Review Article

ERAS and patient reported outcomes in thoracic surgery: a review of current data

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Contributions: (I) Conception and design: All authors; (II) Administrative support: FG Fernandez, OV Khullar; (III) Provision of study materials or patients: All authors; (IV) Collection and assembly of data: All authors; (V) Data analysis and interpretation: RL Medbery; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

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Abstract: Quality-focused, cost-effective, patient-centered care is at the forefront of current healthcare reform. Recent data show that enhanced recovery after surgery (ERAS) results in improved surgical outcomes and decreased hospital costs. As a result, ERAS has been widely accepted among multiple surgical subspecialties as a modality for increasing the value of healthcare delivered to our patients. While this objective data is convincing for practitioners and administrators alike, how ERAS directly impacts the patient experience is unclear. Patient reported outcomes (PRO) are starting to drive patterns of healthcare delivery and influence surgical decision-making. In order to improve surgical outcomes and deliver patient-centered care, it is imperative that clinicians start reviewing objective metrics contained within morbidity and mortality data alongside subjective data regarding patients' experience. This article reviews the current data surrounding both ERAS and PROs within thoracic surgery and investigates how the two concepts are ultimately related.

Keywords: Thoracic surgery; enhanced recovery after surgery (ERAS); patient reported outcomes

Submitted Feb 21, 2019. Accepted for publication Mar 29, 2019.
doi: 10.21037/jtd.2019.04.08
View this article at: http://dx.doi.org/10.21037/jtd.2019.04.08

Introduction

Both thoracic and non-thoracic surgeons alike are showing increased interest in enhanced recovery after surgery (ERAS) pathways. These protocolized, evidence-based standards for perioperative patient care have been shown to effectively shorten hospital length of stay and decrease postoperative complication rates (1). As a result, ERAS pathways are becoming more standardized and accepted in the surgical realm. Furthermore, improved surgical outcomes due to ERAS should, in theory, improve our patients' quality of life.

As a community of thoracic surgeons, our research often focuses on patient survival, perioperative mortality, and complication rates following interventions for specific disease processes. These endpoints are objective and relatively easy to measure using patient medical records, institutional and national outcomes databases. However, patients undergoing major thoracic operations experience a myriad of symptoms that are usually not captured and thus not contained in data analysis. Some symptoms are nonspecific—pain, fatigue, emotional distress, anxiety; others are disease or organ specific—dyspnea, dysphagia, gastrointestinal cramping. Regardless, all have some degree of subjectivity and can be patient-specific. These health-related quality of life (HR-QOL) concerns are increasingly of greater concern to patients and providers alike. The most accurate way to evaluate and measure these symptoms is by gathering this data directly from the patient, without interpretation by medical providers. Such data is typically referred to as patient-reported outcomes (PROs).

In order to improve surgical outcomes and deliver patient-centered care, it is imperative that clinicians start

reviewing objective metrics contained within morbidity and mortality data alongside subjective data regarding patients' experience. This article reviews the current data surrounding both ERAS and PROs within thoracic surgery and investigates how the two concepts are ultimately related. Current challenges, recommendations and guidelines are summarized.

ERAS

Background of ERAS

First described in 2001, ERAS was developed by a group of European surgeons who wished to emphasize that the key endpoint in surgical recovery is quality, not speed (2). Fundamental ERAS components include:

(I) a multidisciplinary team;
(II) a multimodal approach to resolving issues that delay recovery and cause complications;
(III) scientific, evidence-based protocols and;
(IV) changes in patient management using interactive and continuous audit.

The concept of enhanced recovery encompasses the entire patient journey from the time of surgical referral until postoperative discharge from the hospital. Initial ERAS studies across multiple surgical subspecialties report improved patient outcomes and decreased healthcare costs (3-6).

ERAS in thoracic surgery: current data

Over the past decade, multiple studies have shown that ERAS protocols in thoracic surgery decrease the incidence of cardiac and pulmonary complications, reduce opiate usage, minimize fluid overload, shorten length of stay, and decrease hospital costs (7-15). Madani and colleagues report a series of 234 patients undergoing open lobectomy for cancer and conclude that ERAS reduced complication rates from 50% to 37% with no difference in readmission rates or emergency room visits (11). Furthermore, they note that earlier removal of chest tubes and foley catheters shortened length of stay. In another study of 2,886 patients undergoing both open and minimally invasive (VATS) pulmonary resections, Van Haren *et al.* conclude that ERAS led to a decreased length of stay by one day, decreased pulmonary complications from 29% to 20%, and decreased cardiac complications from 18% to 12% (14). Interestingly, the authors conclude that while ERAS has clear benefit in thoracotomy patients, the study did not show clear benefit of ERAS in patients undergoing minimally invasive surgery. Similarly, in a study investigating ERAS in 600 patients after VATS lobectomy or segmentectomy, Brunelli *et al.* also conclude that ERAS did not significantly improve measured outcomes (8). The authors believe that many of the ERAS elements were already part of their standard care following VATS, and thus their new protocol may not have been significantly different enough to impact outcomes.

Another study investigating VATS-specific and thoracotomy-specific ERAS protocols, Martin *et al.* conclude that ERAS shortened length of stay by 2 days in patients undergoing thoracotomy and significantly reduced opiate usage (12). However, similar to the previously mentioned studies no LOS difference was identified after VATS. There were no differences in complication, readmission or mortality rates. Most notably, however, was the finding that ERAS contributed to a cost savings of $5,300 per VATS patient and $15,000 per thoracotomy patient. Finally, a recent prospective study by Rogers *et al.* examined overall compliance with ERAS pathways, as well as with fifteen individual components of the pathway (7). Univariate analysis revealed that compliance with early mobilization and carbohydrate loading was significantly associated with decreased mortality and shorter length of stay. Multivariate analysis showed that compliance with the entire fifteen-element ERAS pathway was independently associated with decreased mortality.

ERAS guidelines

In summary, standardized ERAS protocols have been shown to reduce cost, complications, and length of stay, without sacrificing quality of care. This is particularly true after thoracotomy, though the impact may not be as great after VATS. Given the abundance of evidence supporting improved outcomes using ERAS protocols in thoracic surgery patients, the ERAS Society and European Society of Thoracic Surgeons (ESTS) recently reviewed 45 ERAS items spanning from initial presentation to postoperative discharge following lung surgery (16). After extensive literature review, the authors graded quality of evidence and consensus recommendations were formed on each topic. A summary of their guidelines can be found in *Table 1*.

Patient reported outcomes (PRO)

Background of PRO

In 2013, Basch and colleagues introduced the concept of patient reported outcomes (PRO) and defined them as

measures of patient physical and psychosocial well-being obtained by direct patient self-report (*Table 2*). They may provide a more reliable means of evaluating and comparing postoperative outcomes and effectiveness of various treatment options (17). Furthermore, because PRO measure those outcomes that matter most to patients, they serve as the basis for improved patient-centered care and a reliable means for measuring HR-QOL. As a result, there has been a rapidly increasing demand for the integration of PRO into surgical outcomes research. Several national organizations, including the Center for Medicare and Medicaid Services (CMS), National Quality Forum, National Institutes of Health (NIH), National Cancer Institute, the US Food and Drug Administration (FDA) and the American College of Surgeons (ACS) advocate for integration of PRO into the measurement of patient outcomes and assessments of clinical performance (18). The American College of Chest Physicians (ACCP) has included PRO measures as part of their guidelines for lung cancer treatment, recommending the routine use of HR-QOL instruments in clinical care (19). The Center for Medical Technology Policy has advocated for the use of PRO in all prospective, adult oncology clinical effectiveness research studies (20). Perhaps most notable is the Affordable Care Act's creation of the Patient-Centered Outcomes Research Institute (PCORI), which has provided nearly $2 billion of funding to promote high-quality clinical effectiveness research through the incorporation of PRO (21).

Current tools for PRO

In order to improve upon patient-centered care, PROs must be gathered as part of a routine, standard practice (*Figure 1*) (22). The ideal tool for data collection must be generalizable, efficient, user-friendly, accurate, and cost-effective. Furthermore, it should integrate into existing clinical workflow and technical infrastructure including the electronic medical record, with minimal burden to the patient and the provider.

Multiple potential PRO instruments exist for use in Thoracic Surgery Patients (*Table 3*). Our preferred instrument is PROMIS®—a well-validated system of measuring PROs which include a variety of questionnaires

Table 1 Guidelines for enhanced recovery after lung surgery: recommendations of the ERAS society and the ESTS

Phase	Category	Recommendations	Evidence level*	Grade**
Preoperative	Preadmission information, education and counseling	Patients should routinely receive dedicated preoperative counseling	Low	Strong
	Perioperative nutrition	Patients should be screened preoperatively for nutritional status and weight loss	High	Strong
		Oral nutritional supplements should be given to malnourished patients	Moderate	Strong
		Immune-enhancing nutrition may have a role in the malnourished patient postoperatively	Low	Weak
	Smoking cessation	Smoking should be stopped at least 4 weeks before surgery	High	Strong
	Alcohol dependency management	Alcohol consumption (in alcohol abusers) should be avoided for at least 4 weeks before surgery	Moderate	Strong
	Anaemia management	Anaemia should be identified, investigated and corrected preoperatively	High	Strong
	Pulmonary rehabilitation and prehabilitation	Prehabilitation should be considered for patients with borderline lung function or exercise capacity	Low	Strong
Admission	Preoperative fasting and carbohydrate treatment	Clear fluids should be allowed up until 2 h before the induction of anaesthesia and solids until 6 h before induction of anaesthesia	High	Strong
		Oral carbohydrate loading reduces postoperative insulin resistance and should be used routinely	Low	Strong
	Preanaesthetic medication	Routine administration of sedatives to reduce anxiety preoperatively should be avoided	Moderate	Strong

Table 1 (*continued*)

Table 1 (*continued*)

Phase	Category	Recommendations	Evidence level*	Grade**
Perioperative	Venous thromboembolism prophylaxis	Patients undergoing major lung resection should be treated with pharmacological and mechanical VTE prophylaxis	Moderate	Strong
		Patients at high risk of VTE may be considered for extended prophylaxis with LMWH for up to 4 weeks	Low	Weak
	Antibiotic prophylaxis and skin preparation	Routine intravenous antibiotics should be administered within 60 min of, but prior to, the skin incision	High	Strong
		Hair clipping is recommended if hair removal is required	High	Strong
		Chlorhexidine-alcohol is preferred to povidone-iodine solution for skin preparation	High	Strong
	Preventing intraoperative hypothermia	Maintenance of normothermia with convective active warming devices should be used perioperatively	High	Strong
		Continuous measurement of core temperature for efficacy and compliance is recommended	High	Strong
	Standard anaesthetic protocol	Lung-protective strategies should be used during one-lung ventilation	Moderate	Strong
		A combination of regional and general anaesthetic techniques should be used	Low	Strong
		Short-acting volatile or intravenous anaesthetics, or their combination, are equivalent choices	Low	Strong
	PONV control	Non-pharmacological measures to decrease the baseline risk of PONV should be used in all patients	High	Strong
		A multimodal pharmacological approach for PONV prophylaxis is indicated in patients at moderate risk or high risk	Moderate	Strong
	Regional anaesthesia and pain relief	Regional anaesthesia is recommended with the aim of reducing postoperative opioid use. Paravertebral blockade provides equivalent analgesia to epidural anaesthesia	High	Strong
		A combination of acetaminophen and NSAIDs should be administered regularly to all patients unless contraindications exist	High	Strong
		Ketamine should be considered for patients with pre-existing chronic pain	Moderate	Strong
		Dexamethasone may be administered to prevent PONV and reduce pain	Low	Strong
	Perioperative fluid management	Very restrictive or liberal fluid regimes should be avoided in favour of euvolemia	Moderate	Strong
		Balanced crystalloids are the intravenous fluid of choice and are preferred to 0.9% saline	High	Strong
		Intravenous fluids should be discontinued as soon as possible and replaced with oral fluids and diet	Moderate	Strong
	Atrial fibrillation prevention	Patients taking β-blockers preoperatively should continue to take them in the postoperative period	High	Strong
		Magnesium supplementation may be considered in magnesium deplete patients	Low	Weak
		It is reasonable to administer diltiazem preoperatively or amiodarone postoperatively for patients at risk	Moderate	Weak
	Surgical technique: thoracotomy	If a thoracotomy is required, a muscle-sparing technique should be performed	Moderate	Strong
		Intercostal muscle- and nerve-sparing techniques are recommended	Moderate	Strong
		Reapproximation of the ribs during thoracotomy closure should spare the inferior intercostal nerve	Moderate	Strong
	Surgical technique: minimally invasive surgery	A VATS approach for lung resection is recommended for early-stage lung cancer	High	Strong

Table 1 (*continued*)

Table 1 (*continued*)

Phase	Category	Recommendations	Evidence level*	Grade**
Postoperative	Chest drain management	The routine application of external suction should be avoided	Low	Strong
		Digital drainage systems reduce variability in decision-making and should be used	Low	Strong
		Chest tubes should be removed even if the daily serous effusion is of high volume (up to 450 mL/24 h)	Moderate	Strong
		A single tube should be used instead of 2 after anatomical lung resection	Moderate	Strong
	Urinary drainage	In patients with normal preoperative renal function, a transurethral catheter should not be routinely placed for the sole purpose of monitoring urine output	Moderate	Strong
		It is reasonable to place a transurethral catheter in patients with thoracic epidural anaesthesia	Low	Strong
	Early mobilization and adjuncts to physiotherapy	Patients should be mobilized within 24 h of surgery	Low	Strong
		Prophylactic mini-tracheostomy use may be considered in certain high-risk patients	Low	Weak

*, evidence levels defined as follows: High, further research unlikely to change confidence in estimate of effect; Moderate, further research likely to important impact on confidence in estimate of effect and may change estimate; Low, further research very likely to have important impact on confidence in estimate of effect and likely to change the estimate; Very low, any estimate of effect is very uncertain. **, Grade of recommendation strength definitions: Strong, when desirable effects of intervention clearly out-weigh the undesirable effects or clearly do not; Weak, when trade-offs are less certain, either because of low-quality evidence or because evidence suggests that desirable or undesirable effects are closely balanced. ERAS, enhanced recovery after surgery; ESTS, European Society of Thoracic Surgeons; LMWH, low-molecular-weight heparin; NSAID, non-steroidal anti-inflammatory drugs; PONV, postoperative nausea and vomiting; VATS, video-assisted thoracoscopic surgery; VTE, venous thromboembolism. Reprinted with permission from Batchelor *et al*. (16).

Table 2 PRO definitions (17)

Term	Definition	Example
Patient Reported Outcome (PRO)	The concept of any report of the status of a patient's health condition that comes directly from the patient (or in some cases a caregiver or surrogate), without interpretation of the patient's response by a clinician or anyone else	Physical function
PRO Measure (PROM)	An instrument, scale, or single item measure used to assess the PRO concept as perceived by the patient, obtained by directly asking the patient (or in some cases a caregiver or surrogate) to self-report	PROMIS®*
PRO-based Performance Measure (PRO-PM)	A performance measure that is based on PROM data aggregated for an accountable health care entity	The proportion of patients who do not return to their baseline physical function 6 months after surgery

*, Patient Reported Outcomes Measurement Information System.

that span multiple realms of physical, mental and social health (11,23-27). Because it utilizes a variety of short-form modules across multiple health domains, surveys can be customized to the patient population and disease process of interest. PROMIS questionnaires and instruments use item response theory and computer adaptive testing that acclimates to patient-specific symptoms. Due to its versatility and advantages, it has been recommended by the Center for Medical Technology Policy as one of their preferred PRO measures for cancer clinical research and has been used in a variety of fields including oncology, orthopedics, cardiothoracic surgery, transplantation, and pediatrics (23,26). It is easily translated into a web-based, electronic interface and easily incorporates into several widely-utilized electronic medical record systems.

Other validated and commonly utilized instruments

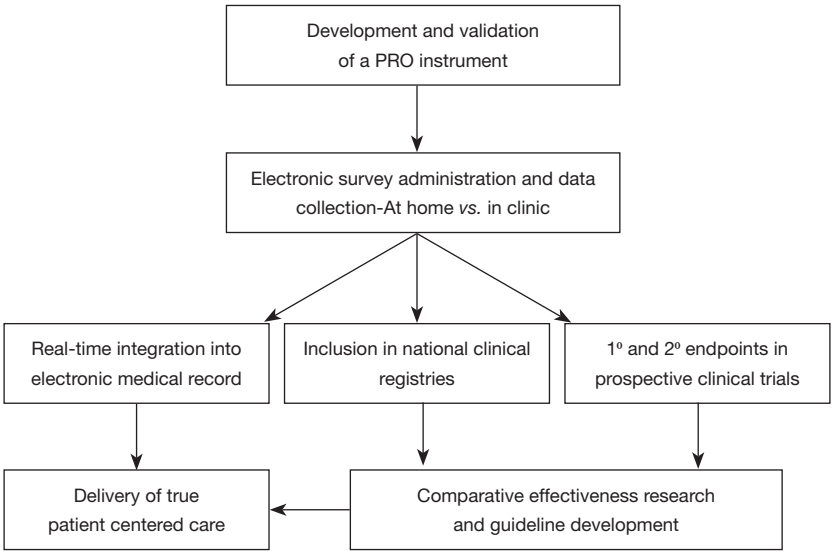

Figure 1 Overview of PROs. Reprinted with permission from Khullar OV *et al.* (22). PRO, patient reported outcomes.

Table 3 Existing PRO instruments for thoracic surgery patients

Generic questionnaires
Patient Reported Outcomes Measurement Information System (PROMIS®)
MD Anderson Symptom Inventory (MDASI)
Patient Health Questionnaire (PHQ-2)
RAND Medical Outcomes Study Short Form 36 (SF-36) and Short Form 12 (SF-12)
World Health Organization Disability Assessment Schedule
Quality of Recovery-15
Rotterdam Symptom Checklist
Depression, Anxiety and Stress Scale 21 (DASS-21)
Rose Dyspnea Scale
Nottingham Health Profile
Thoracic specific
European Organisation for Research and Treatment of Cancer (EORTC) Modules
Quality of Life Questionnaire Core 30 (QLQ C-30)
QLQ Oesophagus Module (OES-18)
QLQ Lung Cancer Module (LC13)
Lung Cancer Symptom Scale (LCSS)
Functional Assessment of Cancer Therapy (FACT) Oncologic and Organ-Specific Modules
Gastroesophageal Reflux Disease Health Related Quality of Life Questionnaire (GERD-HRQL)
Gastrointestinal quality of life index

include the following: The MD Anderson Symptom Inventory (MDASI) is generic to all cancers, while the European Organization for Research and Treatment of Cancer Lung Cancer Module (EORC-LC13), Lung Cancer Symptom Scale (LCSS) and Functional Assessment of Cancer Therapy-Lung (FACT-L) are specific to lung cancer (28-31). The Rose Dyspnea Scale specifically measures pulmonary function (scores range 0–4; higher scores indicate worse dyspnea). The Patient Health Questionnaire (PHQ-2), RAND Medical Outcomes Study Short Form (SF-36 and SF-12), and World Health Organization Disability Assessment Schedule (WHODAS) all measure general health (32-34). The Quality of Recovery (QOR-15) measures general health with a short recall period of 24 hours, making it ideal for use in the immediate post-operative period (35).

PRO in thoracic surgery: current data

A variety of both retrospective and prospective studies have examined PRO and HR-QOL results after surgery for thoracic malignancies (27,28,36-43). These studies are relatively small, single center, observational studies. However, valuable information can still be gleaned from them. Several of these studies have compared non-operative *vs.* operative therapy, VATS *vs.* thoracotomy, and sublobar resection *vs.* lobectomy, among other important questions. Overall, these studies show an expected initial decline in physical function, dyspnea, and quality of life scores after surgery, with most studies showing a return to baseline within 6 months to a year.

We recently published the initial results of a pilot study investigating the feasibility of integrating PRO into the institutional Society of Thoracic Surgery General Thoracic Surgery Database (STS-GTSD) (27). In this prospective cohort study, 127 patients undergoing lung cancer surgery completed HR-QOL surveys using PROMIS software at their preoperative, initial postoperative and 6-month follow-up clinic appointments. The data were collected electronically on tablet devices and merged with institutional STS data. Similar to other studies, there was a significant increase in pain, fatigue, sleep impairment and decrease in physical function reported at the first postoperative visit. By 6 months, however, these PRO measures generally improved towards baseline (*Figure 2*, republished with permission). Most importantly, survey completion rates were over 90% and took only 13–15 minutes to complete on average. Since completion of this study, we have further streamlined the survey to require only 3 to 5 minutes to complete at each clinic visit.

Using PRO in ERAS pathways

As discussed earlier, ERAS pathways in thoracic surgery have been shown to improve patient outcomes and decrease hospital costs. Unfortunately, these data alone can paint an incomplete picture of the post-operative experience. The goal of any ERAS pathway is to improve patient recovery after surgery. Improving length of stay and reducing complications is only half of this picture. Improving HR-QOL is the other half, and as discussed PRO are the best way to measure this. In a recent review of ERAS in lung surgery patients, the notion of including PRO is emphasized (44). Eustache *et al.* highlight the concept of postoperative recovery and "returning to baseline" after surgery. As previously mentioned, most studies have demonstrated a return to functional baseline with 6 months to 1 year of surgery. How patients perceive this recovery process and their HR-QOL along the way may be just as important to them, if not more so, than the objective outcomes physicians often emphasize. As a result, PROs must to be incorporated into ERAS pathways.

Jensen *et al.* introduced five critical elements of PRO utilization: (I) needs assessment, (II) shared decision-making, (III) symptom management, (IV) outcome assessment, and (V) quality improvement (45). It could be argued, however, that these same concepts parallel the ideology behind ERAS pathways (*Table 4*). Using a PRO instrument during a patient's preoperative clinic visit helps assess their clinical needs and can highlight areas of focus for postoperative recovery. Furthermore, because ERAS emphasizes preoperative education and counseling to help patients manage expectations and plan appropriately, gathering baseline QOL metrics helps with shared decision making. During the hospital phase of perioperative recovery, both PRO and ERAS alike focus upon symptom management and outcome assessment and may guide patient specific interventions needed to aide recovery. Lastly, incorporation of PRO into ERAS pathways allows for optimization of quality improvement pathways.

Finally, a recent article from Refai and colleagues highlights their unique ERAS methodology following thoracic surgery (46). The authors emphasize patient education and counseling through the use of separate patient, surgical, anesthesia, nursing, and respiratory care-plans in the perioperative period. They utilize written

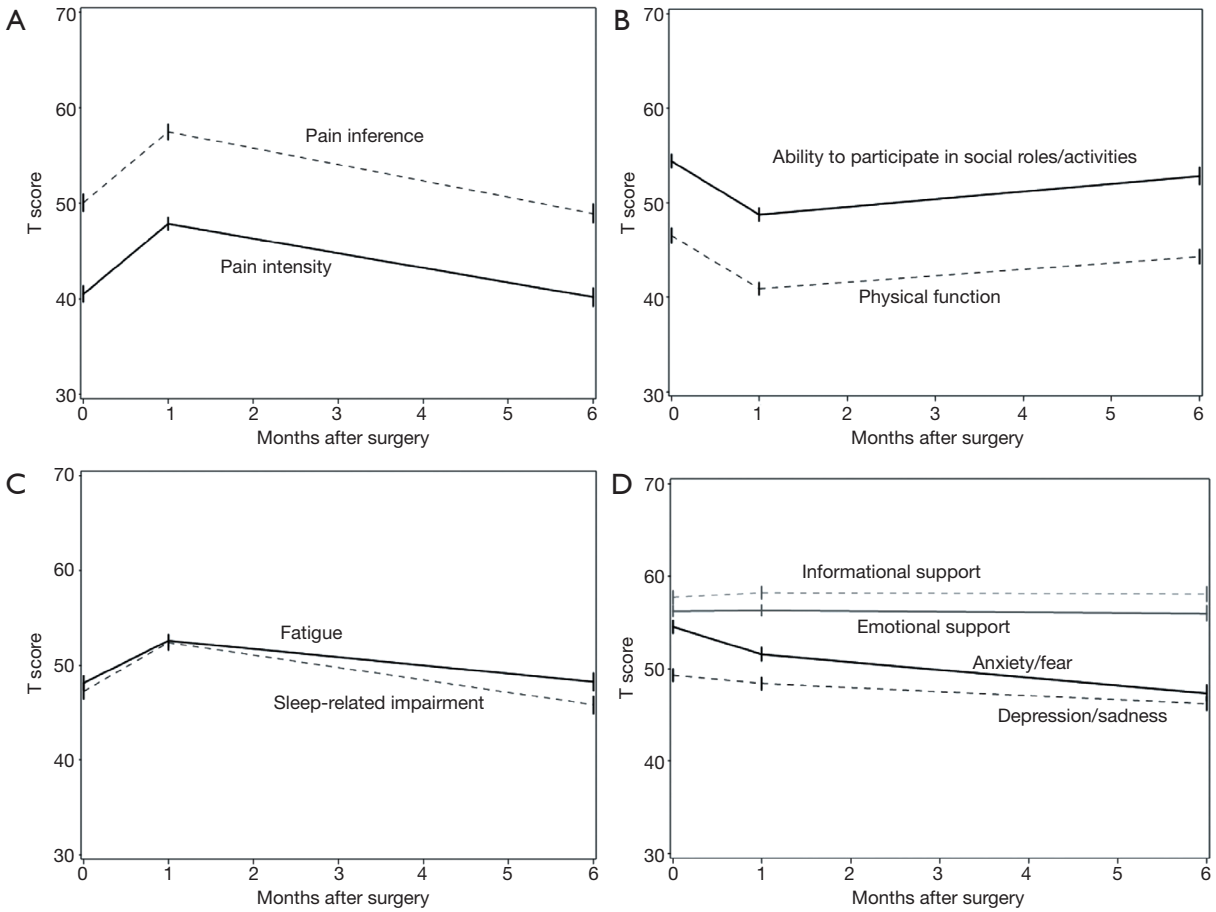

Figure 2 PRO following lung surgery. Postoperative PROMIS scores in patients who underwent lung cancer resection: (A) pain intensity and interference, (B) physical function, fatigue, and sleep-related impairment, (C) anxiety/fear and depression/sadness, and (D) ability to participate in social activities, emotional support, and informational support. Reprinted with permission from Khullar *et al.* (27). ERAS, enhanced recovery after surgery.

Table 4 Parallels between PRO and ERAS in thoracic surgery

Element	PRO example	ERAS example
Needs assessment	Patient reports lower than population mean baseline physical function	Planned preoperative conditioning/physical therapy/pulmonary rehab
Shared decision-making	Patient reports increased anxiety/fear or lack of emotional support	Increased amount of preoperative counseling with physicians, nurse case managers, and social workers
Symptom management	Patient reports history of postop nausea/vomiting	Anesthesia and surgical teams use multimodal approach for symptom control
Outcome assessment	Patient reports ongoing thoracotomy pain	Aim to use minimally invasive approaches whenever possible along with adjunct interventions to address pain
Quality improvement	Patient reports unclear discharge instructions lead to unplanned hospital readmission	Focused preoperative education materials given to patients about postoperative recovery and discharge process

ERAS, enhanced recovery after surgery; PRO, patient reported outcomes.

material in the form of a booklet that is given to the patient preoperatively. The booklet highlights each of the specific care-pathways and includes a daily checklist so that patients may track their progress following surgery. They also describe the planned development of a digital platform including a smartphone application that would allow for virtual data collection of patient reported outcomes. This would undoubtedly facilitate real-time process improvement in order to optimize patient-centered care.

Conclusions

Quality-focused, cost-effective, patient-centered care is at the forefront of current healthcare reform. Implementation of ERAS pathways in both thoracic and non-thoracic surgery has demonstrated consistent improvement in patient outcomes with an associated decrease in healthcare spending. Furthermore, the incorporation of PRO data into clinical outcomes registries is not only feasible, but also necessary to ensure that the care we deliver meets the needs of patients and stakeholders alike. Without a doubt, clinical practice should adapt recent ERAS guidelines with the goal of on-going quality improvement. Moreover, future studies reporting on surgical outcomes ought to report upon PROs alongside traditional morbidity and mortality data in order to ensure optimal surgical therapy.

Acknowledgements

None.

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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Cite this article as: Medbery RL, Fernandez FG, Khullar OV. ERAS and patient reported outcomes in thoracic surgery: a review of current data. J Thorac Dis 2019;11(Suppl 7):S976-S986. doi: 10.21037/jtd.2019.04.08

