Effects of Enhanced Recovery After Surgery (ERAS) on Perioperative Outcomes in Total Shoulder Arthroplasty

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Disclosures: There are no financial disclosures or conflicts of interest to report from all authors listed.

INTRODUCTION: Enhanced Recovery After Surgery (ERAS) is a multidisciplinary, evidence-based management pathway that has been widely adopted by many surgical subspecialties. ERAS protocol in orthopedic surgery is promising, as it has been shown to significantly reduce both length of stay (LOS) and post-operative complication rates in many orthopedic surgeries. However, no current literature explores outcomes after ERAS protocol in total shoulder arthroplasty (TSA). We aim to analyze the effects of ERAS protocol on perioperative outcomes in patients who underwent an elective, inpatient TSA.

METHODS: Data was obtained from the Premier Healthcare Database (PHD) by Premier Applied Sciences, Premier Inc. Patients who underwent an aTSA or rTSA were identified using ICD-9 codes. Billable ERAS criteria were identified following the official protocol for THA and TKA: (1) regional anesthesia; (2) multimodal analgesia; (3) Day 0 nausea/vomiting prophylaxis; (4) Day 0 antibiotic prophylaxis; (5) Day 0 or 1 venous thromboembolism (VTE) prophylaxis; (6) Day 0 or 1 physical therapy; (7) Tranexamic Acid (TXA); (8) absence of a foley catheter; (9) absence of a wound drain; and (10) discharge to home. Patients were categorized into 'Low ERAS', 'Medium ERAS', or 'High ERAS', which corresponded to receiving <4, 4, or >4 ERAS criteria, respectively. A mixed model logistic regression measured the association between ERAS category and complications. Odds ratios (OR) and 95% confidence intervals were obtained. An area under the receiver operating characteristic curve (AUROC) was calculated for each complication and a Youden index was calculated to determine the optimal cutoff point for the best predictive model. All statistical analyses were performed in R. Significance was set at $p < 0.05$.

RESULTS SECTION: We identified 74,338 records of patients who underwent an elective, inpatient aTSA or rTSA from 2010 to 2015. This cohort consisted of 42,049 aTSA (56.6%) and 32,289 rTSA (43.4%) patients. 21.7% of patients were subject to at least 5 ERAS components ('High ERAS'), while 35.2% and 43.1% were administered 4 components and less than 4 components ('Medium' and 'Low ERAS', respectively). 'High ERAS' patients had significantly decreased ORs of experiencing any complication (OR 0.63, p<0.0001), cardiopulmonary complications (OR 0.66, p<0.0001), in-hospital mortality (OR 0.10, p=0.0016), and blood transfusions (OR 0.40, p<0.0001), and a shorter LOS from 2.34 days to 1.79 days (p<0.0001). **Table 1** highlights relative effects regarding the adjusted association between patient outcomes and 'High', 'Medium', or 'Low ERAS'. The AUROC for the number of ERAS criteria received and in-hospital mortality was 0.7265 with an optimal cutoff point of three ERAS criteria (**Figure 1)**.

DISCUSSION: Overall, patients in the 'High ERAS' category demonstrated better outcomes with significantly lower complication profiles, mortality rates, LOS, and need for blood transfusions. ERAS categories of 'Low', 'Medium', and 'High' had the greatest discriminatory ability for in-hospital mortality. This cutoff value can help physicians properly allocate resources and optimize care for patients who may be at higher risk for life-threatening complications. This study is not without limitations. The ERAS protocols selected for the study were only billable items found in the PHD chargemaster. Other ERAS criteria to consider, such as preoperative nutrition, maintenance of fluid volume, and normothermia, may have had an underlying influence on patient outcomes as well. These results demonstrate that TSAs are not an exception to the promising benefits of the ERAS protocol. Efforts should be made to create an official ERAS protocol in TSAs and help hospitals allocate resources to make its implementation possible.

SIGNIFICANCE/CLINICAL RELEVANCE: An analysis on perioperative outcomes in elective, inpatient total shoulder arthroplasties using an evidence-based surgical pathway that creates a multidisciplinary framework pre-, peri-, and post-operatively to reduce complications, mortality, and length of stay.

IMAGES AND TABLES:

Outcome	**Relative effects**				
	Low ERAS	**Medium ERAS**		**High ERAS**	
		OR (95% CI)	**P-value**	**OR (95% CI)**	**P-value**
Any complication	Reference	0.73	<0.0001	0.63	<0.0001
Cardiopulmonary complication	Reference	0.78	<0.0001	0.66	<0.0001
In-hospital mortality	Reference	0.41	0.005	0.10	0.0016
Blood transfusion need	Reference	0.58	<0.0001	0.40	<0.0001
Length of stay	Reference		<0.0001		<0.0001

Table 1. Relative effects from mixed-effects regression evaluating the (adjusted) association between 'High' or 'Medium' (compared with 'Low') ERAS. OR, odds ratio; CI, confidence interval; ERAS, Enhanced Recovery After Surgery; Relative effects are reported as odds ratios (OR) for binary outcomes.

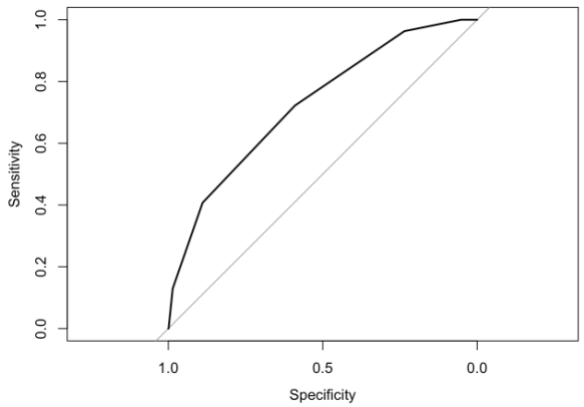

Figure 1. ROC of the number of ERAS criteria received vs. in-hospital mortality. AUROC = 0.7265.