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Did we prioritize quality improvement in general surgery: Time for a focus on outcomes and enhanced recovery care plans?

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ABSTRACT

Background: In 2008, 2005–2006 National Surgical Quality Improvement Program (NSQIP) data were used to identify surgical operations contributing disproportionately to morbidity and mortality. Since then, numerous enhanced recovery programs have been utilized to augment quality improvement efforts. This study reassesses procedural complication incidence after a decade of quality improvement efforts.

Methods: Data from the 2015 NSQIP were used. The same original 36 general surgery procedure groups were created using Current Procedural Terminology codes. Ninety percent of our 409,230 patients matched into a procedure group and adverse event rates were analyzed for each.

Results: Ten procedure groups accounted for 80% of adverse events. Colectomy ranked the highest for adverse events (34%), readmissions (27%) and mortality rates (45.8%). For outpatient cholecystectomy, the relative percent point difference for adverse events has increased by 224% since 2005.

Conclusion: Refocusing on colectomy and outpatient cholecystectomy represent current priorities in general surgery.

Introduction

Since the advent of the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) –subsequent to its' success in the VA Healthcare system—it has been considered the standard of surgical quality metric systems in the US. In 2008, Schilling et al.[1] published data using the 2005–2006 NSQIP databases to distinguish a list of general surgery procedures according to their relative contributions for mortality, morbidity, and length of stay (LOS).

In recent years a number of quality measures, care pathways, and reporting programs have been implemented to focus on improving the quality of care. An example is the generation of 'Never Events' that has influenced the reimbursements, and occasionally resulted in penalties, by insurance companies for general surgery procedures.[2] Another example of improving the quality of surgical care is the use of enhanced recovery protocols (ERP) in surgery that have managed to shorten the length of hospital stay and reduces complications rates in the varying areas of surgery, with particular emphasis on colorectal surgery.[3]

Despite the significant efforts enjoined over the last decade with respect to quality reporting and ERP adoption, there has not been a reappraisal of global general surgical outcomes within the ACS-NSQIP database to identify areas of demonstrated improvement and remaining priorities in general surgery. We interrogated recent ACS-NSQIP data to define overall changes in morbidity, excess length of stay, readmission, and mortality outcomes within general surgery procedures over the past decade.

Methods

Study cohort

Using the 2015 ACS NSQIP dataset, 885,502 de-identified surgical cases from 603 hospitals were analyzed. ACS NSQIP is a nationwide multi-institutional surgical database for which perioperative surgical data are collected by trained NSQIP nurses for up to 30 postoperative days.[4] Our NSQIP review identified 409,230 patients (≥18 years old) undergoing a procedure by a general surgeon. To ensure adequate comparison, we included only the 36

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general surgery procedure groups previously identified,[1] using the Current Procedural Terminology (CPT) codes. In addition, inguinal hernia and cholecystectomy were subdivided into inpatient and outpatient categories to ensure appropriate risk stratification and severity of illness between the two operative settings for these procedures as previously done.

The primary outcome was any "adverse event": an inpatient complication, return to the operating room, or in-patient mortality. The types of morbidity experienced by patients included superficial and deep surgical site infection, wound disruption, pneumonia, unplanned intubation, pulmonary embolism, progressive renal insufficiency, urinary tract infection (UTI), stroke, deep venous thrombosis (DVT) requiring therapy, myocardial infarction, sepsis, and septic shock. A full list of complications is described elsewhere by ACS.[4]

Secondary outcomes included mortality within the first 30 postoperative days, all-cause readmission and length of stay.

Statistical analysis

For each of the 36 general surgery procedure groups, the total number of cases was populated from the NSQIP database. For each procedure type, we reported adverse event rate as a proportion of surgical cases with adverse events. We calculated proportion of total adverse events for each procedure group as its number of adverse events divided by the total number of adverse events for all 36 groups. We determined the total mean length of stay per procedure group, and the mean length of stay of those with and without a complication were calculated as well. Similarly, we calculated mortality and readmission rates for each procedure group stratified by adverse events.

The Institutional Review Board at the University of Texas Medical Branch approved the study. SAS 9.4 was used for statistical analysis.

Results

Our study identified 369,911 cases for the 36 procedural groups. Table 1 reports adverse event rates for 36 surgery procedures. Eighty percent of adverse events were associated with 10 procedure groups, representing 74% of the total number of cases. As originally reported by Schilling et al.,[1] colectomy continues to account for the majority of morbidity in general surgery cases with approximately 34% of the complications experienced by all patients.

The top three procedures with the greatest increase in absolute percent point differences for adverse events were colectomy (10%), outpatient cholecystectomy (3.4%) and appendectomy (3.2%) (Table 1). Ventral hernia was the only procedure group that doubled in the percentage of total cases compared to that previously reported at 13%, which resulted in a greater contribution to general surgery related adverse events (2% increase). With the exception of pancreatectomy, which is a more inherently morbid procedure, colectomy had the longest LOS (No Complication 5.8 days vs. with Complications 13.5 days) (Table 2). Ventral Hernia Repair patients stayed on average of 6.2 days longer when complications arose (No Complications: 1.2 days vs. Complications: 7.4). Outpatient Cholecystectomy resulted in 3.7 more inpatient days when complications occurred (No Complications 1.4 days vs. Complications: 5.1 days).

The top 5 complications for colectomy within the NSQIP 2015 database were as follows: the number of bleeding occurrences requiring transfusion (10.3%), sepsis (5.51%), return to the OR (5.43%), organ/space surgical site infection (SSI) (5.07%) and superficial SSI (4.49%). Of the 50,467 patients who underwent an outpatient cholecystectomy, the following complications were reported in descending order: return to the operating room (1.04%); sepsis (0.82%); urinary tract infection (UTI) (0.60%); superficial SSI (0.58%); organ space SSI (0.56%); the number of bleeding occurrences requiring transfusion (0.53%); pneumonia (0.53%). Mortality contribution was highest for those undergoing a colectomy (45.8%) of total mortality for all procedures, followed by small intestinal resection (12.4%), and ventral hernia repair (4.2%). Lumpectomy ± axillary lymph node dissection (0.05%) had the lowest rate of mortality (Table 2).

Colectomy had the highest unadjusted readmission rates among all procedures (27%) followed by outpatient cholecystectomy (10%) and ventral hernia repair (9.5%) (Table 2). A comparison of NSQIP data, absolute and relative percent point differences between the databases is available for review in Table 1.

Discussion

Our study results indicate that compared to 2008, colectomy remains unchanged as the procedure with the most negative outcomes in general surgery. Despite many technical advances and incorporation of ERP protocols, colectomy remains high risk to overall patient health and to hospital performance with increased proportion of adverse events (34%), readmissions (27%), and mortality (46%). The most common complications associated with colectomy within our data were the number of bleeding occurrences requiring transfusion (10.3%), sepsis (5.51%), and organ/space surgical site infection (5.07%). Although postoperative ileus (POI) could not be clearly distinguished with the available NSQIP data elements, it has been delineated throughout the literature as the most common postoperative complication after colectomy.[5]

Minimally invasive techniques and ERPs have reduced a variety of complications and overall hospital stay after elective and emergent colectomy, including less intraoperative blood **loss** when compared to open surgery.[3,6] Most ERP's also serve to shorten the duration of time until full bowel recovery by utilizing a narcotic-sparing analgesia approach, early feeding, early mobilization, and judicious postoperative fluid management. Moreover, care bundles, which include mechanical and oral antibiotic preparation, have been demonstrated to reduce SSIs, although deep and organ-space SSIs have not been impacted in a similar fashion.[7] The largest study evaluating the adherence of ERP protocol and colectomies found a significant difference when analyzing the ACS NSQIP Procedure Targeted Colectomy data registry. As expected, those with lower adherence were found to have an increased number of complications, increased length of time to bowel function, as well as LOS.[8] Therefore, individual institutions should assess their adherence to ERP protocols in conjunction with their own NSQIP data to allow customization of their care plans.

In terms of outpatient cholecystectomy, it is no surprise that the number of procedures has increased since the introduction of laparoscopy – which has since become the gold standard for cholecystectomy. However, the increased number of adverse outcomes including the number of technical complications—the most severe of which is common bile duct injury—is a cause for concern. In terms of adverse events over the past decade, our study has revealed a relative and absolute percent point difference of 224% and 3.36%, respectively. Adverse events with the highest contribution were return to the OR (1.04%) and sepsis (0.82%) – both potentially due to technical complications from the initial operation (i.e., intraoperative injury and biliary spillage). Our results support current literature, which indicate the most common postoperative complications of laparoscopic cholecystectomy are bile leak, wound infection, bleeding, and retained duct stones.[9]

Accordingly, The Society of American Gastrointestinal and

Table 1
Thirty-six general surgery procedures, adverse event rate and overall adverse event rate.

Procedure	Total Cases		Adverse events			
	N	%[a]	2015 Proportion of all adverse events (%)[b]	2005–2006 Proportion of all adverse events (%)	Absolute Percent Point Difference	Relative Percent Point Difference
1. Colectomy ± colostomy	55,712	15.06	34.22	24.3	9.92	40.82
2. Small intestine resection	9391	2.54	6.84	7.7	−0.86	−11.17
3. Cholecystectomy/inpatient	3027	0.82	1.73	5.7	−3.97	−69.65
4. Ventral hernia repair	47,576	12.86	6.87	4.9	1.97	40.20
5. Pancreatectomy	7462	2.02	6.79	4.4	2.39	54.32
6. Appendectomy	40,662	10.99	7.46	4.3	3.16	73.49
7. Bariatric procedures	27,681	7.48	3.1	3.4	−0.3	−8.82
8. Proctectomy ± colectomy ± anastomosis	5898	1.59	3.99	2.9	1.09	37.59
9. Lysis of adhesions	4758	1.29	2.02	2	0.02	1
10. Liver resection	5075	1.37	3.45	1.9	1.55	81.58
11. Mastectomy/simple, radical, or sub.	24,354	6.58	3.11	1.6	1.51	94.38
12. Cholecystectomy/outpatient	50,467	13.64	4.86	1.5	3.36	224
13. Gastrectomy/total or partial	920	0.25	0.75	1.4	−0.65	−46.43
14. Lumpectomy ± axillary lymph node	14,040	3.80	1.1	1.4	−0.3	−21.43
15. Gastrorrhaphy/perforation or bleeding ulcer	1222	0.33	1.45	1.2	0.25	20.83
16. Suture small or large bowel perforation	498	0.13	0.55	1	−0.45	−45
17. Fundoplasty or paraesophageal hernia repair	6250	1.69	1.11	1	0.11	11
18. Esophagectomy/total or near total	802	0.22	0.76	0.9	−0.14	−15.56
19. Splenectomy/total or partial	985	0.27	0.78	0.9	−0.12	−13.33
20. Gastrojejunostomy	825	0.22	0.73	0.9	−0.17	−18.89
21. All fistula repairs	519	0.14	0.48	0.8	−0.32	−40
22. Inguinal or femoral hernia repair/inpatient	3652	0.99	0.59	0.7	−0.11	−15.71
23. Inguinal or femoral hernia repair/ outpatient	36,128	9.77	1.75	0.7	1.05	150
24. Above- or below-knee amputation	1174	0.32	1.13	0.6	0.53	88.33
25. Debridement for necrotizing soft tissue	594	0.16	0.69	0.6	0.09	15
26. Bilioenteric anastomosis	376	0.10	0.3	0.6	−0.3	−50
27. Drain peritoneal abscess/not appendiceal	447	0.12	0.48	0.6	−0.12	−20
28. Debride pancreas	153	0.04	0.25	0.6	−0.35	−58.33
29. Thyroidectomy/total or subtotal	11,244	3.04	0.6	0.6	0	0
30. Excision of intraabdominal or retroperitoneal tumor	1239	0.33	0.78	0.5	0.28	56
31. Parathyroidectomy	4670	1.26	0.25	0.3	−0.05	−16.67
32. Vagotomy and other gastric procedures	77	0.02	0.09	0.3	−0.21	−70
33. Adrenalectomy	904	0.24	0.21	0.3	−0.09	−30
34. Reduction of volvulus, intussusception, or hernia by laparotomy	832	0.22	0.35	0.2	0.15	75
35. Pelvic exenteration	142	0.04	0.24	0.1	0.14	140
36. Toe or foot amputation	155	0.04	0.11	0.1	0.01	10

[c]Data from 2005 to 2006 NSQIP (Schilling et al., 2008).[1]
[a] Calculated as procedure per total case volume.
[b] Calculated as adverse event number divided by total number of adverse events for all cases.

Endoscopic Surgeons (SAGES) have implemented The SAGES Safe Cholecystectomy Program, which aims to minimize bile duct injuries.[10] The program emphasizes the importance of delineating the critical view of safety, use of intraoperative timeouts prior to important aspects of the case, and arguably, more use of intraoperative cholangiogram as it can help clearly delineate biliary anatomy and thus reduce the extent of bile duct injuries. While these recommendations are neither novel nor specifically ERP-related, the implementation is clearly safe and rational, with the potential to bend the curve on the rate of biliary tree complications.

Another significant finding in our study, with potential to modify its negative results, was the increased prevalence of ventral hernia repair and its' associated proportion of adverse events (2% increase). Ventral hernia repair is a common procedure performed by most, if not all, general surgeons in the US. There are a number of well-known factors that contribute to postoperative morbidity, particularly SSIs and hernia recurrence: high body mass index (BMI) and surgeon influenced factors. In addition to well-known preoperative weight loss efforts that reduce complications, Regner et al.[11] elucidated the differences between open and laparoscopic ventral hernia repair. Using the NSQIP database, they demonstrated that laparoscopic ventral hernia repair reduced SSIs and hernia recurrences among obese patients when compared to open repair, with patient in the highest BMI category demonstrating the greatest benefit.

The concept of quality improvement in healthcare is overall a slow process and as the results of this study show, it is difficult to move the needle despite significant efforts over the ten years, particularly for performing a colectomy. Although there have been clear wins in the quality improvement efforts, this analysis provides the basis for a renewed, but more focused, approach to quality improvement. Quality improvement efforts should be both institution specific and procedure-specific if we are to see rapid improvement. Targeting high-frequency, high-cost, and high-impact complications with cost effective mitigation strategies provides the best opportunity to improve surgical outcomes of individual surgical operations within individual healthcare systems.

This study's results are strengthened by the large number of cases across a broader group of institutions in the present study compared to that reported a decade ago. However, the limitations of this study include inherent biases related to the retrospective

Table 2
LOS with and without complication, average difference, and overall readmission and mortality.

Procedure	n	Adverse Rate (%)[a]	Total Mean LOS- Without Complications (d)[b]	Total Mean LOS- With Complications (d)[c]	Average Difference of LOS (d)[d]	Readmission Proportion (%)[e]	Mortality Proportion (%)[f]
1. Colectomy ± colostomy	15970	28.67	5.8	13.5	7.7	26.62	45.83
2. Small intestine resection	3190	33.97	6.6	14.9	8.3	5.07	12.36
3. Cholecystectomy/inpatient	809	26.73	5.6	10.9	5.3	1.28	1.72
4. Ventral hernia repair	3204	6.73	1.2	7.4	6.2	9.45	4.21
5. Pancreatectomy	3168	42.46	7.9	13.9	6	6.28	3.57
6. Appendectomy	3483	8.57	1.6	5.1	3.5	6.9	1.5
7. Bariatric procedures	1449	5.23	1.9	4.7	2.8	5.67	0.91
8. Proctectomy ± colectomy ± anastomosis	1862	31.57	5.8	11.7	5.9	4.68	1.82
9. Lysis of adhesions	943	19.82	5.9	14.3	8.4	2.19	3.83
10. Liver resection	1612	31.76	5.2	10.6	5.4	2.53	2.23
11. Mastectomy/simple, radical, or sub.	1451	5.96	0.8	2	1.2	3.65	0.43
12. Cholecystectomy/outpatient	2268	4.49	1.4	5.1	3.7	9.6	2.98
13. Gastrectomy/total or partial	350	38.04	7.6	16.7	9.1	0.56	0.75
14. Lumpectomy ± axillary lymph node	514	3.66	0.2	0.5	0.3	1.61	0.05
15. Gastrorrhaphy/perforation or bleeding ulcer	679	55.56	7.8	15	7.2	0.56	3.11
16. Suture small or large bowel perforation	258	51.81	8.8	15	6.2	0.25	1.29
17. Fundoplasty or paraesophageal hernia repair	518	8.29	2.3	9.1	6.8	1.72	1.07
18. Esophagectomy/total or near total	357	44.51	8.8	18.5	9.7	0.37	0.78
19. Splenectomy/total or partial	364	36.95	4.4	11.2	6.8	0.52	0.83
20. Gastrojejunostomy	342	41.45	10.2	18.4	8.2	0.56	1.74
21. All fistula repairs	224	43.16	8	19.8	11.8	0.35	0.24
22. Inguinal or femoral hernia repair/inpatient	276	7.56	1.3	7.1	5.8	0.84	0.83
23. Inguinal or femoral hernia repair/outpatient	815	2.26	0.4	2.5	2.1	3.61	1.34
24. Above- or below-knee amputation	528	44.97	9.1	14.5	5.4	0.79	2.31
25. Debridement for necrotizing soft tissue	322	54.21	7.6	16.1	8.5	0.25	0.97
26. Bilioenteric anastomosis	138	36.7	8.1	13.5	5.4	0.27	0.24
27. Drain peritoneal abscess/not appendiceal	225	50.34	6.2	15.5	9.3	0.2	0.94
28. Debride pancreas	118	77.12	15.3	33.6	18.3	0.1	0.21
29. Thyroidectomy/total or subtotal	281	2.5	1.1	4.9	3.8	1.32	0.21
30. Excision of intraabdominal or retroperitoneal tumor	364	29.38	4.8	11.9	7.1	0.53	0.62
31. Parathyroidectomy	115	2.46	1	6.5	5.5	0.71	0.08
32. Vagotomy and other gastric procedures	43	55.84	7.5	17.2	9.7	0.07	0.08
33. Adrenalectomy	97	10.73	2.5	8.4	5.9	0.23	0.13
34. Reduction of volvulus, intussusception, or hernia by laparotomy	165	19.83	4.7	12.4	7.7	0.37	0.56
35. Pelvic exenteration	112	78.87	9.4	16.1	6.7	0.17	0.08
36. Toe or foot amputation	53	34.19	8.6	11.7	3.1	0.12	0.13

[a] Calculated as adverse event number divided by the total procedure case volume.
[b] Calculated as LOS if a patient did not experience a complication; time of admission to discharge.
[c] Calculated as LOS if a patient experiences a complication; time of admission to discharge.
[d] Calculated as the difference between LOS for those with and without complications.
[e] Calculated as percentage of readmission per procedure of total readmissions.
[f] Calculated as percentage of deaths per procedure of total deaths.

nature of the study design, as well as the unadjusted results which provide insightful information but could be confounded by other variables. Moreover, we did not stratify emergent versus elective procedures. Despite this, the generalizability of the study participants is well recognized; however, the inclusion of only hospitals which volunteer to participate in NSQIP is another limitation, as well as the possibility of coding errors.

Conclusions

Previously identified general surgery quality priorities have shown limited improvement over the previous decade. It is possible that the recent urgency to drive adoption of highly effective components of ERP's may have an impact on this quality gap. Therefore, quality improvement efforts should focus on colectomy, outpatient cholecystectomy, and ventral hernia repair as the current high-risk priority areas. NSQIP provides a potentially valuable tool to drive such quality and value, however, greater specificity with respect to particular complications and the direct processes of care will be required for transformative improvements.

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Conflicts of interest

None of the authors have conflicts of interest.

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