

The Perioperative Surgical Home and Enhanced Recovery After Surgery: Perspectives from Two Continents

Yusuf H Mirza, Adam T Yassen, Sam Oussedik, Ran Schwarzkopf, Zeev Kain

Yusuf H Mirza, Adam T Yassen, Sam Oussedik, Department of Trauma and Orthopaedics, University College London Hospital, 235 Euston Road, London NW1 2BU, the United Kingdom

Ran Schwarzkopf, Division of Adult Reconstruction, Department of Orthopaedic Surgery, NYU Langone Medical Center Hospital For Joint Diseases, 301 East 17th Street, New York, NY 10003, the United States

Zeev Kain, Department of Anesthesiology & Perioperative Medicine, University of California, Irvine, 101 The City Drive South, Orange, CA 92868, the United States

Conflict-of-interest statement: The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper.

Open-Access: This article is an open-access article which was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

Correspondence to: Yusuf H Mirza, Department of Trauma and Orthopaedics, University College London Hospital, 235 Euston Road, London NW1 2BU, the United Kingdom.
Email: mirzyusuf@gmail.com

Received: April 21, 2017

Revised: June 18, 2017

Accepted: June 19 2017

Published online: August 28, 2017

ABSTRACT

The concept of enhanced recovery after surgery – ERAS – has been in place in surgical practice in Europe since the 1990s, but its uptake in the United Kingdom has been more recent, especially its use in orthopaedic surgery. Encompassing 20 or so specific clinical practices, ERAS aims to reduce length of inpatient stay, minimise costs, and improve patient outcomes after surgery. Based on these same principles, a new model of care delivery has been developed in

the United States, with similar aims. Under a multi-professional team, led by the Orthopaedic Surgeon and an Anaesthetist, this expands the provision of care from the moment the decision for surgery is made, to a period of 30 and even 90 days following discharge – what the American Society of Anesthesiologists have defined as the ‘Perioperative Surgical Home’. Preliminary results of the PSH model for patients undergoing arthroplasty surgery in the US have so far been promising. Surgical leadership must be provided to better utilise anaesthetic services in arthroplasty pathways, to reduce length of stay, readmission and move towards a model for care provision that extends to the entire perioperative period. The review aims to compare the perioperative surgical home to current UK practice and provide an evidence based summary of both surgical and non surgical interventions to help achieve a reduction in length of stay, decrease readmissions, and improve functional outcomes as well as a discussion of the potential for integrating some of its elements into current care models.

Key words: Enhanced recovery; ERAS; Perioperative surgical home; Arthroplasty; Health economics

© 2017 The Author(s). Published by ACT Publishing Group Ltd. All rights reserved.

Mirza YH, Yassen AT, Oussedik S, Schwarzkopf R, Kain Z. The Perioperative Surgical Home and Enhanced Recovery After Surgery: Perspectives from Two Continents. *International Journal of Orthopaedics* 2017; **4(4)**: 779-785 Available from: URL: <http://www.ghrnet.org/index.php/ijo/article/view/2050>

INTRODUCTION

Total Hip and Total Knee Arthroplasty (THA and TKA) significantly improve a patient’s quality of life^[1,2]. The trauma of arthroplasty causes a derangement in normal physiology and organ dysfunction contributing to perioperative morbidity. Venous thromboembolism and non-healing wounds contribute to lengthy hospital stay and unfavourable patient outcomes. Multiple factors contribute to perioperative morbidity, as summarised in table 1^[3,4].

Enhanced Recovery After Surgery (ERAS) achieves this by reducing the stress response to surgery^[3,5]. Pioneered by Professor Henrik Kehlet^[6], it is a relatively new concept in the UK, but has

been adopted across surgical specialties and by an increasing number of arthroplasty surgeons.

Traditionally, LOS for colorectal resection was in the range of 9-10 days. Kehlets ‘multimodal approach to peri-operative care’ lowered inpatient stay to 2 days^[7]. A multimodal approach included the use of an epidural anaesthesia, early mobilisation and oral feeding with limited use of nasogastric tubes and drains. The study described the techniques in patients with a range of indications for sigmoidectomy including diverticulitis and cancer, without the use of novel technologies. However the study has a small sample, of 16 patients. The majority of these patients are American Society of Anaesthesiologist (ASA) grade 1, with a high level of preoperative function (7). The National Health Service (NHS) Enhanced Recovery Partnership Program (ERPP) has consolidated Kehlets work^[8]. An evidence-based approach to all aspects of surgical care, it aims to improve quality of care and deliver cost-effectiveness. It fulfills both High Quality Care for All^[9] and the quality and productivity criteria of the Quality and Productivity Challenge (QIPP). Surgery currently accounts for an estimated 65% of total healthcare expenditure in the US whilst the Royal College of Surgeons estimates that the total surgical costs in England, alone, is some £ 4.5 billion^[10,11].

Cost-saving measures are thus welcomed. A high quality, cost effective orthopaedic service is not just a UK concern but also one shared by our American counterparts^[12]. The problem of a variation in care and high attendant costs are well described. To counter this, initiatives have been co-opted from the world of business.

In the US, the Lean and Six Sigma methodologies, derived from Toyota and Motorola respectively, have been co-opted for arthroplasty with very promising results.

The Six Sigma aims to improve quality control. The cause of defects in a manufacturing process is removed and variability minimised. Clinically, a pathway can improve quality and realise cost effectiveness. Arthroplasty surgery, in terms of diagnosis and treatment, is fertile ground for such a pathway. Clinical pathways can improve the process, limiting needless investigations, with a corresponding decrease in expenditure ranging from \$800 -\$3000^[13].

The review aims to provide an evidence based insight into the concept of the North American perioperative surgical home (PSH) and to compare and contrast it with the European enhanced recovery (ER) pathway in TKA/THA.

METHODOLOGY

A piecemeal adaptation of ER took place throughout the UK NHS in the early 2000s^[14]. Economic austerity and rationalisation of healthcare spending has led to the Department of Health championing ER. The resultant Enhanced Recovery Partnership Program (ERPP)

has led to the widespread implementation of enhanced recovery (ER). The principles of ER can yield many benefits for arthroplasty surgery. A large cohort study of 6000 patients, comparing an ER arthroplasty cohort to a traditional control found that ER patients can reduce length of stay (LOS) and need for blood transfusion^[15]. Others have corroborated these findings^[12-20]. Other advantages include reduction of both 30-day incidence of myocardial ischaemic events ($p = 0.03$) and 30-day mortality ($p = 0.03$)^[15]. The cause for this is not clear, with the authors pointing out that the ER cohort have a higher prevalence of comorbidities including diabetes and ischaemic heart disease amongst others. However the ER patients suffered fewer cardiac ischaemic events. However others have discovered no difference in 90-day mortality ($p = 0.80$) for TKA patients on an ERP compared to those on traditional protocols^[16].

One large series described an ER arthroplasty pathway^[21]. Pre-operatively, a comprehensive consultant anaesthetist-led pre-assessment of the patient took place. Tests were ordered according to a protocol. The pre-assessment minimised day of surgery case cancellations^[21]. Patients attended an interactive pre-operative education class, in which patients were provided with a detailed overview of the inpatient journey. The patients arranged their own admission dates, reducing the chances of patient-initiated cancellation. Finally, discharge planning began pre-operatively and risk assessments identified those patients likely to have a longer LOS. On the day of surgery, admissions were staggered, according to the time of the surgery. Patients had less anxiety and avoided a lengthy pre-operative fast^[21].

The movement from previous dogma, with fasting commenced from midnight prior to surgery, is evidence based. “Nil by mouth from midnight” was recommended to prevent the risk of aspiration but this was based on the false principle that the ingestion of food was equivalent to a full stomach^[22]. Recommendations endorsing minimal perioperative fasting now mirror the findings of a Cochrane review, a systematic review of 38 studies which found that fasting for 6 hours for solid food and 2 hours for clear fluids are completely safe^[23]. Another Cochrane review of 27 trials, 1976 patients, including 4 orthopaedic studies, discovered that the use of pre operative carbohydrate loading, a cornerstone of ERAS, reduced post operative insulin resistance whilst also significantly reducing the length of hospital stay by 0.30 days (95% confidence interval, 0.56-0.04)^[24]. Post operative insulin resistance is an independent predictor of length of inpatient stay. Other clinical benefits include a 34% reduction in in-hospital mortality and 41% reduction in acute renal failure, demonstrated by one study infusing insulin to induce normoglycaemia in surgical ICU patients^[25].

Both ER and the PSH promote minimal perioperative fasting and early recommencement of food^[26].

Table 1 Factors contributing to perioperative morbidity.

Pre-operative	Intra-operative	Post-operative
Underlying disease/co-morbidity; Pre-operative anemia; Inadequate hydration; Inadequate nutrition.	Long operating times; Excessive heat loss; Large surgical incisions; Poor surgical technique; Excessive blood loss; Inadequate fluid resuscitation; Inadequate analgesia.	Inadequate/ineffective pain control; Nausea/vomiting; Generalised weakness and dizziness; Prolonged use of IV lines, drains, catheters and tubes; Sleep disturbance; Delayed mobilisation; Wound problems; Infections; Cardiopulmonary complications; Venous thromboembolic events.

Adapted from Stowers, M. D., et al (2014). Perioperative care in enhanced recovery for total hip and knee arthroplasty. *Journal of Orthopaedic Surgery*, 22(3), 383-92. Kehlet, H., & Wilmore, D. W. (n.d.). Multimodal strategies to improve surgical outcome. Retrieved from <http://www.infodocor.org/bandolera/b119-5.pdf>

Spinal anaesthetic with a local nerve block was favoured. Spinal anaesthesia can both prevent DVT and postoperative deficiencies in cerebral and pulmonary functions as well as limiting intraoperative blood loss, minimising blood transfusion post operatively^[27].

Post-operative pain was addressed with multimodal pain management techniques, to promote early recovery of function^[21,30]. Such multimodal pain management has demonstrated both earlier ambulation and earlier discharge from hospital^[31-33]. Other benefits include lower blood transfusion rates for TKA patients on ERAS pathways. Furthermore, units that discontinued use of IV fluids sooner after surgery, and avoided patient-controlled analgesia, were more likely to mobilise their patients earlier and had shorter LOS^[34].

IV cannula, catheters, and drains were removed where possible after surgery to promote independence and normalisation of self^[21]. A consensus on post operative drain use has not been met. One systematic review and meta-analysis evaluated the benefits of the use of drains in primary THA in 16 studies ($n = 2705$). The use of drainage was found to increase total blood loss and blood transfusion requirements ($p < 0.05$)^[35]. Another systematic review evaluated the use of drains in TKA in 6 studies and concluded that there was no difference in terms of drainage, recovery of knee flexion and reduction in swelling length of hospital stay, ($p < 0.05$)^[36]. However, Middleton *et al* considered the lack of a drain encouraged an earlier return to normal activities^[21].

Evidence examining successful ER strategies in colorectal surgery concluded that the early discontinuation of the catheter led to a reduced LOS^[37,38]. Intensive physiotherapy encouraged early ambulation and active range of movement (ROM), while simultaneously proactively dealing with swelling by use of elevation and ice^[21].

Postoperatively the evidence suggests that the earlier the commencement of physiotherapy, the earlier the discharge^[39]. One study looking at early mobilisation of TKR patients enrolled to an ER programme, patients were discharged, on average 69 hours earlier than control patients^[39]. LOS from this ER protocol was 4 days, compared to the previous traditional pathway LOS of 7.8 days^[21]. Such a programme is recommended as best practice by NHS Evidence. Besides clinical benefits, there were marked cost effectiveness benefits with gross savings at £ 275 per bed amounting to £ 247,500 or £ 5,893 per 100,000 population^[40]. Studies have also demonstrated overall higher patient satisfaction for those on ERPs post-surgery than those on traditional pathways^[41,42-45]. Machin described a study comparing arthroplasty patients on standard pathways to those on enhanced recovery pathways. Satisfaction was evaluated according to a 5 point scale and the EQ-5D health questionnaires. Mean patient satisfaction score of 4.07 in ER patients was significantly higher than the control, 3.68 ($p = 0.037$). Such findings was mirrored in postoperative health score between the ER and control groups 74.1 to 64.7 respectively, ($p = 0.0029$)^[42].

The NHS ERPP defines a successful ER programme as one in which the patient: (1) Is medically optimised for surgery; (2) Has the best possible perioperative management and; (3) Experiences the best post-operative rehabilitation.

The ‘Perioperative Surgical Home’ (PSH) addresses such requirements. It is defined, by the American Society of Anaesthesiologists, as a “patient centered model designed to improve health, the delivery of health care and to reduce the cost of care”. It extrapolates from the concept of a ‘medical home’^[46]. Although perhaps not readily familiar to European audiences, a medical home is a term whose principles are well understood in American clinical practice. It refers to “patient-centred, comprehensive, coordinated,

accessible and committed to quality and safety” medicine^[47]. The term, coined by the American Academy of Pediatrics, referred to centralization of medical records with a special focus on those children with chronic conditions or disability^[48]. The PSH model builds upon ER principles and expands the medical care from the time the decision for surgery is made, to a period of 30 days post-discharge.

PSH has three principles: improving quality of care, improving the service delivery, and reducing the cost of care, mirroring the underlying principles of the ERPP (Table 2). In an anaesthetist and surgeon led team, with the anaesthetist uniquely positioned to function as a ‘perioperativist’^[49]; co-ordinating pre-operative work-up, anaesthesia and post-operative medical and pain management^[20]. The PSH empowers the patient to have greater choice through shared and informed decision making, from the point of referral when assessing the individual needs of patients prior to surgery, to the management of personalised patient care during and after surgery.

The Perioperative Surgical Home aims to: (1) Standardise and increase the reliability of care using evidence-based practices and guidelines, to reduce variability in utilisation of resources; (2) Reduce last-minute operative case cancellation, reduce peri-operative complications and re-admission rates, and decrease LOS, thereby leading to reduced costs of care; (3) Improve overall satisfaction of patients, physicians, nurses, and all other allied health professionals; (4) Provide quality and performance improvement measures, and comply with all regulatory requirements.

The University of California Irvine has spearheaded the PSH concept for arthroplasty, drawing on experience with ERAS, Lean and Six Sigma methodology. Results are very promising. The incidence of blood transfusion was a median of 6.2% (95% confidence interval 2.9-11.4%) with a 30 day readmission of 0.7% (0.0-3.8%) an inpatient mortality of and in-hospital mortality was 0.0 (0.0-7.0)%. Patient satisfaction was high with a 98% percentile Press Ganey satisfaction score, providing a solid foundation for the PSH practical use^[50,51].

Before surgery, the anaesthetic team oversees clinical testing. The patient’s medical condition is optimised. Performed 3-4 weeks prior to the planned admission, further testing or medical intervention can be completed without the need to cancel or reschedule surgery. Garson *et al* demonstrated a case cancellation rate of 0.7%^[50].

Furthermore the use of a clinical pathway curtails unnecessary investigation. Three studies reported a statistically significant decrease in the cumulative number of gratuitous tests^[13]. A multidisciplinary pre-operative assessment clinic, in which patients are assessed by an anaesthetic-led team, can limit unplanned intensive care unit (ICU) admissions, and reduce LOS on high dependency unit (HDU) and ICU, as well as decreasing mortality rates, for complex orthopaedic surgery patients^[52].

Before surgery, the PSH team can educate the patient about the surgery itself, post-operative rehabilitation and different types of anaesthesia. Patients’ expectations are aligned to the reality of post-operative rehabilitation. The education process allows patient participation in the decisions regarding their care and gives an opportunity to the PSH team to plan, thereby decreasing surgical care inefficiency throughout the inpatient stay. The evidence is somewhat mixed, with regards to the benefits of patient education. Moulton *et al* establishes that those attending a preoperative education class prior to a elective THR led to a reduced length of stay compared to non attenders (3.53 vs 4.27 days, $p = 0.046$)^[53]. Another study examining patient education prior to TKA concluded that the education group had a mean reduced length of stay to that of the conventional group (5 days vs 7 days $p \leq 0.01$)^[54].

Table 2 A comparison of Enhanced Recovery with the Perioperative Surgical Home.

	Enhanced Recovery	Perioperative Surgical Home
Definition	Perioperative care pathway with adaptation of best treatments to enhance patient journey.	Patient-centered, anesthetist- led, yet interdisciplinary team- based coordinated care.
Aims	Reduction in recovery time, inpatient stay and complication rates.	A reproducible high quality standard of care with prevention operational mistakes, detrimental care and increasing costs.
Time scale	Time period about inpatient admission and immediate post- operative.	From decision for surgery to 30 days post- discharge.
Pre-operative phase	Anaesthetic assessment; Physiological Optimisation; Patient education with advice beginning from general practitioner and pre operative class; Ability to choose operation date.	Multidisciplinary patient assessment in PACT (pre- operative assessment, consultation, treatment) clinic; Early pre-admission assessments; Identify and minimise complications; Individualised protocol for assessment; Health systems to centralise care of patient; Pre-habilitation of patient to optimise targeted patient for surgery.
Intra-operative phase	Staggered admission; Use of regional anaesthetics; Goal directed fluid therapy; Predictable surgical technique; Minimally invasive surgery; Copious analgesia/anti- emetics; Appropriate prophylactic antibiotics.	Standardised protocol governing fluid resuscitation, and others; Multimodal analgesia; Opioid analgesics for breakthrough pain; Improve operating room flow/efficiency.
Post-operative phase	Normalise patient activity and mobilise; Encourage oral intake; Rationalise IV access; Venous thromboembolic prophylaxis; Well defined discharge criteria, reducing readmission; Early preparation of discharge medication; Telephone consultation post- discharge.	Early mobilisation; Limit factors preventing discharge; Coordinate and communicate discharge plan to inpatient unit/intensive care.

However a Cochrane review discovered that such education only decreased inpatient stay by a single day, concluding that the intervention may not offer any additional benefits^[55].

Standardised protocols governing fluid resuscitation, blood transfusion and antibiotic administration guide anaesthetic care. The use of drains by the surgical team is minimised. Goal directed therapy, the anaesthetic initiative to optimise perioperative outcomes monitors haemodynamic parameters and oxygen delivery is described in a number of enhanced recovery protocols. It is usually utilised in surgery with a high risk of mortality, usually > 5%^[56]. One RCT examined goal directed therapy versus control therapy in elective THA. There was no difference in length of inpatient stay but the median number of complications were reduced in the goal directed therapy^[57].

After surgery, standardised protocols outlining effective analgesia, early involvement of physiotherapy and early ambulation - starting on the day of surgery - can stave off complications, reduce costs, and lead to a reduction in LOS. The concept of multimodal analgesia begins two days before surgery, with the administration of non-steroidal anti-inflammatory drugs (NSAIDs), followed by oral medications (including paracetamol and opioid analgesia) in the holding area before the patient is taken to the operating theatre. Pre-emptive analgesia's effectiveness is disputed.

One study, in which a pre-emptive analgesic regimen was administered to THA patients, led to over 80% of patients undergoing same day discharge^[58]. The patients were carefully selected for, excluding those with serious co morbidities such as ischaemic heart disease and respiratory disorders and 142 of the 150 patients were those with osteoarthritis. There were no readmissions for pain, nausea or hypotension but the study mentions 9 admissions to the emergency room for pain. Another case series examining pre-emptive analgesia in TKA, with 104 of 111 patients (94%) being discharged home on the day of surgery, with only 4 readmissions^[59]. However a

systematic review of 82 studies, 3761 patients, comparing different pharmacological agents, pre incisional analgesia to post incisional analgesia found no difference^[60].

Intraoperatively regional spinal anaesthesia is utilised with Fentanyl and local anaesthetics. The use of IV opioid medication is reserved for breakthrough pain and not recommended beyond the first post-operative day^[49]. Upon discharge, the patient is followed up by a telephone consultation, addressing issues of wound care, medications or function, thus helping to prevent unnecessary early readmissions. Post-discharge physiotherapy is offered to the patient when needed.

The multiple benefits afforded by the PSH, including reduced LOS, reduced readmission rate, improved clinical outcomes and high rates of patient satisfaction, however, do not come without difficulty. Firstly, there may be resistance and skepticism to change from traditional pathways. Teamwork is key. Both Involvement and support of senior executive management and primary care from the very outset of the project, in addition to the surgeon, anaesthetist, and nursing staff, is essential^[17,49,61]. Secondly, the logistical difficulty of changing ward protocols, and reorganisation of services for implementation of such a model, may impede its delivery^[14,61]. Compliance to protocols and completing required documentation may be taxing. Lastly, extra financial investment to set up such a model may initially be required.

However, the release of bed capacity, generated by reduction in length of stay, reduced case cancellations, and better operating theatre throughput, should enhance its appeal^[62]. Moreover, a reduction in unnecessary pre-operative and post-operative patient testing (as recommended by the 'Choose Wisely' programme of the American Board of Internal Medicine in partnership with the ASA), and improved matching of staffing and resource allocation to patients' requirements, may produce considerable cost savings. Furthermore, if ER becomes incorporated into the Best Practice Tariff for primary hip and knee arthroplasty, as recommended by the British Orthopaedic

Association, this will further enhance its appeal.

As the group at the University of Alabama concluded, “a health care organisation must be willing to purchase the value created by a PSH model”^[49].

ERAS programmes are based on well-defined clinical protocols that rely on the performance of very specific items, and can essentially be viewed as a subset of the PSH^[21,63]. These protocols will therefore be largely similar both in the UK and the US. The PSH is itself a larger conceptual framework that includes coordination of care for the entire patient journey. PSH protocols may vary significantly between institutions, being dependent on the surgical and anaesthetic services available, and the local peri-operative environment in which it is employed^[64]. Current practice in the UK, however, would not support the transfer of direct responsibility of in-patient care to the anaesthetic team as seen in the US. This might be revisited in the future if LOS were driven down to approach that of the US, where day case arthroplasty is fast becoming a reality. As the surgeon is the first and last point of contact through the patient’s journey, from initial consultation, to outpatient follow-up, it may be most appropriate for surgeons to lead this initiative in close partnership with anaesthetic colleagues. Being at the forefront of change may better enable surgeons to choose the services their patients require, and may be advantageous in the allocation of resources and practical support^[64,65].

CONCLUSION

Adopting new practices in delivering safe and effective arthroplasty surgery remains challenging. The advantages of ERAS are now well documented and this is now the gold standard. Incorporating principles from the PSH programme may see further improvements. Developing a UK PSH model requires cooperation between surgeons and anaesthetists to integrate new pathways into pre-existing models of care delivery. Sharing ownership of this process will allow greater cooperation, improving the patient experience by dividing up pre- and post-operative care into its constituent parts, each of which can then be overseen by the most appropriate specialist. Many units already employ specific pre-operative assessment clinics in order to optimise patient risk factors prior to surgery. Specialist pain teams are also involved to deliver safe and effective analgesia peri-operatively. Coordination and integration of these teams into a protocol-driven framework may yield the predictable improvements in quality of care, LOS, readmission rates, and the experience patients are increasingly demanding. Furthermore, these programmes may also be attractive to healthcare commissioners, who may consider them as an opportunity to drive down costs whilst potentially increasing the quality of the care. As such, the orthopaedic community should take up the challenge of driving safe changes in practice, to develop the best possible services for our patients.

REFERENCES

1. Ethgen O, Bruyère O, Richey F, Dardennes C, Reginster JY. Health-related quality of life in total hip and total knee arthroplasty. A qualitative and systematic review of the literature. *J. Bone Joint Surg. Am.*, 2004 May; **86-A(5)**: 963-74. [PMID: 15118039]; [DOI: 10.1056/nejm199009133231106]
2. Malchau H, Garellick G, Eisler T, Kärrholm J, Herberts P. Presidential guest address: the Swedish Hip Registry: increasing the sensitivity by patient outcome data. *Clinical Orthopaedics and Related Research*, 2005 Dec; **441**: 19-29. [PMID: 16330981]; [DOI: 10.1097/01.blo.0000193517.19556.e4]
3. Wilmore DW, Kehlet H. Management of patients in fast track

- surgery. *BMJ (Clinical Research Ed.)*, 2001; **322(7284)**: 473-4746. [PMID: 11222424]; [DOI: 10.1136/bmj.322.7284.473]
4. Stowers MD, Lemanu DP, Coleman B, Hill AG, Munro JT. Review Article: Perioperative Care in Enhanced Recovery for Total Hip and Knee Arthroplasty. *Journal of Orthopaedic Surgery*, 2014 Dec; **22(3)**: 383-92. [PMID: 25550024]; [DOI: 10.1177/230949901402200324]
5. Kehlet H, Wilmore DW.. Multimodal strategies to improve surgical outcome. *American Journal of Surgery*. 2002; Jun; **183(6)**: 630-641. [PMID: 12095591]; [DOI: 10.1016/S0002-9610(02)00866-8]
6. Kehlet, H. Multimodal approach to control postoperative pathophysiology and rehabilitation. *Br J Anaesth*, 1997; **78(5)**: 606-617. [PMID: 9175983]; [DOI: 10.1097/00132586-199808000-00048]
7. Kehlet H, Mogensen T. Hospital stay of 2 days after open sigmoidectomy with a multimodal rehabilitation programme. *British Journal of Surgery*, 1999; **86(2)**: 227-230. [PMID: 10100792]; [DOI:10.1046/j.1365-2168.1999.01023.x]
8. NHS Enhanced Recovery Programme (2010). *Delivering enhanced recovery. Helping patients to get better sooner after surgery*. Retrieved from http://webarchive.nationalarchives.gov.uk/20130107105354/http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/documents/digitalasset/dh_119382.pdf
9. Darzi A. (2008). *High quality care for all : NHS Next Stage Review final report*. Stationery Office. Retrieved from <https://www.gov.uk/government/publications/high-quality-care-for-all-nhs-next-stage-review-final-report>
10. Health Care Cost Institute, “Health Care Cost and Utilization Report: 2011.,” Washington, DC, 2012. Retrieved from http://www.healthcostinstitute.org/files/HCCI_HCCUR2011.pdf
11. Royal College of Surgeons, “Surgery and the NHS in numbers,” 2014. [Online]. Available: Retrieved from <https://www.rcseng.ac.uk/media/media-background-briefings-and-statistics/surgery-and-the-nhs-in-numbers>.
12. Chaurasia A, Garson L, Kain ZL, Schwarzkopf R. “Outcomes of a joint replacement surgical home model clinical pathway.,” *Biomed Res. Int.*, 2014; 2014: 296302. [PMID: 25025045]; [DOI: 10.1155/2014/296302]
13. Van Herck P, Vanhaecht K, Deneckere S, Bellemans J, Panella M, Barbieri A, Sermeus W. Key interventions and outcomes in joint arthroplasty clinical pathways: A systematic review. *Journal of Evaluation in Clinical Practice*. 2010 Feb; **16(1)**: 39-49. [PMID: 20367814]; [DOI: 10.1111/j.1365-2753.2008.01111.x]
14. Ljungqvist, O. ERAS—Enhanced Recovery After Surgery. *Journal of Parenteral and Enteral Nutrition*, 2014; **38(5)**: 559–566. [PMID: 24567343]; [DOI: 10.1177/0148607114523451]
15. Khan SK, Malviya A, Muller SD, Carluke I, Partington PF, Emmerson KP, Reed MR. Reduced short-term complications and mortality following Enhanced Recovery primary hip and knee arthroplasty: results from 6,000 consecutive procedures. *Acta Orthopaedica*, 2014; **85(1)**: 26-31. [PMID: 24359028]; [DOI: 10.3109/17453674.2013.874925]
16. Berend KR, Lombardi AVJ, Mallory TH. Rapid recovery protocol for peri-operative care of total hip and total knee arthroplasty patients. *Surgical Technology International*, 2004; **13**: 239-247. [PMID:15744696]
17. Husted H, Hansen HC, Holm G, Bach-Dal C, Rud K, Andersen KL, Kehlet H. What determines length of stay after total hip and knee arthroplasty? A nationwide study in Denmark. *Archives of Orthopaedic and Trauma Surgery*, 2010 Feb; **130(2)**: 263-8. [PMID: 19633865]; [DOI: 10.1007/s00402-009-0940-7]
18. Raphael M, Jaeger M, van Vlymen J. Easily adoptable total joint arthroplasty program allows discharge home in two days. *Canadian Journal of Anesthesia/Journal Canadien D’anesthésie*, 2011; **58(10)**: 902-910. [PMID: 21822756]; [DOI: 10.1007/s12630-011-9565-8]

19. Den Hertog A, Gliesche K, Timm J, Mühlbauer B, Zebrowski S. Pathway-controlled fast-track rehabilitation after total knee arthroplasty: A randomized prospective clinical study evaluating the recovery pattern, drug consumption, and length of stay. *Archives of Orthopaedic and Trauma Surgery*, 2011; **132(8)**: 1153-1163. [PMID: 22643801]; [DOI: 10.1007/s00402-012-1528-1]
20. Kain ZN, Vakharia S, Garson L, Engwall S, Schwarzkopf R, Gupta R, Cannesson M. "The perioperative surgical home as a future perioperative practice model." *Anesth. Analg.*, 2014; **118(5)**: 1126-1130. [DOI: 10.1213/ANE.000000000000190]
21. Wainwright T, Middleton R. An orthopaedic enhanced recovery pathway. *Current Anaesthesia and Critical Care*, 2010; **21(3)**: 114-120. [DOI: 10.1016/j.cacc.2010.01.003]
22. Maltby JR. Fasting from midnight - the history behind the dogma. *Best Practice and Research: Clinical Anaesthesiology*. 2006 Sep; **20(3)**: 363-378. [PMID: 17080690]; [DOI: 10.1016/j.bpa.2006.02.001]
23. Brady M, Kinn S, Stuart P. Preoperative fasting for adults to prevent perioperative complications. In M. C. Brady (Ed.), *Cochrane Database of Systematic Reviews* (p. CD004423). Chichester, UK: John Wiley & Sons, Ltd. 2003; **(4)**:CD004423. [PMID: 14584013]; [DOI: 10.1002/14651858.CD004423]
24. Smith MD, McCall J, Plank L, Herbison GP, Soop M, Nygren J. Preoperative carbohydrate treatment for enhancing recovery after elective surgery. In M. D. Smith (Ed.), *Cochrane Database of Systematic Reviews* (p. CD009161). Chichester, UK: John Wiley & Sons, Ltd. 2014 Aug 14; **(8)**:CD009161. [PMID: 25121931]; [DOI: 10.1002/14651858.CD009161.pub2]
25. van den Berghe G, Wouters P, Weekers F, Verwaest C, Bruyninckx F, Schetz M, Vlasselaers D, Ferdinande P, Lauwers P, Bouillon R. Intensive Insulin Therapy in Critically Ill Patients. *New England Journal of Medicine*, 2001 Nov 8; **345(19)**:1359-1367. [PMID: 11794168]; [DOI: 10.1056/NEJMoa011300]
26. Lambert E, Carey S. Practice Guideline Recommendations on Perioperative Fasting: A Systematic Review. *Journal of Parenteral and Enteral Nutrition*, 2016; **40(8)**: 1158-1165. [PMID::25575497]; [DOI: 10.1177/0148607114567713]
27. Indelli PF, Grant SA, Nielsen K, Vail TP. Regional Anesthesia in Hip Surgery. *Clinical Orthopaedics and Related Research*, 2005 Dec; **441**: 250-255. [PMID: 16331011]; [DOI: 10.1097/01.blo.0000192355.71966.8e]
28. Horlocker TT, Kopp SL, Pagnano MW, Hebl JR. Analgesia for total hip and knee arthroplasty: a multimodal pathway featuring peripheral nerve block. *The Journal of the American Academy of Orthopaedic Surgeons*, 2006 Mar; **14(3)**: 126-35. [PMID: 16520363]; [DOI: 10.1097/01.blo.0000192355.71966.8e]
29. Ranawat AS, Ranawat CS. Pain Management and Accelerated Rehabilitation for Total Hip and Total Knee Arthroplasty. *The Journal of Arthroplasty*, 2007 Oct; **22(7 Suppl 3)**: 12-15. [PMID:17919586]; [DOI: 10.1016/j.arth.2007.05.040]
30. Mallory TH, Lombardi AV Jr, Fada RA, Dodds KL, Adams JB. Pain management for joint arthroplasty: Preemptive analgesia. *The Journal of Arthroplasty*, 2002 Jun; **17(4 Suppl 1)**: 129-133. [PMID: 12068423]; [DOI: 10.1054/arth.2002.32460]
31. Andersen KV, Pfeiffer-Jensen M, Haraldsted V, Søballe K. Reduced hospital stay and narcotic consumption, and improved mobilization with local and intraarticular infiltration after hip arthroplasty: A randomized clinical trial of an intraarticular technique versus epidural infusion in 80 patients. *Acta Orthopaedica*, 2007 Apr; **78(2)**: 180-186. [PMID: 17464604]; [DOI: 10.1080/17453670710013654]
32. Robinson KP, Wagstaff KJ, Sanghera S, Kerry RM. Postoperative pain following primary lower limb arthroplasty and enhanced recovery pathway. *The Annals of The Royal College of Surgeons of England*, 2014 May; **96(4)**: 302-306. [PMID: 24780024]; [DOI: 10.1308/003588414X13946184900525]
33. Scott NB, McDonald D, Campbell J, Smith RD, Carey AK, Johnston IG, James KR, Breusch SJ. The use of enhanced recovery after surgery (ERAS) principles in Scottish orthopaedic units - An implementation and follow-up at 1 year, 2010-2011: A report from the Musculoskeletal Audit, Scotland. *Archives of Orthopaedic and Trauma Surgery*, 2013 Jan; **133(1)**: 117-124. [PMID: 23070220]; [DOI: 10.1007/s00402-012-1619-z]
34. Kelly EG, Cashman JP, Imran FH, Conroy R, O'Byrne J. Systematic review and meta-analysis of closed suction drainage versus non-drainage in primary hip arthroplasty. *Surgical Technology International*, 2014 Mar; **24**: 295-301. [PMID: 24574017]
35. Quinn M, Bowe A, Galvin R, Dawson P, O'Byrne J. The use of postoperative suction drainage in total knee arthroplasty: a systematic review. *International Orthopaedics*, 2015 Apr; **39(4)**: 653-658. [PMID: 25027980]; [DOI: 10.1007/s00264-014-2455-2]
36. Aarts MA, Okrainec A, Glicksman A, Pearsall E, Victor JC, McLeod RS. Adoption of enhanced recovery after surgery (ERAS) strategies for colorectal surgery at academic teaching hospitals and impact on total length of hospital stay. *Surgical Endoscopy*, 2012 Feb; **26(2)**: 442-450. [PMID: 22011937]; [DOI: 10.1007/s00464-011-1897-5]
37. Renz BW, Kasperek MS, Seeliger S, Worthley DL, Jauch KW, Kreis ME, Smith MJ, Mueller MH. The CR-POSSUM risk calculator predicts failure of enhanced recovery after colorectal surgery. *Acta Chirurgica Belgica*, 2015 Jan; **115(1)**: 20-26. [PMID: 27384892]; [DOI: 10.1080/00015458.2015.11681062]
38. Ibrahim MS, Alazzawi S, Nizam I, Haddad FS. An evidence-based review of enhanced recovery interventions in knee replacement surgery. *The Annals of The Royal College of Surgeons of England*, 2013 Sep; **95(6)**: 386-389. [PMID: 24025284]; [DOI: 10.1308/003588413X13629960046435]
39. NHS South East Coast, Orthopaedic enhanced recovery programme: to reduce length of hospital stay. (2012). Retrieved June 13, 2017, from <https://www.nice.org.uk/savingsandproductivityandlocalpracticeresource?ci=http%3A%2F%2Fwww.nhs.uk%2Fresources%2FQIP%2F670741%2Fattachment%3Fni-ceorg%3Dtrue>
40. The NHS Institute for Innovation and Improvement, "The NHS Institute for Innovation and Improvement," *Reducing Cancelled Operations*, 2013. Retrieved June 13, 2017, from http://www.institute.nhs.uk/quality_and_service_improvement_tools/quality_and_service_improvement_tools/day_surgery_-_treat_day_surgery_as_the_norm.html
41. Machin JT, Phillips S, Parker M, Carrannante J, Heath MW. Patient satisfaction with the use of an enhanced recovery programme for primary arthroplasty. *Annals of the Royal College of Surgeons of England*, 2013 Nov; **95(8)**: 577-581. [PMID: 24165340]; [DOI: 10.1308/rcsann.2013.95.8.577]
42. Jones EL, Wainwright TW, Foster JD, Smith JR, Middleton RG, Francis NK. A systematic review of patient reported outcomes and patient experience in enhanced recovery after orthopaedic surgery. *Annals of the Royal College of Surgeons of England*. 2014 Mar; **96(2)**: 89-94. [PMID: 24780662]; [DOI: 10.1308/003588414X13824511649571]
43. Larsen K, Hansen TB, Søballe K, Kehlet H. Patient-reported outcome after fast-track hip arthroplasty: a prospective cohort study. *Health and Quality of Life Outcomes*, 2010 Nov 30; **8**: 144. [PMID: 21118517]; [DOI: 10.1186/1477-7525-8-144]
44. Larsen K, Hansen TB, Søballe K, Kehlet H. Patient-reported outcome after fast-track knee arthroplasty. *Knee Surgery, Sports Traumatology, Arthroscopy*, 2012 Jun; **20(6)**: 1128-1135. [PMID: 22349544]; [DOI: 10.1007/s00167-012-1919-4]
45. American Society of Anesthesiologists, "Perioperative Surgical Home." 2014. [Online]. Available: <http://www.asahq.org/ps>.
46. Kash BA, Zhang Y, Cline KM, Menser T, Miller TR. The perioperative surgical home (PSH): A comprehensive review of

- us and non-us studies shows predominantly positive quality and cost outcomes. *Milbank Quarterly*. Milbank Memorial Fund. 2014 Dec; **92(4)**: 796-821 [PMID: 25492605]; [DOI: 10.1111/1468-0009.12093]
47. Asarnow JR, Kolko DJ, Miranda J, Kazak AE. The Pediatric Patient-Centered Medical Home: Innovative Models for Improving Behavioral Health. *American Psychologist*, 2017 Jan; **72(1)**: 13-27 [PMID: 28068135]; [DOI: 10.1037/a0040411]
 48. Vetter TR, Boudreaux AM, Jones KA, Hunter JM Jr, Pittet JF. The perioperative surgical home: how anesthesiology can collaboratively achieve and leverage the triple aim in health care., *Anesth. Analg.*, 2014 May; **118(5)**: 1131-6. [PMID: 24781579]; [DOI: 10.1213/ANE.0000000000000228]
 49. Garson L, Schwarzkopf R, Vakharia S, Alexander B, Stead S, Cannesson M, Kain Z. Implementation of a total joint replacement-focused. *Anesthesia and Analgesia*, 2014 May; **118(5)**: 1081-1089. [PMID: 24781576]; [DOI:10.1213/ANE.0000000000000191]
 50. Raphael DR, Cannesson M, Schwarzkopf R, Garson LM, Vakharia SB, Gupta R, Kain ZN. Total joint Perioperative Surgical Home: an observational financial review. *Perioperative Medicine*, 2014 Aug 27; **3**: 6. [PMID: 25177486]; [DOI: 10.1186/2047-0525-3-6]
 51. Kamal T, Conway RM, Littlejohn I, Ricketts D. The role of a multidisciplinary pre-assessment clinic in reducing mortality after complex orthopaedic surgery. *Annals of the Royal College of Surgeons of England*, 2011 Mar; **93(2)**: 149-151. [PMID: 22041145]; [DOI: 10.1308/003588411X561026]
 52. Moulton LS, Evans PA, Starks I, Smith T. Pre-operative education prior to elective hip arthroplasty surgery improves postoperative outcome. *International Orthopaedics*, 2015 Aug; **39(8)**: 1483-1486. [PMID: 25862634]; [DOI: 10.1007/s00264-015-2754-2]
 53. Jones S, Alnaib M, Kokkinakis M, Wilkinson M, St Clair Gibson A, Kader D. Pre-operative patient education reduces length of stay after knee joint arthroplasty. *The Annals of The Royal College of Surgeons of England*, 2011 Jan; **93(1)**: 71–75. [PMID: 21418755]; [DOI: 10.1308/003588410X12771863936765]
 54. McDonald S, Page MJ, Beringer K, Wasiaik J, Sprowson A. Preoperative education for hip or knee replacement. In S. McDonald (Ed.), *Cochrane Database of Systematic Reviews* (p. CD003526). Chichester, UK: John Wiley & Sons, Ltd. 2014 May 13; **(5)**: CD003526. [PMID: 24820247]; [DOI: 10.1002/14651858.CD003526.pub3]
 55. Waldron NH, Miller TE, Gan TJ. Perioperative goal-directed therapy. *Journal of Cardiothoracic and Vascular Anesthesia*, 2014 Dec; **28(6)**: 1635-1641. [PMID: 25440644]; [DOI: 10.1053/j.jvca.2014.07.008]
 56. Ceconi M, Fasano N, Langiano N, Divella M, Costa MG, Rhodes A, Della Rocca G. Goal-directed haemodynamic therapy during elective total hip arthroplasty under regional anaesthesia. *Critical Care*, 2011; **15(3)**: R132. [PMID: 21624138]; [DOI: 10.1186/cc10246]
 57. Berger RA, Sanders SA, Thill ES, Sporer SM, Della Valle C. Newer anesthesia and rehabilitation protocols enable outpatient hip replacement in selected patients. In *Clinical Orthopaedics and Related Research* 2009 Jun; **467(6)**: 1424-1430 [PMID: 19252961]; [DOI: 10.1007/s11999-009-0741-x]
 58. Berger RA, Kusuma SK, Sanders SA, Thill ES, Sporer SM. The Feasibility and Perioperative Complications of Outpatient Knee Arthroplasty. *Clinical Orthopaedics and Related Research?* 2009 Jun; **467(6)**: 1443–1449. [PMID: 19238499]; [DOI: 10.1007/s11999-009-0736-7]
 59. Moïniche S, Kehlet H, Dahl JB. A Qualitative and Quantitative Systematic Review of Preemptive Analgesia for Postoperative Pain Relief. *Anesthesiology*, 2002 Mar; **96(3)**: 725–741. [PMID: 11873051]; [DOI: 10.1097/00000542-200203000-00032]
 60. Butterworth JF 4th, Green JA. The anesthesiologist-directed perioperative surgical home: a great idea that will succeed only if it is embraced by hospital administrators and surgeons. *Anesthesia and Analgesia*, 2014 May; **118(5)**: 896-7. [PMID: 24781556]; [DOI: 10.1213/ANE.0000000000000217]
 61. Maessen J, Dejong CHC, Hausel J, Nygren J, Lassen K, Andersen J, Kessels AGH, Revhaug A, Kehlet H, Ljungqvist O, Fearon KCH, von Meyenfeldt MF. A protocol is not enough to implement an enhanced recovery programme for colorectal resection. *British Journal of Surgery*, 2007; **94(2)**: 224–231. [DOI: 10.1002/bjs.5468]
 62. Cannesson M, Ani F, Mythen MM, Kain Z. Anaesthesiology and perioperative medicine around the world: different names, same goals. *British Journal of Anaesthesia*, 2015; **114 (1)**: 8-9. [DOI: 10.1093/bja/aeu265]
 63. Cannesson M, Kain Z. Enhanced recovery after surgery versus perioperative surgical home: Is it all in the name? *Anesthesia and Analgesia*, 2014; **118(5)**: 901–902. [DOI: 10.1213/ANE.0000000000000177]
 64. Dexter F, Wachtel RE. Strategies for net cost reductions with the expanded role and expertise of anesthesiologists in the perioperative surgical home. *Anesthesia and Analgesia*, 2014; **118(5)**: 1062–1071. [DOI: 10.1213/ANE.0000000000000173]

Peer reviewer: Ben Marson