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The intraoperative Surgical Apgar Score predicts post-discharge complications after colon and rectal resection

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Abstract

Background—We previously developed an intraoperative 10-point Surgical Apgar Score--based on blood loss, lowest heart rate, and lowest mean arterial pressure--to predict major complications after colorectal resection. However, because complications often arise after uncomplicated hospitalizations, we sought to evaluate whether this intraoperative metric would predict post-discharge complications after colectomy.

Methods—We linked our institution's National Surgical Quality Improvement Program database with an Anesthesia Intraoperative Management System for all colorectal resections over four years. Using chi-square trend tests and logistic regression, we evaluated the Surgical Apgar Score's prediction for major postoperative complications before and after discharge.

Results—Among 795 colectomies, there were 230 (29%) major complications within 30 days; 45 (20%) after uncomplicated discharges. Surgical Apgar Scores predicted both inpatient complications and late post-discharge complications (both $p < 0.0001$). Late complications occurred from 0–27 (median 11) days after discharge; the most common were surgical site infections (42%), sepsis (24%) and venous thromboembolism (16%). In pairwise comparisons against average-scoring patients (Surgical Apgar Scores 7–8), the relative risk of post-discharge complications trended lower, to 0.6 (95% CI 0.2–1.7) for those with the best Scores (9–10); and were significantly higher, at 2.6 (1.4–4.9) for Scores 5–6, and 4.5 (1.8–11.0) for Scores 0–4.

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This paper was presented in poster format the 2009 Annual Meeting of the American Society of Colon and Rectal Surgeons in Hollywood, Florida, and as an oral presentation at the 2009 Annual Spring Meeting of the New England Society of Colon and Rectal Surgeons in Manchester, New Hampshire.

Conclusions—The intraoperative Surgical Apgar Score remained a useful metric for predicting post-colectomy complications arising after uncomplicated discharges. Even late complications may thus be related to intraoperative condition and events. Surgeons could use this intraoperative metric to target low-scoring patients for intensive post-discharge surveillance and mitigation of post-discharge complications after colectomy.

Introduction

Hospitals and surgeons strive to provide a consistently low occurrence of complications after surgery, but standard methods of surgical audit, such as incident reporting and morbidity and mortality conferences, focus almost entirely on the index postoperative hospitalization.^{1, 2} Within general surgery, adverse events after colon and rectal resections account for a disproportionate burden of morbidity in general surgery, and have been identified as a priority area for quality improvement,³ but many complications after colectomy arise only after discharge.^{4–6} The average time to diagnosis of a postoperative anastomotic leak approaches two weeks,⁵ and unplanned postoperative readmissions after intestinal surgery occur an average of 8 to 19 days after discharge.^{4, 7–9} With the increasing utilization of fast-track discharge pathways and minimally-invasive colon and rectal surgery,¹⁰ post-discharge complications after colectomy will be an increasingly important contributor to surgical morbidity and cost.

The ability to identify patients at risk for late postoperative complications and target them for surveillance and early treatment offers an opportunity to develop interventions that might significantly improve outcomes and efficiency. Unfortunately, surgeons have lacked a routine quantitative metric of operative performance and patient-related procedural risk,² from which to assess patients' likelihood of experiencing major complications after discharge. Instead, they rely principally on “gut-feeling” clinical assessments of the operative course to inform postoperative prognostication, and guide clinical care.¹¹ In colon and rectal surgery, attempts to reliably identify patients at risk for early unplanned readmission have been largely unsuccessful.^{4, 8, 9}

We have previously developed and validated a ten-point Surgical Apgar Score that provides surgeons with a simple, objective, and direct rating of operative performance and risk.^{12, 13} In deriving the score, we screened more than two dozen parameters collected in the operating room, and found that just three intraoperative variables remained independently predictive of major postoperative complications and death in colectomy—the lowest heart rate, lowest mean arterial pressure, and estimated blood loss. A score built from these three predictors has proved strongly predictive of the risk of major postoperative complications and death across the range of general and vascular surgery,^{12, 13} and remains an important predictor, even after accounting patients' comorbidities and procedure-specific risk factors.¹⁴ Still, it remains simple enough for teams to collect immediately upon completion of an operation for patients in any setting, regardless of resource and technological capacity.

In this study, we sought to evaluate whether such a score, that integrates components of patient susceptibility, procedure complexity and operative performance, might also serve to inform surgeons and patients about the likelihood of late complications after discharge from an otherwise uncomplicated post-colectomy hospital course.

Materials and Methods

Patient cohort

The Massachusetts General Hospital (MGH) Department of Surgery maintains an outcomes database on a systematic sample of surgical procedures for submission to the American

College of Surgeons' National Surgical Quality Improvement Program (NSQIP). In this program,^{15, 16} trained nurse-reviewers retrospectively collect 49 preoperative, 17 intraoperative, and 33 outcome variables on surgical patients, for the monitoring of risk-adjusted outcomes. Patients age 16 and over, undergoing procedures by general or vascular surgeons with general, epidural, or spinal anesthesia are eligible for inclusion. Trauma surgery, transplant surgery, vascular access surgery, and endoscopic-only procedures are excluded. For this study, we selected all colon and rectal resections (Current Procedural Terminology codes 44140–60, 45110–45123, 44204–12, and 45395–7) in the MGH-NSQIP database between July 1, 2003, and June 30, 2007 for whom complete 30-day follow-up was obtained.

The study protocol, including a waiver of individual informed consent, was approved by the Human Subjects Research Committees of Massachusetts General Hospital and the Harvard School of Public Health.

Preoperative risk factors and postoperative outcomes

Preoperative patient variables were collected according to standardized NSQIP techniques, by audited, trained clinical nurse reviewers. All variables were either treated as dichotomous or categorized according to the FY2005 NSQIP models.¹⁷ Clinical details, including specific operative resection and indication for surgery, were obtained from our institution's electronic medical record. The primary endpoint was the occurrence of one or more major complications within 30 days after surgery, as recorded in the NSQIP database. Patients were classified as having an “inpatient” complication if their first recorded occurrence preceded discharge, and as a “post-discharge” complication if the first recorded adverse event occurred after discharge from a hospitalization that was free from previous postoperative complications.

The following NSQIP-defined¹⁶ events were considered major complications: acute renal failure, bleeding requiring ≥ 4 units of red cell transfusion within 72 hours after surgery, cardiac arrest requiring CPR, coma for ≥ 24 hours, deep venous thrombosis, myocardial infarction, unplanned intubation, ventilator use for ≥ 48 hours, pneumonia, pulmonary embolism, stroke, wound disruption, deep or organ-space surgical site infection, sepsis, septic shock, systemic inflammatory response syndrome (SIRS). All deaths were assumed to include a major complication. Superficial surgical site infection and urinary tract infection were not considered major complications. Patients having complications categorized in the database as “other occurrence” were reviewed individually and severity of the occurrence was evaluated according to the Clavien classification.¹⁸ “Other occurrences” involving complications of Clavien Class III and greater (those that require surgical, endoscopic or radiologic intervention or intensive care admission, or are life-threatening) were considered major complications, in accordance with our previous work.^{12, 13}

Calculation of the intraoperative score

As described and validated previously,¹³ we extracted intraoperative hemodynamic data from the electronic Anesthesia Information Management System (Saturn, Dräger Medical, Telford, PA) database, using a Structured Query Language algorithm to filter out artifactual readings, using criteria developed through comparisons of electronic and hand-written intraoperative records.¹⁹ The Surgical Apgar Score was then computed according to the parameters arrayed in Table 1.

Statistical analysis

We evaluated relationships between patient and procedure characteristics and the likelihood of pre- and post-discharge complications using two-sided t-tests for continuous variables and

Pearson's chi-square tests for categorical predictors. We used chi-square tests and the Cochran-Armitage chi-square trend test²⁰ to evaluate the relationship between each level of the score and the incidence of either pre- or post-discharge outcomes. We treat patients with Surgical Apgar Scores of 7–8 as the comparison group, in accordance with our previous finding that these patients represent an average-risk cohort.¹⁴ Discrimination was computed with the c-statistic from a univariable logistic regression using the Surgical Apgar Score as a categorical predictor, and the incidence of major complications as the outcome. We used Kaplan-Meier survival curves to demonstrate time trends in the onset of complications within each score category, and evaluated differences using non-parametric log rank tests. All analyses were performed using the SAS 9.1 statistical software package (SAS Institute, Cary, N.C., 2003).

Results

Characteristics of patients, by incidence and timing of major complications

Among the 795 patients, 230 (29%) suffered one or more major complications within 30 days of surgery. The first complication arose during the index hospitalization in 185 (80%) of these cases; in the other 45 (20%), complications occurred only after an uncomplicated discharge. Comparisons of demographic characteristics, baseline comorbidities, laboratory data, operative characteristics, and postoperative adverse events, according to the incidence and timing of complications, are shown in Table 2.

Compared with patients free from complications within 30 days of surgery, those who suffered post-discharge complications only were significantly more often of non-white race, and had preoperative sepsis, metastatic cancer, weight loss, steroid use, ascites, or altered mental status. Unlike those with inpatient complications, the proportion of these patients with heart disease, pulmonary disease, diabetes, renal failure, bleeding disorders, and alcohol abuse was no greater than that of complication-free patients. They did more frequently have preoperative leukocytosis, anemia, hypoalbuminemia, hyperbilirubinemia or transaminitis. There was no difference in the incidence of thrombocytopenia, abnormal coagulation studies, hyponatremia or azotemia.

Emergency operations were significantly more common among those with inpatient complications (23% vs. 9%, $p < 0.001$), but not among those with post-discharge complications (7% vs. 9%, $p = 0.62$). Among those with post-discharge complications only, inflammatory bowel disease was more than twice as common as among uncomplicated cases (20% vs. 9%, $p = 0.02$), yet the overall distribution of indications did not differ between these groups (global $p = 0.33$).

Among those with post-discharge complications, total and subtotal colectomy were more prevalent than among uncomplicated cases, but the difference did not reach statistical significance ($p = 0.054$); and the overall distribution of operations was no different (global $p = 0.26$). Length of stay among patients with uncomplicated hospitalizations were not different among those who suffered complications after discharge (5.7 ± 3.4 days), compared with those without any major complications (5.1 ± 3.9 days; $p = 0.34$).

Types of complications before and after discharge

The distribution of complications observed before and after discharge differed significantly ($p < 0.001$). Surgical site infections accounted for 42% of post-discharge complications, compared with just 8% of inpatient events. Sepsis represented more than half of inpatient complication, versus less than one-fourth of those as outpatient. And 16% of post-discharge complications were thromboembolic events were, compared with just 3% of inpatient ones.

Relationship of Surgical Apgar Score with pre- and post-discharge outcomes

With increasing scores, the incidence of major complications decreased monotonically, both overall, and individually among patients who suffered inpatient complications and those whose complications arose only after uncomplicated discharges (all trends $p < 0.001$; see Table 3). Compared with average-scoring patients (Surgical Apgar Scores 7–8), the relative risks of major postoperative complications overall (inpatient and outpatient combined) were 0.7 (95% CI 0.5–1.0) for those scoring 9–10; 1.5 (95% CI 1.2–1.9) for scores 5–6; and 2.7 (95% CI 2.1–3.5) for scores ≤ 4 .

Among patients discharged free from inpatient complications, those with Surgical Apgar Scores of 9–10 had lower-than-average incidence of major complication, but this difference was not statistically significant. Those with scores of 5–6 had 2.6 times greater risk (95% CI 1.4–4.9) and those with scores 0–4 had 4.5 times greater likelihood (95% CI 1.8–11.0) of experiencing complications after discharge. The c-statistic for predicting post-discharge complications with the Surgical Apgar Score alone was 0.68—moderately good discrimination.²¹

Discussion

Late surgical complications after hospital discharge incur significant disability and cost,^{22, 23} and are proposed by some researchers and policy-makers as metrics of health care quality and safety.^{24, 25} Among general surgery operations, colon and rectal resections account for a disproportionately large share of complications and their resulting costs,³ and many post-colectomy complications arise only after uncomplicated discharges.^{4, 5} As a result, there is significant interest in understanding key risk factors for post-discharge complications and readmission after colectomy, and targeting high-risk patients for early prevention and management of adverse events. We have found here that the simple 10-point intraoperative Surgical Apgar Score remains a useful measure of these patients' risk of major complications, not only in the immediate postoperative period, but well beyond the index hospitalization.

Among patients discharged from the hospital without an adverse event, those with the worst intraoperative scores—4 or less—were four times more likely than average-risk patients to experience a subsequent complication within 30 days of surgery. About one in four of these lowest-scoring patients suffered late complications, compared with just 3% of those with the highest scores (9 or 10). Despite the relatively low prevalence of scores ≤ 4 (6% overall), the consistent trend toward worse outcomes, even at the extremes of the scale suggests that the score has good discriminative ability across the full point spectrum.²¹

If the Surgical Apgar Score were routinely recorded in the operating room, therefore, surgeons could use it as a quantitative adjunct to their subjective impressions of the operative course, to scale their expectations for both early and late complications after colectomy. Patients thereby identified as highest-risk for post-discharge complications, could be targeted for stricter discharge criteria, earlier follow-up appointments or phone contacts, and/or ancillary care such as home care visitation, with a goal of early detection and mitigation of late adverse events.^{26–28} Since we and others^{6, 9} have found that most post-discharge complications are infectious in nature, we could imagine interventions such as scheduled temperature surveillance, wound examinations, and/or white blood cell analyses as means of early diagnosis and treatment for patients considered high risk. Any such interventions would require careful development and testing to determine whether they actually reduce the severity and/or incidence of adverse events.

The association of an intraoperative metric like the Surgical Apgar Score with the incidence of post-discharge complications suggests that perhaps even these late postoperative outcomes are related to condition and events in the operating room. Still, its components are not necessarily independent predictors of patient outcomes. In our previous work,¹⁴ we found that the Surgical Apgar Score was closely correlated with a variety of other important patient- or procedure-related risk factors. Yet, even after detailed adjustment for comorbidity and procedure-specific risk factors, the amount of blood loss, lowest heart rate and lowest blood pressure were still important predictors of the risk of a major complication.

In accordance with our findings, Kariv et al.⁹ observed that blood loss was nearly doubled among patients who later required unplanned admissions after, but this difference did not reach statistical significance among their sample of 300 colectomy patients. Further, these results are consistent with previous observations that most surgical complications originate in the operating room,^{29, 30} and that intraoperative hemodynamics are powerful predictors of surgical outcome,^{31–35} even up to a year after the operation.³⁶ And unlike complex multivariable algorithms that depend on the availability and interpretation of complex comorbidity and laboratory data, the Surgical Apgar Score can be available in real time, immediately usable for clinical decision-support and easily and inexpensively collected for any patient in any hospital.^{12, 13}

Previous studies have failed to identify a consistent set of predictors for post-discharge complications among colectomy patients—some authors have gone so far as to conclude that these events might simply be unpredictable.^{4, 7, 8} The only predictors that have appeared in more than one study are perioperative steroid use,^{7, 9, 37} pulmonary comorbidity,^{9, 37} inflammatory bowel disease or ulcerative colitis as the indication for surgery,^{8, 37} and subtotal or total colectomy as the procedure.^{7, 8} And even this limited set of factors did not reach statistical significance in every study, often due to sample size limitations. We likewise found that steroids, inflammatory bowel disease and total/subtotal colectomy were significantly more prevalent among the post-discharge complication group, but these factors accounted for only a small share of the complications. Perhaps previous studies' difficulties in identifying consistent risk factors results from the lack of detailed metrics of operative performance and success in those analyses. Interestingly, despite trends toward short hospital stay after colectomy,¹⁰ we found no evidence that post-discharge complications were associated with premature discharge from the hospital—postoperative length of stay for patients with post-discharge complications was no different from that of patients free from complications altogether.

There remain several limitations to our study. First, NSQIP outcomes are not procedure-specific, so complications particular to alimentary tract surgery, such as anastomotic leaks or small bowel obstruction, may not be properly captured in all cases. The patient follow-up is, however, comprehensive and validated. Second, we are limited to a 30-day postoperative surveillance period, and do not capture later events beyond that timeframe, but longer-term studies have found that the great majority of events occur within this interval.^{5, 8} It is important to note that timing of complications is not a validated data point in the NSQIP. Yet the similarity in length of stay between patients without complications and those with only post-discharge complications suggests that misclassification is probably uncommon. Third, the sensitivity of low scores for detecting post-discharge complications is only moderate—even average- and high-scoring patients remain at some risk. Still, the overall discrimination for post-discharge complications (c-statistic of 0.68) is no worse than that of a risk-adjustment algorithm promoted elsewhere for benchmarking NSQIP outcomes in colorectal surgery.^{38, 39} Fourth, like the obstetrical Apgar score, this surgical score does not allow comparison of quality between institutions or surgeons, as its three variables are influenced not only by intraoperative performance, but also by patients' prior condition and

the magnitude of the operations they undergo. Finally, this study evaluated only colectomy—not the full range of general and vascular surgery included in the NSQIP—so we do not know whether the score's predictive value would generalize as consistently for post-discharge complications as it does for complications overall.^{12, 13} And even among patients undergoing colon and rectal resections, their inherent risk varies widely, depending on particular procedure, indication, preoperative therapy, and other factors, so there may be subsets of patients among whom the score is more or less clinically useful.

We find here that a simple clinically-derived surgical outcome score, computed from intraoperative data alone, can provide useful measure of surgical risk after colon and rectal resection, even beyond the initial postoperative hospitalization. A more complex model, with more input variables might achieve better discrimination, but the Surgical Apgar Score could provide immediate and inexpensive information, derived from routine intraoperative data available in any hospital, regardless of resource availability. As a prognostic measure and a clinical decision-support tool, the Surgical Apgar Score might thus allow surgeons to effectively target patients for post-discharge monitoring and mitigation of late postoperative adverse events.

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The Ten-Point Surgical Apgar Score

Table 1

The Surgical Apgar Score is calculated at the end of an operation, from the estimated blood loss, lowest mean arterial pressure and lowest heart rate entered in the anesthesia record during the operation. The score is the sum of the points from each category.

	0 points	1 point	2 points	3 points	4 points
Estimated blood loss (mL)	>1000	601–1000	101–600	≤100	
Lowest mean arterial pressure (mm Hg)	<40	40–54	55–69	≥70	
Lowest heart rate (beats per min)	>85*	76–85	66–75	56–65	≤55*

* Occurrence of pathologic bradyarrhythmia, including sinus arrest, atrioventricular block or dissociation, junctional or ventricular escape rhythms, and asystole also receive 0 pts for lowest heart rate

Table 2
Characteristics of patients, procedures, and outcomes, by postoperative outcome

Data are presented as N (%) or mean $\pm$ standard deviation, as indicated. Comparisons used chi-square tests for categorical variables and two-sided t-tests for continuous variables, with the “no complications” patients as the reference group.

Patient Characteristics	No complications N = 565 (71)	Inpatient complications N=185 (23)	Post-discharge complications only N = 45 (6)
Age (years) (mean $\pm$ sd)	62 $\pm$ 16	63 $\pm$ 15	64 $\pm$ 21
Male sex	272 (48)	97 (52)	22 (49)
Non-white race	27 (5)	17 (9)*	7 (16)**
ASA Class		***	*
1	23 (4)	9 (5)	1 (2)
2	379 (67)	86 (46)	21 (47)
3	145 (26)	66 (36)	20 (44)
4	18 (3)	24 (13)	3 (7)
Heart disease (MI, CHF, angina, coronary revascularization)	57 (10)	28 (15)	7 (16)
Hypertension	332 (59)	94 (51)	26 (58)
Pulmonary disease (pneumonia, COPD, dyspnea)	38 (7)	21 (11)***	5 (11)
Diabetes mellitus	50 (9)	27 (15)*	7 (16)
Renal failure	8 (1)	17 (9)***	1 (2)
Sepsis	39 (7)	38 (21)***	8 (18)**
Contaminated or dirty wound	97 (17)	62 (34)***	12 (27)
Bleeding disorder	21 (4)	21 (11)***	3 (7)
History of stroke or TIA	28 (5)	13 (7)	5 (11)
Current smoker	80 (13)	37 (20)	9 (20)
Disseminated cancer	29 (5)	13 (7)	6 (13)*
Weight loss >10% in 6 months	67 (12)	23 (12)	10 (22)*
Steroid use (oral or parenteral)	45 (8)	12 (6)	9 (20)**
Ascites	15 (3)	14 (8)**	4 (9)*
Alcohol use >2 drinks per day	29 (5)	17 (9)*	1 (2)

Patient Characteristics	No complications N = 565 (71)	Inpatient complications N=185 (23)	Post-discharge complications only N = 45 (6)
Impaired Sensorium	6 (1)	15 (8)***	3 (7)**
Chemotherapy within 30 days	10 (2)	3 (2)	2 (4)
Radiation therapy within 90 days	39 (7)	10 (5)	3 (7)
Laboratory data			
White blood cell count >11,000/mm ³	85 (15)	42 (23)*	12 (27)*
Hematocrit <38%	235 (42)	102 (56)***	29 (64)**
Platelet count <150,000/mm ³	21 (4)	16 (9)**	4 (9)
Platelet count >400,000/mm ³	74 (13)	21 (12)	10 (22)
Prothrombin time >13.67 seconds	69 (20)	49 (37)***	10 (28)
Partial thromboplastin time >35 seconds	24 (7)	24 (19)***	5 (14)
Sodium <135 mEq/L	25 (5)	18 (11)*	5 (11)
Sodium >145 mEq/L	3 (1)	4 (2)	1 (2)
BUN >40 mg/dL	14 (3)	16 (9)***	1 (2)
Creatinine >1.2 mg/dL	81 (16)	44 (26)**	4 (9)
Albumin g/dL (mean ± sd)	3.6 ± 0.7	3.2 ± 0.9***	3.2 ± 0.7**
SGOT >40 units/L	41 (11)	20 (16)	7 (20)
Bilirubin >1 g/dL	24 (7)	16 (13)*	6 (17)*
Alkaline phosphatase >125 units/L	39 (11)	28 (22)**	8 (24)*
Operative characteristics			
Emergency operation	50 (9)	43 (23)***	3 (7)
Indication		***	
Cancer	250 (44)	69 (38)	18 (40)
Diverticulitis	136 (24)	38 (26)	9 (20)
Benign neoplasm	64 (11)	11 (6)	4 (9)
Inflammatory bowel disease	51 (9)	14 (8)	9 (20)
Ischemic or infectious colitis	25 (4)	25 (14)	2 (4)
Other	39 (7)	28 (15)	3 (7)
Type of operation		*	

Patient Characteristics	No complications N = 565 (71)	Inpatient complications N=185 (23)	Post-discharge complications only N = 45 (6)
Right colectomy	198 (35)	46 (25)	11 (24)
Left or sigmoid colectomy	158 (28)	59 (32)	15 (33)
Low anterior rectal resection	131 (23)	44 (24)	8 (18)
Abdominoperineal resection	23 (4)	9 (5)	2 (4)
Total or subtotal colectomy	42 (7)	26 (14)	7 (16)
Ileo-anal J-pouch anastomosis	13 (2)	1 (0.5)	2 (4)
Postoperative Outcomes			
Postoperative length of stay, days (mean $\pm$ sd)	5.1 $\pm$ 3.9	13.1 $\pm$ 13.5***	5.7 $\pm$ 3.4
Complication types			
Surgical site infection	N/A	15 (8)	19 (42)
Sepsis/septic shock/SIRS		102 (55)	11 (24)
DVT/PE		6 (3)	7 (16)
Unplanned intubation or prolonged ventilation		26 (14)	3 (7)
Pneumonia		16 (9)	2 (4)
Bleeding		10 (5)	1 (2)
Stroke		3 (2)	1 (2)
Renal failure		4 (2)	1 (2)
Peripheral nerve injury		2 (1)	
Myocardial infarction		1 (1)	

Significance levels are indicated as follows:

Laboratory data were missing for some patients; percentages and comparisons are computed from those with available data.

ASA: American Society of Anesthesiologists, BUN: blood urea nitrogen, CHF: congestive heart failure, COPD: chronic obstructive pulmonary disease, DVT: deep venous thrombosis, MI: Myocardial infarction, PE: pulmonary embolus, sd: standard deviation, SGOT: Serum glutamic oxaloacetic transaminase, TIA: transient ischemic attack

*
p<0.05

**
p<0.01

p<0.001.

Table 3
Overall, inpatient, and post-discharge outcomes according to Surgical Apgar Score

	Surgical Apgar Score					p value (trend)
	0 – 4	5 – 6	7 – 8	9 – 10		
Overall Outcomes						
# of operations	49	186	406	154		
% complications	67%	37%	25%	18%		<0.001
Relative risk (95% CI)	2.7 (2.1–3.5)	1.5 (1.2–1.9)	Reference	0.7 (0.5–1.0)		
p value	<0.001	0.002		0.06		
Inpatient Outcomes						
% pre-discharge complications	57%	27%	21%	15%		<0.001
Relative risk (95% CI)	2.8 (2.0–3.8)	1.3 (1.0–1.8)	Reference	0.7 (0.5–1.1)		
p value	<0.001	0.09		0.12		
Post-Discharge Outcomes						
# discharged without complications	21	136	322	131		
% post-discharge complications	24%	14%	5%	3%		<0.001
Relative risk (95% CI)	4.5 (1.8–11.0)	2.6 (1.4–4.9)	Reference	0.6 (0.2–1.7)		
p value	<0.001	0.002		0.31		