Prioritizing Quality Improvement in General Surgery

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BACKGROUND: Despite growing interest in quality improvement, uncertainty remains about which procedures offer the most room for improvement in general surgery. In this context, we sought to describe the relative contribution of different procedures to overall morbidity, mortality, and excess length of stay in general surgery.

STUDY DESIGN: Using data from the American College of Surgeons' National Surgery Quality Improvement Program (ACS-NSQIP), we identified all patients undergoing a general surgery procedure in 2005 and 2006 (n = 129,233). Patients were placed in 36 distinct procedure groups based on Current Procedural Terminology codes. We first examined procedure groups according to their relative contribution to overall morbidity and mortality. We then assessed procedure groups according to their contribution to overall excess length of stay.

RESULTS: Ten procedure groups alone accounted for 62% of complications and 54% of excess hospital days. Colectomy accounted for the greatest share of adverse events, followed by small intestine resection, inpatient cholecystectomy, and ventral hernia repair. In contrast, several common procedures contributed little to overall morbidity and mortality. For example, outpatient cholecystectomy, breast procedures, thyroidectomy, parathyroidectomy, and outpatient inguinal hernia repair together accounted for 34% of procedures, but only 6% of complications (and only 4% of major complications). These same procedures accounted for < 1% of excess hospital days.

CONCLUSIONS: A relatively small number of procedures account for a disproportionate share of the morbidity, mortality, and excess hospital days in general surgery. Focusing quality improvement efforts on these procedures may be an effective strategy for improving patient care and reducing cost. (J Am Coll Surg 2008;207:698–704. © 2008 by the American College of Surgeons)

There is growing interest in measuring and improving quality of care in general surgery in the US. Until now, these efforts have focused on general aspects of perioperative care applicable to a wide range of procedures. For example, the Surgical Care Improvement Project has targeted appropriate use of antibiotics to reduce surgical site infection (SSI), proper prophylaxis for deep vein thrombosis, and use of perioperative β-blockers to reduce the risk of cardiac events.[1,2] But there is growing recognition that improving quality in general surgery will require understanding of both processes and outcomes that are specific to individual operations.[3] The American College of Surgeons National Quality Improvement Program (ACS-NSQIP), as such, is moving toward procedure-specific measures of performance in future versions of its measurement system.[4]

Disclosure Information: Nothing to disclose.

Received March 1, 2008; Revised June 2, 2008; Accepted June 3, 2008.
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Yet uncertainty remains about the operations on which ACS-NSQIP and other efforts should be focusing. From the perspective of quality improvement, it might make sense to consider the extent to which different operations contribute to overall morbidity and mortality.[5] Such an approach would account for how frequently the operation is performed and its underlying complication rate. From the perspective of payers, it might be reasonable to prioritize procedures according to the excess cost or length of stay attributable to procedures' complications.

In this context, we sought to prioritize procedures for quality improvement efforts in general surgery in terms of these two perspectives. Specifically, we used data from ACS-NSQIP to describe the relative contribution of different surgical procedures to overall morbidity, mortality, and excess length of hospital stay in general surgery.[6-8]

METHODS

Study population

We used the most recent data available from the American College of Surgeons' National Surgery Quality Improvement Program (ACS-NSQIP public use file, 2005 to

ISSN 1072-7515/08/$34.00
doi:10.1016/j.jamcollsurg.2008.06.138

2006). This data file contains 152,490 deidentified surgical cases from 121 participating hospitals. The data are collected by trained clinical nurses and contain information on a wide spectrum of variables. For the purposes of this study, we used information on morbidity and mortality occurring within the first 30 postoperative days. This included the occurrence of superficial, deep incisional, or organ space surgical site infection, wound disruption, urinary tract infection, stroke or cerebrovascular accident (CVA) with neurologic deficit, coma lasting longer than 24 hours, peripheral nerve injury, cardiac arrest requiring CPR, myocardial infarction, bleeding transfusions, mechanical failure of extracardiac graft, deep vein thrombosis or thrombophlebitis, sepsis, septic shock, return to operating room, and death. ACS-NSQIP data are available to researchers at sites that participate in the program. Additional details about the data are well described elsewhere.[4]

We created a cohort of 129,233 general surgery cases from ACS-NSQIP data by selecting those for which the primary surgeon was specified as being a general surgeon. Patients under the age of 18 years were excluded. We used the Current Procedural Terminology (CPT) code of the principal operative procedure field to define the primary procedure of the case (Appendix). We aggregated these CPT codes into 36 clinically recognizable procedure groups. We created initial code groupings based on the code groupings used by billing services.[9] Refinement and finalization of the groupings was based on the clinical judgment of the authors and included consideration of a procedure's anatomic location and pathologic indication. For inguinal hernia repair and cholecystectomy we dichotomized the procedure definitions across operative setting (inpatient versus outpatient) because of differences in baseline risk and pathologic indication. The 36 procedure categories accounted for 85% of the 129,233 cases in the cohort (109,841 cases).

Analysis

We first examined procedure groups according to their relative contribution to overall morbidity and mortality, ie, the public health perspective. We began by calculating the total number of patients in the entire cohort who experienced morbidity or mortality. For each of the 36 procedure groups, we then summed the number of patients who experienced an adverse event within the first 30 postoperative days. Finally, we determined the proportion of the total number of adverse events attributable to each of the 36 procedure groups. We ranked the procedure groups in descending order according to their relative contribution to the cohort's total count of adverse events.[10]

We then assessed procedure groups according to their relative contribution to overall excess length of stay attributable to adverse events, ie, the payer perspective. We defined excess length of stay for an adverse event as the difference in the average length of stay for patients who did and did not experience an adverse event within the first 30 postoperative days (ie, average excess length of stay). We calculated this for each of the 36 procedure groups and determined the proportion of the cohort's overall excess length of stay accounted for by each of the groups. Finally, we ranked the procedure groups in descending order according to their relative contribution.

We conducted a sensitivity analysis to determine how our findings would be changed by using different definitions of adverse events. First, we repeated the analysis, excluding superficial surgical site infection as a complication. Second, we repeated the analysis using mortality as the only included adverse event. For both of these additional analyses, we again ranked the procedure groups based on their relative contribution to the overall morbidity or mortality in the specialty. The resultant rankings were compared against the rankings under the initial assumptions.

RESULTS

Ten procedure groups accounted for 62% of the adverse events and 44% of the cases in the cohort (Table 1, Fig. 1). Colectomy registered the greatest share of complications (24%) followed by small intestine resection (8%), inpatient cholecystectomy (6%), ventral hernia repair (5%), and pancreatic resection (4%). In contrast, several common procedures contributed little to overall morbidity and mortality. For example, outpatient cholecystectomy, breast procedures, thyroidectomy, parathyroidectomy, and outpatient inguinal hernia repair together accounted for 34% of procedures but only 6% of overall morbidity and mortality.

In general, procedure group rankings were similar regardless of whether they were based on overall morbidity, morbidity excluding superficial surgical site infection (SSI), or mortality (Table 2). There were a couple of notable exceptions, however. Surgery for bleeding or perforated gastric ulcers accounted for only 1% of overall morbidity, but for 3% of mortality. Conversely, appendectomy and bariatric procedures each accounted for 4% of overall morbidity, but for $<$ 1% of mortality.

Rankings based on excess length of stay were also similar to the rankings based on morbidity and mortality (Table 2). The top 10 procedure groups accounted for 54% of excess hospital days and 39% of cases in the cohort (Table 1, Fig. 2). The top five procedure groups were exactly the same as those based on overall morbidity and mortality, both in composition and rank order.

Table 1. Relative Contribution of 36 Procedures to Adverse Events and Excess Length of Stay in General Surgery, American College of Surgeons – National Surgery Quality Improvement Program, 2005–2006

Procedure	Procedures		Adverse event rate, %	Proportion of all adverse events, %	Average excess length of stay for adverse event, d	Proportion of all excess length of stay, %
	n	% of total				
1. Colectomy ± colostomy	12,767	9.9	28.9	24.3	9.8	23.5
2. Small intestine resection	3,576	2.8	32.9	7.7	13.9	10.6
3. Cholecystectomy/inpatient	11,718	9.1	7.5	5.7	8.7	4.9
4. Ventral hernia repair	7,477	5.8	10.1	4.9	6.3	3.1
5. Pancreatectomy	1,927	1.5	34.9	4.4	6.8	3.0
6. Appendectomy	9,016	7.0	7.2	4.3	4.4	1.9
7. Bariatric procedures	6,167	4.8	8.3	3.4	3.7	1.2
8. Proctectomy ± colectomy ± anastomosis	1,402	1.1	31.5	2.9	6.2	1.8
9. Lysis of adhesions	1,323	1.0	23.1	2.0	10.5	2.1
10. Liver resection	1,045	0.8	27.0	1.9	8.8	1.6
11. Mastectomy/simple, radical, or subcutaneous	4,313	3.3	5.6	1.6	0.9	0.1
12. Cholecystectomy/outpatient	12,258	9.5	1.8	1.5	0.9	0.1
13. Gastrectomy/total or partial	731	0.6	28.7	1.4	11.8	1.6
14. Lumpectomy ± axillary lymph node dissection	10,270	7.9	2.0	1.4	1.2	0.2
15. Gastrorrhaphy/perforation or bleeding ulcer	451	0.3	40.6	1.2	16.1	1.9
16. Suture small or large bowel perforation	301	0.2	49.5	1.0	12.5	1.2
17. Fundoplasty or paraesophageal hernia repair	1,871	1.4	7.9	1.0	10.7	1.0
18. Esophagectomy/total or near total	254	0.2	55.1	0.9	11.6	1.1
19. Splenectomy/total or partial	659	0.5	20.2	0.9	13.2	1.1
20. Gastrojejunostomy	381	0.3	34.9	0.9	10.6	0.9
21. All fistula repairs	362	0.3	34.0	0.8	19.5	1.6
22. Inguinal or femoral hernia repair/inpatient	1,452	1.1	7.7	0.7	6.1	0.4
23. Inguinal or femoral hernia repair/outpatient	9,509	7.4	1.1	0.7	0.2	0.01
24. Above- or below-knee amputation	307	0.2	31.3	0.6	9.2	0.6
25. Debridement for necrotizing soft tissue infection	222	0.2	43.2	0.6	20.5	1.3
26. Bilioenteric anastomosis	278	0.2	33.5	0.6	8.9	0.5
27. Drain peritoneal abscess/not appendiceal	188	0.1	47.3	0.6	17.5	1.0
28. Debride pancreas	128	0.1	69.5	0.6	26.6	1.5
29. Thyroidectomy/total or subtotal	5,192	4.0	1.7	0.6	3.8	0.2
30. Excision of intraabdominal or retroperitoneal tumor	429	0.3	18.4	0.5	9.0	0.5
31. Parathyroidectomy	2,521	2.0	2.1	0.3	5.5	0.2
32. Vagotomy and other gastric procedures	655	0.5	6.7	0.3	10.0	0.3
33. Adrenalectomy	480	0.4	8.5	0.3	12.2	0.3
34. Reduction of volvulus, intussusception, or hernia by laparotomy	138	0.1	22.5	0.2	12.6	0.3
35. Pelvic exenteration	40	0.03	45.0	0.1	11.1	0.1
36. Toe or foot amputation	33	0.02	39.4	0.1	2.5	0.02

DISCUSSION

We found that a small number of operations account for a disproportionate share of morbidity, mortality, and excess length of stay in general surgery. Colectomy registered the greatest share of adverse events followed by small intestine resection, inpatient cholecystectomy, ventral hernia repair, and pancreatic resection. These procedures account for a large proportion of overall adverse events because they are frequently performed, associated with high baseline risk, or both. Baseline risks, as for the latter, are no doubt a func-

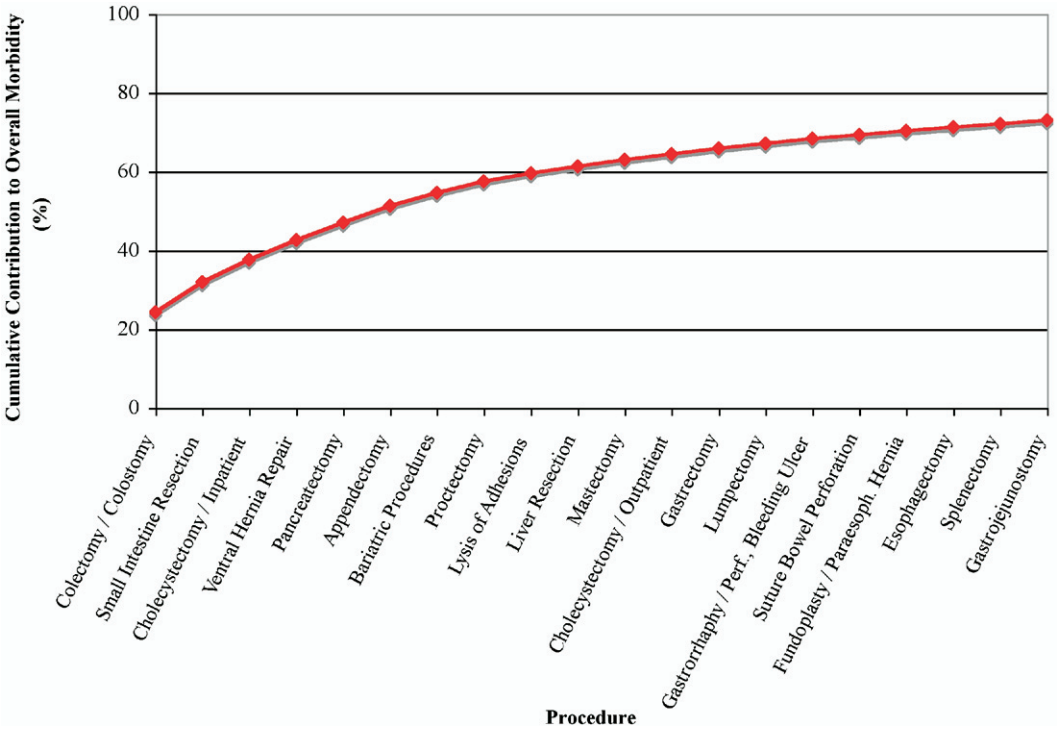

Figure 1. Cumulative contribution of different procedures to overall morbidity and mortality in general surgery patients.

tion of the procedure complexity and patient risk factors.[11,12] Conversely, we found that some very common operations, including breast procedures, outpatient cholecystectomy, and groin hernia repair, account for only a small share of adverse events.

Our main finding, that morbidity and mortality are concentrated within a small number of procedures, may be even more true for other specialties. With the possible exception of orthopaedics, no specialty is as diverse as general surgery in terms of its clinical scope or the number of different procedures. In contrast, the scope of most surgical specialties is considerably narrower. So we expect that an even smaller number of procedures would account for most of the morbidity and mortality in other surgical specialties, including vascular, urologic, and cardiac surgery.

It is important to acknowledge the potential limitations of this study. The first limitation pertains to the degree to which ACS-NSQIP hospitals represent the greater universe of hospitals in the US. At present, ACS-NSQIP is substantially over-represented by large teaching hospitals. Of the 121 hospitals that participated in 2005 and 2006, 67% were classified as teaching hospitals. Academic hospitals may differ from community hospitals with regard to their procedure mix and their adverse event rates. Both factors could affect the generalizability of our findings. For this reason, we repeated our analysis stratifying by hospital type. We found that the top 10 procedure groups accounted for the same share of procedures in community versus teaching hospitals (45% and 44%, respectively), and also the same share of adverse events (63% and 62%, respectively). So quality improvement efforts targeting these procedures have the potential to improve surgical care at teaching and nonteaching hospitals alike.

A second limitation pertains to the representation of the procedures sampled by ACS-NSQIP. Because the program only samples procedures performed under regional or general anesthesia, minor operations performed under local anesthesia are excluded. Because such procedures are associated with extremely low morbidity and mortality, their inclusion would not significantly alter our rank lists. At hospitals with large caseloads, ACS-NSQIP limits the inclusion of low risk procedures by setting ceilings on the number that can be sampled during a given time period (eg, no more than five inguinal hernia repairs or laparoscopic cholecystectomies can be selected during a given sampling period). Inclusion of all such procedures might increase, to some degree, their contribution to overall morbidity and mortality. But these increases would not be large enough to alter our main conclusions.

These results have important implications for future quality improvement efforts in surgery. First, surgeons might use these rankings as a guide to prioritize their local

Table 2. Sensitivity Analysis: Rank of Procedures Based on Relative Contributions to Morbidity or Mortality, and Excess Length of Stay in General Surgery, American College of Surgeons – National Surgery Quality Improvement Program, 2005–2006

	Rank			
Procedure	**Overall morbidity**	**Overall morbidity excluding SSI**	**Mortality**	**Excess length of stay**
1. Colectomy ± colostomy	1	1	1	1
2. Small intestine resection	2	2	2	2
3. Cholecystectomy/inpatient	3	3	3	3
4. Ventral hernia repair	4	5	9	4
5. Pancreatectomy	5	4	6	5
6. Appendectomy	6	6	19	8
7. Bariatric procedures	7	7	15	15
8. Proctectomy ± colectomy ± anastomosis	8	8	17	9
9. Lysis of adhesions	9	9	5	6
10. Liver resection	10	10	8	11
11. Mastectomy/simple, radical, or subcutaneous	11	13	29	32
12. Cholecystectomy/outpatient	12	15	22	33
13. Gastrectomy/total or partial	13	11	10	10
14. Lumpectomy ± axillary lymph node dissection	14	23	32	31
15. Gastrorrhaphy/perforation or bleeding ulcer	15	12	4	7
16. Suture small or large bowel perforation	16	14	7	16
17. Fundoplasty or paraesophageal hernia repair	17	16	21	19
18. Esophagectomy/total or near total	18	18	23	18
19. Splenectomy/total or partial	19	17	13	17
20. Gastrojejunostomy	20	19	14	21
21. All fistula repairs	21	20	27	12
22. Inguinal or femoral hernia repair/inpatient	22	21	12	25
23. Inguinal or femoral hernia repair/outpatient	23	28	28	36
24. Above- or below-knee amputation	24	26	18	22
25. Debridement for necrotizing soft tissue infection	25	22	16	14
26. Bilioenteric anastomosis	26	29	26	23
27. Drain peritoneal abscess/not appendiceal	27	24	11	20
28. Debride pancreas	28	25	20	13
29. Thyroidectomy/total or subtotal	29	27	34	29
30. Excision of intraabdominal or retroperitoneal tumor	30	30	24	24
31. Parathyroidectomy	31	31	30	30
32. Vagotomy and other gastric procedures	32	33	31	27
33. Adrenalectomy	33	32	33	26
34. Reduction of volvulus, intussusception, or hernia by laparotomy	34	34	25	28
35. Pelvic exenteration	35	35	36	34
36. Toe or foot amputation	36	36	35	35

SSI, surgical site infection.

quality improvement efforts.[13] For surgical organizations, our findings might be useful in targeting large-scale quality improvement efforts. For example, ACS-NSQIP might begin targeting a small number of procedures that account for the largest share of morbidity and mortality, rather than sampling procedures across the entire breadth of the specialty. Finally, our findings are relevant to value-based purchasing and other initiatives being led by payers and policy makers.[14-16] These rankings identify high-leverage procedures, not only in terms of their potential for improving patient outcomes, but also in terms of their potential for reducing excess hospital days and cost.

This article does not assess the extent to which quality improvement could reduce morbidity and mortality for each procedure. Stakeholders, as such, would undoubtedly want to consider other factors in setting their quality im-

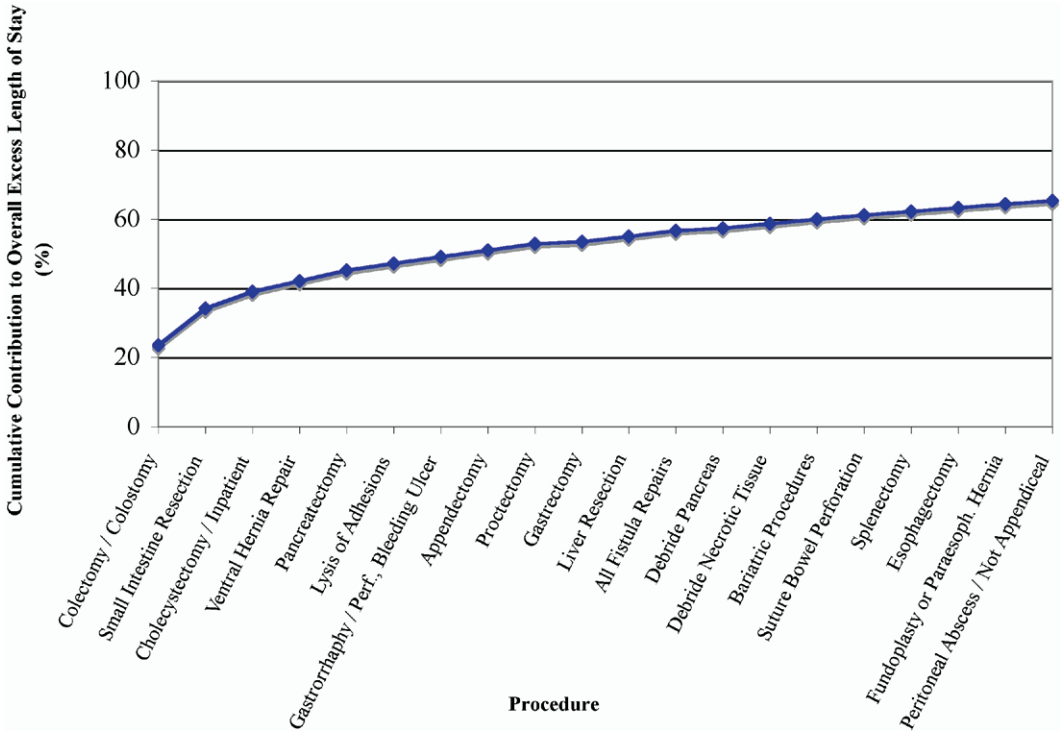

Figure 2. Cumulative contribution of different procedures to overall excess length of stay in general surgery patients.

provement priorities. In particular, it would be important to weight each procedure's potential for quality improvement. For some procedures, high rates of adverse outcomes may reflect the illness the patient brings to the hospital rather than the quality of care the patient receives. Small bowel resection, second only to colectomy in its contribution to overall morbidity and mortality, is a good example. With this procedure, patient outcomes may be driven more by the indication for operation, eg, mesenteric ischemia or strangulated bowel, rather than the quality of care rendered within the hospital.

In this analysis, we stratified overall morbidity and mortality according to common procedures and procedure groups. But priorities for quality improvement might be refined by considering relevant subgroups within the procedure groups. For example, procedure acuity might be an important consideration if urgent or emergent procedures are responsible for a disproportionate share of adverse events relative to elective procedures. For other procedures, it might be useful to stratify according to the underlying diagnosis (eg, appendectomy for ruptured or nonruptured appendix).

Although not sufficient as the sole criteria for prioritizing quality improvement, our findings provide a useful starting point. Ultimately, improving quality will require efforts that go beyond outcomes assessment alone. Future work should aim to improve our current understanding of processes of care associated with superior surgical outcomes.[17]

Appendix

Procedure groups were created according to the following algorithm:

> We calculated the frequency of CPT (Current Procedural Terminology) codes listed in the principal operative procedure field for the patients in the cohort. We ranked these CPT codes in descending order from the most common principal operative procedure code to the least common code within the cohort. We began the process of code grouping by moving sequentially down the list of CPT codes in the cohort (eg, most common to least common). Initial code groupings were created by entering the CPT codes into an on-line code grouping program used by billing services. The authors made modifications to two procedure groupings. For inguinal hernia repair and cholecystectomy we dichotomized the procedure definitions across operative setting (inpatient versus outpatient) because of differences in baseline risk and pathologic indication. We continued this process until we had considered every CPT code within the cohort. At the end of this process, we had created 36

procedure groups that, together, accounted for 85% of the 129,233 cases in the cohort (109,841 cases).

Author Contributions

Study conception and design: Dimick, Birkmeyer
Acquisition of data: Dimick, Birkmeyer
Analysis and interpretation of data: Schilling, Dimick, Birkmeyer
Drafting of manuscript: Schilling
Critical revision: Dimick, Birkmeyer

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