PDSA cycle 2 and performed data collection and analysis of this cycle. MB planned and produced updated physio protocols. Disseminated information via. The Derby Shoulder Unit website. AAT contributed to senior authorship of the manuscript. Part of the MDT work group driving the project and consulting on all aspects of the programme. DIC contributed to senior authorship of the manuscript. Part of the MDT work group driving the project and consulting on all aspects of the programme.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research. Patients were indirectly involved in the design and conduct of this research. The lower limb arthroplasty enhanced recovery programme on which this service is based was broadly directed by formal and informal patient feedback. Specifically the priority of research questions and choice of outcome measures were extrapolated from this previously collected patient feedback.

Patient consent for publication Not required.

Ethics approval This study involves human participants but was not approved by an Ethics Committee. While this study involved human participants, this work did not impose or involve novel therapeutic strategies. It was instead a process of bringing together existing well-established practices into a cohesive and consistent programme. All patients gave informed consent to be included in the study and understood their data would be used in the ongoing quality improvement process and could be used in future research.

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ORCID iD

Gareth R Davies-Jones http://orcid.org/0000-0002-5886-3250

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