

1 **Enhanced Recovery After Surgery (ERAS): Concepts and application to total shoulder replacement**

2

3 **Abstract**

4 **Background**

5 Enhanced Recovery After Surgery (ERAS) focuses on optimising each element on a treatment
6 pathway, and encouraging the patient to actively engage in their recovery and rehabilitation. It
7 requires collaboration across a multidisciplinary team, and has been successful in improving patient
8 outcomes, length of stay (LOS) and costs for a wide range of surgical procedures, including
9 musculoskeletal surgeries such as total hip and total knee replacement.

10 **Purpose**

11 To examine the application of ERAS concepts to total shoulder replacement (TSR) surgery.

12 **Methods**

13 Hospital Episode Statistics (HES) in England on length of stay (LOS) for TSR surgery were examined,
14 and a review of literature on the use of ERAS concepts in TSR was undertaken.

15 **Results**

16 Analysis of HES data suggested scope for improvement in reducing LOS. A review of the literature
17 found some evidence of the use of ERAS concepts, particularly in multimodal pain management.

18 **Conclusions**

19 Future research is now required for ERAS procedure specific components for TSR surgery.

20

1 **Introduction**

2 Enhanced Recovery After Surgery (ERAS) (also known as fast-track, accelerated recovery or rapid
3 recovery) is a multimodal approach to the care of patients following surgery. It has been successful
4 in improving patient outcomes, and reducing recovery time and costs for a wide range of surgical
5 procedures (Adamina et al.; 2011; Ljungqvist et al., 2017, Paton et al., 2014).

6 **ERAS Rationale**

7 The concept of ERAS was developed following work by a Danish colorectal surgeon, Henrik Kehlet, in
8 which he questioned why his abdominal surgery patients did not leave hospital sooner following
9 surgery (Kehlet, 1997). ERAS aims to minimise the stress response that occurs during surgery by
10 modulating perioperative insulin sensitivity (Carli, 2015), and it has been successfully adopted across
11 a range of complex surgical procedures such as rectal/pelvic surgery, colonic surgery, gastrectomy,
12 bariatric surgery and pancreaticoduodenectomy (Ngren et al., 2013; Gustaffson et al., 2013;
13 Mortensen et al., 2014; Thorell et al., 2016; Lassen et al., 2013). ERAS focuses on improving quality
14 of care, speeding-up rehabilitation, reducing morbidity following surgery, and lowering costs (Carli,
15 2015). It also highlights the importance of continual audit and feedback on the process, outcomes
16 and cost effectiveness, and the monitoring of patient satisfaction to maximise the pathway's success
17 (Husted, 2012; Wainwright et al., 2019).

18 In contrast to many traditional pathways, ERAS requires collaboration across a multidisciplinary
19 team of nurses, surgeons, anaesthetists, pharmacists, physiotherapists and other support staff
20 (Montgomery and McNamara, 2016). The team work with the patient and their family, encouraging
21 the patient to be active in their own recovery. Prior to surgery, patients are educated on how to
22 prepare for surgery, and reduce any pre-surgery risk such as anemia or smoking. They are also
23 informed on the content of the care pathway, how pain is managed, the requirement for early
24 mobilization, pre and post-surgery nutrition, to manage expectations and enable appropriate

1 planning for discharge (Brady et al., 2015; Montgomery and McNamara, 2016). It is common for the
2 ERAS pathway to be co-ordinated by an ERAS nurse or project manager, who leads on training new
3 staff and communication within the team, and continually evaluates compliance and outcome audit
4 data (Wainwright et al., 2018).

5

6 **The application of ERAS to musculoskeletal surgery**

7 ERAS concepts have been successfully adopted into musculoskeletal surgical procedures such as
8 total hip replacement (THR) and total knee replacement (TKR). Key elements in these ERAS pathways
9 prior to surgery are education and counselling along with the optimization of patients' health.
10 During surgery, a standardized multi-modal anesthetic regime is adopted and blood loss is prevented
11 using tranexamic acid. Optimal pain management is achieved through multimodal opioid-sparing
12 analgesia; and antimicrobial and antithrombotic prophylaxis treatments given. The routine use of
13 surgical drains and urinary catheters is not recommended. Early mobilization is encouraged along
14 with early post-operative nutritional care and early discharge to home (Wainwright et al., 2019).

15 At present there is insufficient evidence in regard to type of surgical approach or the use of
16 minimally invasive techniques for these surgeries (Lloyd et al., 2012). There is also conflicting
17 evidence on the best anesthesia regime to use. Neuroaxial techniques have been favored in many
18 successful ERAS pathways (Khan et al., 2014; McDonald et al, 2012); however recent studies at ERAS
19 centers have found evidence to support the use of a modern general anesthesia (Harsten et al.,
20 2013; Harsten et al., 2015). The use of nerve block techniques has been studied with the aim of
21 reducing hypotension and opioid use; however they may hinder early mobilization and so are not
22 part of the essential ERAS pathway (Wainwright et al., 2019).

23

1 There is consistent evidence that ERAS can reduce length of stay (LOS) in hospital (Aasvang et al.,
2 2015; Husted, 2012; Ibrahim et al., 2013) without increasing complications, readmissions and
3 mortality rates (Malviya et al., 2011), or negatively impacting patient satisfaction (Specht et al.,
4 2015). Indeed, the success in reducing LOS for THR and TKR patients through the adoption of ERAS
5 has highlighted the possibility of discharging patients on the day of surgery (Aynardi et al., 2014; Den
6 Hartog et al., 2015), and a study in Denmark indicates that this is possible for 15% of all patients in
7 unselected cohorts (Gromov et al., 2017).

8 ERAS concepts have also been successfully adopted in other musculoskeletal areas. In the UK
9 Blackburn et al., (2016) introduced an ERAS pathway to an elective spinal service which included
10 complex and traditionally longer stay procedures such as posterior scoliosis correction. To develop
11 the pathway they sought input from an expert team of anesthetists, surgeons, other clinicians, staff
12 and patients; explored the literature for best available evidence; and examined the THR and TKR
13 enhanced recovery pathways already in use at their site. They standardized the descriptions of the
14 spinal surgeries, reducing procedure descriptions from 135 to 12. The earliest expected discharge
15 day was defined for all staff and perioperative laxatives were prescribed along with preoperative
16 carbohydrate drinks. Patients were set daily aims to prepare them for discharge and a team of
17 experienced community-based nurses provided wound care and analgesia advice to patients post
18 discharge. The service was continually audited and improvements made accordingly. The
19 introduction of the ERAS pathway resulted in a reduced mean LOS of 3 days; readmissions were
20 reduced from 7% to 3%; and patient satisfaction was excellent with nearly 100% of patients rating
21 their care as good or excellent. ERAS has also been introduced to total ankle replacement surgery
22 (Gonzalez et al., 2017; Mulligan et al., 2017) and fractured neck of femur pathways (Kosy et al.,
23 2013; Lofti et al., 2015, Macfie et al., 2012), although as yet there are few studies in these areas.

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25 **The application of ERAS to total shoulder replacement (TSR)**

1 There is little reporting in the literature of the application of ERAS to TSR surgery which indicates
2 that as a concept it is less well advanced for TSR than for THR and TKR surgeries. One reason for this
3 may be that for TSR there is already a relatively short LOS with studies in the US reporting LOS of 2
4 days (Basques et al., 2015; Dunn et al., 2015). Even a reduction in LOS from 2 days to 1 day is of great
5 benefit to patients, as well as health care economics, particularly as there are an increasing number
6 of shoulder replacements being performed annually worldwide.

7 In England, data are recorded on all admissions, emergency attendances and outpatient
8 appointments for all National Health Service (NHS) trusts in the Hospital Episode Statistics (HES)
9 database (NHS Digital, 2016). This includes data on 134 trusts who have reported on primary
10 shoulder replacement surgery. Examination of these data from April 2015 to March 2016 found
11 that mean LOS across NHS Trusts in England ranged from 1.0 to 6.4 days (mean 2.8 days), compared
12 to the case-mix adjusted expected range of 1.0 to 3.9 days. Figure 1 shows the observed LOS for 134
13 Trusts.

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15 Insert Figure 1: Observed LOS for TSR ordered by Trust from lowest to highest LOS

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17 This variation in observed LOS is unlikely to be due to case mix alone, which suggests that the range
18 of observed LOS of 1.0 to 6.4 days may be due to differences in local protocols and pathways. Trusts
19 that have already adopted approaches analogous to ERAS to optimize patients medically and
20 physically, are more likely to have the shortest LOS. We suggest therefore that there is scope to
21 improve LOS in shoulder replacement surgery by introducing ERAS.

22 The Office of Population Censuses and Surveys (OPCS) Classification of Interventions and Procedures
23 (v4) codings for the data examined using Dr Foster's Practice and Provider Monitor tool (Dr Foster)
24 are given in Table 1. The analysis included data in which a total of 2354 superspells were recorded at

1 134 Trusts. A superspell includes all related spells for a single patient during an episode of care, and
2 so takes into account the differing practices of trusts in transferring patients from an acute setting to
3 either rehabilitation or home. See Table 2 for further definitions.

4

5 Insert Table 1: OPCS4 codes included in analysis

6 Insert Table 2: Definitions of outcome measures (Dr Foster)

7

8 To examine what evidence had been published on the use of ERAS protocols in TSR and/or
9 outpatient TSR, a literature search was carried out in January 2018 of peer reviewed articles (English
10 language only) since January 2000. The search terms adopted are in Table 3. Once duplicates and
11 non-relevant papers were removed, the authors found 15 papers related to TSR and ERAS concepts
12 and/or outpatient TSR, 12 retrospective or prospective studies and 3 reviews. One additional article
13 was found going through references of the articles (Banghu et al., 2017).

14

15 Insert Table 3: Literature search terms

16 The studies investigate the use of specific anesthetic techniques (Banghu et al., 2017; Chalmers et
17 al., 2017; Ifield et al., 2006; Routman et al., 2017; Sabesan et al., 2017; Thompson et al., 2017;
18 Weller et al., 2017) or multimodal pathways consistent with ERAS concepts (Basques et al., 2017;
19 Brolin et al., 2017; Cancienne et al., 2017; Gallay et al., 2008; Leroux et al., 2016; Padegimas et al.,
20 2016). The main outcomes reported were pain scores, LOS, complications, readmissions and hospital
21 costs. As the majority of studies were retrospective, no information was reported on patient
22 satisfaction. Unsurprisingly, ambulatory TSR was found to be significantly more cost effective than
23 inpatient TSR (Cancienne et al., 2017; Brolin, 2018).

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2 A US retrospective study (Padegimas et al., 2016) compared 136 patients in a tertiary referral centre
3 (TRC) to 136 matched TSR patients in an orthopaedic speciality hospital (OSH), that had fast-track
4 rehabilitation and strict discharge protocols likely to be analogous to ERAS concepts. It found that
5 patients in the OSH had a significantly shorter length of stay (LOS) compared to the TRC (1.3 ± 0.5
6 days vs 1.9 ± 0.6 days, $p < 0.001$), and readmission rates at the two institutions were similar. However,
7 there is limited information in the paper on the exact content of the OSH pathway, so it is difficult to
8 ascertain which elements of the OSH pathway enabled the shorter LOS.

9

10 Recent publications around multimodal pain management in TSR suggest that when this element of
11 ERAS is implemented, LOS is reduced. Routman et al. (2017) investigated the addition of intravenous
12 dexamethasone and liposomal bupivacaine injections in the surgical site intraoperatively, as part of a
13 multimodal pain strategy in patients undergoing TSR under general anaesthesia combined with a
14 single-injection interscalene block. They found that the addition of intravenous dexamethasone and
15 liposomal bupivacaine significantly reduced median LOS from 2 days to 1 day. There were also
16 reductions in pain and the need for opioids.

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18 Further studies (Chalmers et al., 2017; Thompson et al., 2017) also sought to refine the multi-modal
19 analgesic approach synonymous with ERAS, but found conflicting results for the best combination of
20 regional block. As highlighted earlier, these inconsistent findings are also reflected in the more
21 extensive literature on ERAS in THR and TKR, where no evidence has been found to support one
22 specific multimodal anaesthetic regime over another (Kehlet and Aasvang, 2015). Further research
23 is required in these areas.

24

1 It is interesting to note that an NHS treatment centre in the UK is offering selected patients the
2 opportunity to have outpatient TSR (Care UK Group, 2017). Patients are asked to maintain or build
3 their fitness levels prior to surgery, and then commit to a program of physiotherapy following their
4 operation. The operation is performed under regional anaesthetic, using minimally invasive
5 techniques, so that potential blood loss is reduced. The patient is then followed up on discharge by
6 the surgeon or a nurse, and the anaesthetist checks on the patient the morning after surgery.

7

8 A study by Jerosch et al. (2012) published in German was not picked up by the search, but was
9 known to the lead author and so was reviewed as part of this work. The paper reports on the
10 introduction of a rapid recovery approach to shoulder replacement patients in a German hospital.
11 The rapid recovery approach optimised treatment by employing a multi-disciplinary treatment team
12 using evidence-based and cross-discipline protocols in areas such as pain management, drainage and
13 catheter management and physiotherapy; early mobilization and positive group dynamic effects;
14 and working in partnership with the patient. ERAS concepts were found to be easily transferable
15 and initial results showed improvements in LOS, quality of care, and patient and staff satisfaction.
16 However, no further information has been published yet on this study, highlighting the need for
17 further studies to identify the required components for a successful ERAS pathway for TSR.

18

19 **Summary**

20 Examination of HES data in England suggests that there is scope to improve LOS for TSR, as there is a
21 variation in Trusts' mean observed LOS of 5.4 days. ERAS has proven results in other orthopaedic
22 procedures such as hip and knee replacement. There is some evidence in the literature on the use of
23 ERAS for shoulder replacement, especially in multimodal pain management, that suggests that

- 1 improvements can be made in LOS and cost, without extra risks or a higher complication rate. Future
- 2 research is now needed on ERAS procedure specific components for TSR surgery.
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