

Documentation of Individualized Preoperative Risk Assessment: A Multi-Center Study

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Abstract

Background Individual surgical risk prediction tools that inform shared-decision making, strengthen the consent process and support clinical management are considered important tools to enhance patient experience and outcomes. Neither the use of individual pre-surgical risk assessment (ISRA) tools nor the rate of documented individual risk is known. The primary endpoint of this study was the rate of physician documented ISRAs within the records of patients with poor outcomes. Secondary endpoints included the effects of age, sex, race, ASA class, and time and type of surgery on the rate of documented presurgical risk.

Methods The records of non-obstetric surgical patients within 22 hospitals in Arizona, Colorado, Nebraska, Nevada, and Wyoming, between January 1 and December 31, 2017 were evaluated. Logistic regression was used to analyze both individual and group effects associated with ISRA documentation.

Results 756 of 140,756 inpatient charts met inclusion criteria [0.54%, 95% CI 0.50% to 0.58%]. ISRAs were documented by 16.08% of surgeons [$p < 0.0001$; R-squared=68.23%] and 4.50% of anesthesiologists [$p < 0.0001$, R-squared 15.38%]. Cardiac surgeons documented ISRAs more frequently than non-cardiac surgeons (25.87% vs 16.15%) [$p = 0.0086$, R-squared=0.970%]. Elective surgical patients were more likely than emergency surgical patients (19.57 vs 12.03%) to have risk documented [$p = 0.0226$, R-squared=0.730%]. Patients over the age of 65 were more likely than patients under the age of 65 to have ISRA documentation (20.31 vs 14.61%) [$p = 0.0429$, R-squared=0.580%].

Conclusions The observed rate of documented individual surgical risk assessment in our sample was low. Surgeons were more likely than anesthesiologists to document individual presurgical risk. In-line with the Salzburg Statement on Shared-Decision Making, information regarding surgical risk represents the bedrock of presurgical decision making and informed consent. The rate and quality of risk documentation must be improved.

Background

An individualized surgical risk assessment is required by several medical societies and regulatory bodies,^{1,2} and represents a National Quality Strategy surgical measure.³ Such assessments provide additional value in their ability to guide preoperative medical optimization,⁴ surgical and anesthetic management,⁵ and post-operative disposition⁶ One recent study has shown that such assessments may also enhance patient outcomes.⁷

Several validated surgical risk tools exist that provide individualized surgical risk assessment, including SORT,⁸ POSSUM,⁹ p-POSSUM,¹⁰ and the American College of Surgeons (ACS) Risk Calculator.¹¹ Of these, only the ACS tool has been validated for use in the United States. The ACS risk model incorporates 20 “patient predictors” (e.g., age, ASA-PS, BMI, Ventilator Dependence, Diabetes) and the surgical procedure to be performed (CPT code). The current calculator is based on a multivariate analysis of 4.3 million surgical episodes that have been entered in the National Surgical Quality Improvement (NSQIP) database

between 2013-17, and provides patient specific risk for 18 different potential outcomes that could occur within 30 days following one of 1557 surgical procedures.^{12,13}

How often validated preoperative individualized risk assessment tools are used or the results documented by perioperative physicians in the United States is unknown, in spite of an abundance of perioperative literature that focuses on surgical risk assessment (Fig. 1). Given the importance of individual surgical risk assessment, we undertook a 22-medical center, 5-State study of surgical patients with poor outcomes to determine the rate of documented individualized, preoperative, risk assessments authored by surgeons and anesthesiologists. Secondary endpoints included the effects of age, sex, race, ASA-PS class, and time and type of surgery on the rate of documented individualized risk assessment.

Methods

Study design

We carried out a retrospective multi-center study aimed at determining the rate of physician documented individual presurgical risk assessments within the records of patients with poor outcomes. Secondary endpoints included the effects of age, sex, race, ASA class, and time and type of surgery on the rate of documented presurgical risk.

Participants

Following Institutional Review Board waiver, all non-obstetric surgical patients cared for within 22 medical centers located in Arizona, Colorado, Nebraska, Nevada, and Wyoming, between January 1, 2017 and December 31, 2017 were included. A cohort of patients was selected for chart evaluation based on having suffered myocardial infarction, respiratory complications, stroke, acute kidney injury, or death either intraoperatively, within 48 hours of surgery, or greater than 48 hours after surgery. These intraoperative and post-procedural complications were identified from medical records (Cerner) and billing data (MedSeries4) associated with each patient's surgical episode of care using the following International Classification of Diseases, Tenth edition (ICD 10) codes: Z53.8, G97.81, G97.82, I24.9, I46.9, I97.710, I97.711, I97.120, I97.121, J95.4, J95.89, J95.88, T14.8XXA, T14.8XXD, T14.8XXS, I97.820, I97.821, G58.8, J69.8, N99.89, N99.0. (Table 2)

Analysis

Our study cohort, which included only patients who experienced one or more complications listed above, had their records assessed by a team of clinicians for the presence of a documented individualized, qualitative or quantitative pre-surgical risk assessment and whether a specific risk assessment tool was named. Study clinicians were trained to assess both anesthesia and surgical preoperative notes for the presence of specific key words and phrases relative to risk assessment and specific risk assessment tool names. Standardized electronic health record generated sentences such as "All risks and benefits have been addressed," were not considered risk assessments. When questions arose during the chart audit

process, both the principal investigator and a second auditor reviewed the material to achieve consensus with the primary reviewer.

The primary endpoint of this study was the rate of documented pre-surgical individualized risk assessments by anesthesiologists and surgeons. Summary statistics for patient demographics were compiled. The proportion of risk assessments were calculated by assessment type (qualitative, quantitative, and quantitative with a named tool) and note type (surgeon or anesthesiologist). Comparisons of cases with any documented risk assessment were made by age, gender, ASA-PS Class, race, time of surgery, emergency status, and case type (cardiovascular versus non-cardiovascular) using a logistic regression model. Mortality by presence of any documented risk assessment was also compared using logistic regression.

Results

756 out of 140,756 non-obstetric surgical inpatients cared for between January 1, 2017 and December 31, 2017 met inclusion criteria (0.54%, 95% CI 0.50% to 0.58%). The average patient age was 65. 51% of patients were Male, 89% were Caucasian, 69% were Hypertensive and 36% were Diabetic requiring medication. The majority of patients were ASA-PS 3 (43.25%) and 4 (39.68%). Patient demographics and clinical characteristics are shown in Table 1. Respiratory (43.65%), cardiac (39.63%), and renal (9.5%) complications accounted for the majority of organ specific post-surgical morbidities (Table 2). 213 (28.17%) patients within this cohort died. Of these, 16 (7.51%) patients died intraoperatively, 47 (22.10%) within 48 hours of surgery, 103 (48.36%) at greater than 48 hours. For 51 patients (22.03%), the time of death could not be determined from the medical record. Out of the total population, 308 (0.22%) patients suffered perioperative cardiac arrest, of which 151 (49%) died. Intraoperative cardiac arrest (ICA) occurred in 47 (0.03%) patients, 92% of which were ASA-PS classification 3 or higher. Of those with ICA, 24 (51.1%) died: 16 (66.67%) intraoperatively, 3 (12.5%) within 48 hours, and 5 (20.83%) at greater than 48 hours. Emergency surgical admissions accounted for 158 (21%) patients. Of these patients, 145 (91.8%) were ASA-PS 3 or higher and 43 (27%) died.

According to the results of our logistic regression models (Table 3), surgeons (16.08%) were more likely to document ISRAs (P-value<0.0001; R-squared=68.23%) than anesthesiologists (4.50%) (P-value<0.0001, R-squared 15.38%). Cardiac surgeons (25.87%) documented ISRAs more frequently than non-cardiac surgeons (16.15%) (P-value=0.0086, R-squared=0.970%). The odds of documenting ISRAs for cardiovascular procedures were 1.8123 times higher than those for non-cardiovascular procedures, 95% Confidence Interval (CI) [1.1769 to 2.7906].

Elective surgical patients (19.57%) received ISRA documentation more frequently than emergency surgery patients (12.03%) (P-value=0.0226, R-squared=0.730%). In turn, ISRA documentation was 1.7795 times more likely to occur in patients who elected to have a surgery than those who had an emergency surgery, 95% CI [1.0577 to 2.9939].

ISRAs were documented more frequently for patients 65 years and older (20.31%) than for patients under 65 (14.61%) (P-value=0.0429, R-squared=0.580%). The odds of documenting ISRAs for patients 65 and over is 1.4898 times higher than those for patients younger than 65, 95% CI (1.0076 to 2.2027).

Neither female (19.09%) nor male (16.93%) gender had a statistically significant effect on ISRA documentation [P-value=0.4397, R-squared=0.080%]. However, the odds of ISRA documentation occurring were 1.1576 times higher for female patients than for male patients, 95% CI (0.7984 to 1.6785).

ISRA documentation was not statistically different between non-Caucasians (25.29%) and Caucasians (17.04%) [P-value = 0.0701, R-squared=0.460%]. However, the odds of ISRA documentation occurring were 1.6478 times higher for non-Caucasian patients than for Caucasian patients, 95% CI (0.9760 to 2.7821).

No associations with individual risk documentation were found between ASA-PS 1 and 2 (17.82%) and ASA-PS 3, 4, and 5 (17.89%) [P-value = 0.9867, R-squared= 0%]. The odds of documenting ISRAs were only 1.0047 times higher for patients with ASA-PS 3, 4, and 5 than for patients with ASA-PS 1 and 2, 95% CI (0.5811 to 1.7369).

A significant relationship [P-value = 0.1275, R-squared=0.330%] did not exist between ISRA documentation and time of surgery (daytime surgery 18.63%; evening surgery 11.59%). The odds of documenting ISRAs were 1.7460 times higher for patients who had daytime surgery than for those who had surgery in the evening. 95% CI (0.8152 to 3.7394).

There was no significant difference between documentation of preoperative ISRA for patients who survived (17.13%) versus those who died (20.19%) [P-value = 0.3287, R-squared=0.130%]. However, the odds of documenting ISRAs for patients who died were 1.2239 higher than for those who survived surgery. 95% CI (0.8186 to 1.8299).

Group effect model design

A logistic regression model was created to analyze the group effect of four predictors (age, emergency status, race, and cardiac surgery) on the likelihood of ISRA documentation. As a group, these predictors had a significant effect on documenting ISRAs (P-value=0.0004) and explain more variability than each measure individually (R-squared=2.86%). The model positively classifies 82.01% of the records.

Parameters estimates

According to our model, 45.2% of the patients who had documented ISRAs were 65 years and older, non-Caucasian, elected to have a surgery, and underwent cardiovascular surgery.

Effect Likelihood Ratio Test

Race did not have a significant relationship upon the documentation of ISRAs (P-value=0.0701). However, it was added into the group of predictors since the probability of being a non-Caucasian and

having documented ISRAs was 25.29%. According to our model, the individual effect of race (P-value=0.0138), age (P-value=0.0275), emergency status (P-value=0.0389), and cardiovascular surgery (P-value=0.0137) were significant.

Discussion

The primary endpoint of our study was to benchmark the rate of documented individual surgical risk assessments by anesthesiologists and surgeons in a large, multi-state health system. While this study is the first of its kind in the United States, one audit of 496 high-risk surgical patients in the United Kingdom demonstrated that only 34 (7%) of preoperative notes included documented risk of organ specific morbidity or mortality.¹⁴ Perioperative complications are said to occur in up to 1:5 surgical patients,^{15,16,17} yet our morbidity rate was far lower (0.54%), likely due to the fact that our patient selection was limited to those who suffered only serious complications, including perioperative stroke, myocardial infarction, acute respiratory failure, and acute renal failure. Of interest, the rate of cardiac arrest in our study (22:10,000) was much higher than the 5.6:10,000 reported by the National Anesthesia Clinical Outcomes Registry (NACOR). We believe this difference exists because NACOR only includes cardiac arrests that happen within a narrow perioperative window, where as we counted all cardiac arrests from the time of anesthetic induction to the end of hospital stay. Indeed, our rate of perioperative cardiac arrest is in line with several published studies.¹⁸

Though surgeons documented individual morbidity and mortality risk more frequently than anesthesiologists, the overall rate for both was surprisingly low. Patients undergoing cardiac surgery were more likely to have documented preoperative risk assessments than patients undergoing non-cardiac surgery. The likely reason for this difference is not simply because surgeons have classically borne the responsibility of assisting patients with weighing the risk of surgery, as this would apply to both cardiac and non-cardiac surgeons.¹⁹ We note that cardiac surgeons have had powerful individualized risk assessment tools, such as the Society of Thoracic Surgeons (STS) risk calculator, at their disposal for almost 40 years.²⁰ The importance of IRSA in cardiac surgery's culture may thus explain the difference.

We were surprised to find that both surgeons and anesthesiologists were more likely to document individual risk in patients undergoing elective surgery rather than emergency surgery, given that patients undergoing emergency surgery are at substantially higher risk for both intraoperative and post-surgical adverse events.²¹ Indeed, emergency surgical patients, which accounted for 21% of our cohort and 34% of its deaths. This mortality rate is substantially higher than published emergency surgical mortality,²² and is perhaps due to the fact that our cohort had a higher than average number of older patients with higher ASA-PS.

We were also surprised to find that patients with ASA-PS scores of 3,4, or 5 did not have higher levels of ISRA documentation than ASA-PS scores of 1 or 2. Although ASA-PS is a population based risk assessment tool that lacks the ability to provide either individualized organ specific morbidity or mortality risk,²³ it has been validated as a reliable predictor of post-surgical morbidity and mortality.²⁴ We did not

differentiate between ASA-PS 3, ASA-PS 4, and ASA-PS 5 in this study. We also acknowledge that there can be significant inter-anesthesiologist variability when assigning ASA-PS scores.^{25,26,27}

Individual risk assessments were documented more frequently in patients older than 65 and in non-Caucasians, which may relate to greater pre-existing chronic conditions in these patient groups.^{28,29} The lack of correlation between perioperative death and documented risk assessment is astonishing, given that perioperative mortality is generally neither a surprise to the surgeon nor the anesthesiologist.³⁰ To this point, the 2000 Report of the National Confidential Enquiry into Perioperative Deaths found that only 12 in 100 deaths were not expected.³¹ Finally, while all anesthesiologists documented an ASA-PS, only 1 in 20 (5%) documented the risk of either individual organ system morbidity or mortality.

According to CMS conditions of participation, the surgical patient must be examined by a physician immediately prior to surgery to evaluate the risk of anesthesia and of the procedure to be performed. Additionally, this assessment must be “specific to each patient.”³² Unfortunately, the ASA-PS score does not provide an assessment of individualized risk, it provides a population-based risk assessment and, while it is a useful *general* predictor of morbidity and mortality,³³ it lacks the ability to specifically predict organ system morbidity or mortality, and was not originally intended to be used as a measure to predict operative risk.^{34,35} It is thus surprising that the ASA-PS remains the standard for surgical risk assessment given the availability of validated, individualized risk assessment tools that provide organ specific morbidity risk in addition to the risk of 30-day mortality. Unfortunately, knowledge of individual surgical risk assessment tools remains low and, as we have demonstrated, utilization is sparse. Sadly, only 1.3% (10) of these 756 patients had morbidity or mortality risk documented alongside a named risk assessment tool, such as the ACS Risk Calculator (Table 4). Given that the Calculator is easy to access and use, and that it is available at no charge makes these findings even more surprising. Also surprising is the ASA’s continued endorsement of a population-based risk assessment tool that neither incorporates procedure type nor provides organ specific risk. The use of the ASA-PS score as a method to enhance shared-decision making and informed consent is not in line with the aforementioned Salzburg Statement, which makes clear the right of patients to be made aware of specific risks regarding their procedure.³⁶ Additionally, because the ASA-PS score does not inform clinicians about organ specific risk, appropriate, targeted preoperative medical optimization and perioperative medical management remains uninformed. Though our study was not designed to demonstrate that preoperative risk assessment improves outcomes, prospective surgical risk assessment has been shown to decrease mortality in patients undergoing both elective³⁷ and emergency surgery.³⁸ Whether the cause of reduced mortality is due to better informed perioperative medical management or patients deciding not to have surgery following informed shared-decision making remains unclear.³⁹

Our study has several potential limitations. First, the majority of our identified patients were older, hypertensive, diabetic, and either ASA-PS class 3 or 4. It is possible that surgical patients who did not meet criteria for chart selection did indeed have documented risk assessments. However, we hypothesized that if any group of patients was likely to have documented individualized risk assessment,

it would be those with co-morbidities, those who underwent emergency surgery, and those who died either intraoperatively or within 48 hours of surgery. Rather than a random selection of patients from our 2017 inpatient surgical population, we felt that identifying patients based on serious intraoperative or post-operative complications or death was the best way to identify a cohort of patients most likely to have had documented preoperative risk assessment. Furthermore, to mitigate the risk of bias from local practice patterns, including assignment of ASA-PS scores, we chose to sample a group of patients from 22 different medical centers located in 5 different States.

Conclusions

Despite being a standard of care, individualized pre-surgical risk assessments are rarely documented by either anesthesiologists or surgeons. Surgeons were more likely than anesthesiologists to document individual morbidity and mortality risk. While ASA-PS score was documented for all patients by anesthesiologists, only 1 in 20 notes authored by anesthesiologists included documentation of organ specific risk or the risk of mortality. Providing patients with individualized pre-procedural risk assessment benefits patients and their clinicians, represents good perioperative practice, is in line with the Salzburg Statement, and is our ethical responsibility. Without documented individualized risk assessment, one must question the quality of informed consent being obtained, after all, it is from this quoted prediction of risk that all perioperative discussions, decisions, and actions must surely follow. Without it, are patients able to adequately make a balanced decision whether to undergo surgery or not?

List Of Abbreviations

ISRA- Individual Surgical Risk Assessment

ASA-PS- American Society of Anesthesiology Physical Status

NACOR- National Anesthesia Clinical Outcomes Registry

ACS- American College of Surgeons

CPT- Current Procedural Terminology

POSSUM- Physiological and Operative Severity **Score** for the enUmeration of Mortality and morbidity

p-POSSUM- Portsmouth-POSSUM

SORT- Surgical Outcomes Risk Tool

Declarations

Ethics Approval and Consent to Participate

A letter from the Banner Health Research Determination Committee (RDC Project 18-003), waiving the requirement for IRB review and approval was received on March 14, 2018.

Consent for Publication

These data are completely deidentified. No individual personal data, in any format, is reported.

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Competing Interests

The authors declare that they have no competing interests.

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This project was unfunded.

Author's Contributions

JBB- Conception, design, author, data acquisition, interpretation.

BTH-Editor, author

EVS- Statistical analysis, author

AB- Statistical analysis, author

GAM- Editor

JC-Statistical analysis, author

TH- Editor, author

JS- Conception, study design

DW-Author, editor

RM-Editor and statistical design following first draft

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Tables

Table 1. Patient demographics, co-morbidities, and ASA-PS score.

	N=756
Patient Characteristic	No. (%)
Male	384 (51)
Female	372 (49)
Non-Caucasian	87 (12)
Current smoker within 1 year	147 (19)
Age Mean [SD]	65 [17]
Clinical Characteristic No. (%)	
Chronic Steroid Use	55 (7)
Preop Ascites	15 (2)
Disseminated Cancer	46 (6)
Diabetes	275 (36)
HTN Requiring Meds	523 (69)
Severe COPD	107 (14)
Acute Renal Failure	125 (17)
Ventilator Dependent	43 (6)
CHF 30 Days Prior to Surgery	91 (12)
Dialysis 14 Days Prior to Surgery	56 (7)
Sepsis within 48 hours of surgery	89 (12)
ASA Class No. (%)	
Class 1	10 (1)
Class 2	91 (12)
Class 3	327 (43)
Class 4	300 (40)
Class 5	27 (4)
Class 6	1 (0.1)
Emergent	154 (20)

Table 2. Complication distribution by ICD-10 code.

ICD-10	Description	Count	% of Total
J89	Other postprocedural complications and disorders of respiratory system, not elsewhere classified	326	43.12%
I69	Cardiac arrest, cause unspecified	268	35.45%
K90	Postprocedural (acute) (chronic) kidney failure	72	9.52%
I71	Intraoperative cardiac arrest during other surgery	26	3.44%
I821	Postprocedural cerebrovascular infarction following other surgery	26	3.44%
I820	Postprocedural cerebrovascular infarction following cardiac surgery	14	1.85%
I20	Postprocedural cardiac arrest following cardiac surgery	11	1.46%
I710	Intraoperative cardiac arrest during cardiac surgery	9	1.19%
J88	Other intraoperative complications of respiratory system, not elsewhere classified	4	0.53%
Total		756	

Table 3. Documentation of risk as a function of gender, race, time of surgery, emergency status, ASA score, age, surgical type, mortality, and author of note.

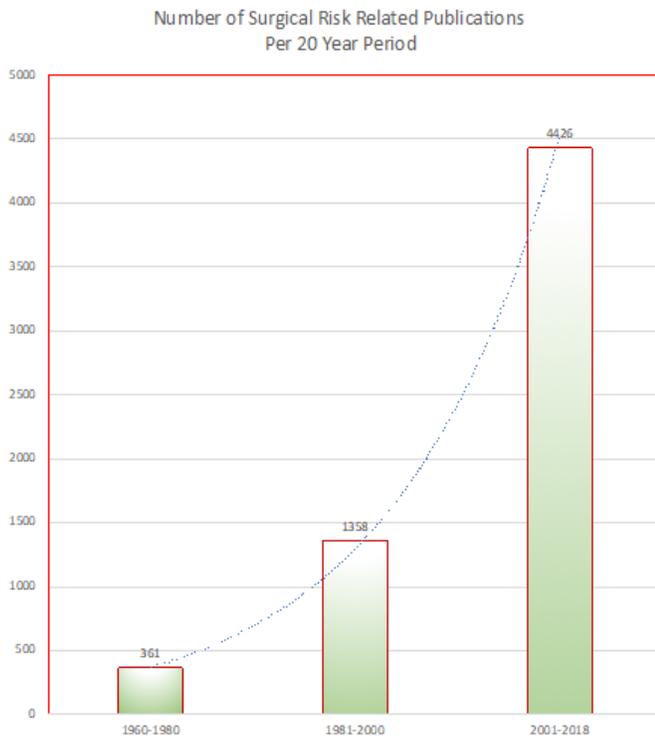
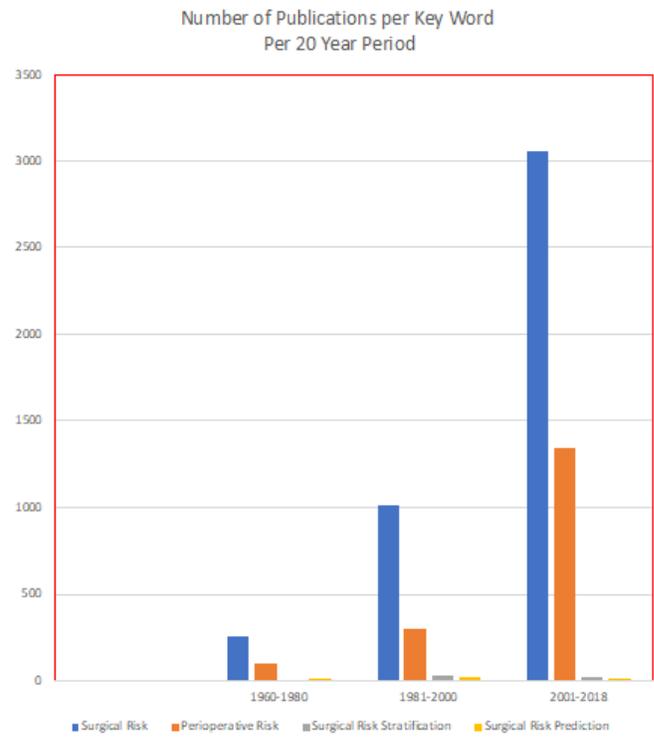
	n	Any Risk Assessment	Any Risk Assessment %	ChiSquare P-Value Logistic Regression	R-squared Logistic Regression	Odds Ratio	CI Lower 95%	CI Upper 95%
men (1)	372	71	19.09%	0.4397	0.080%	1.1576284	0.7984187	1.678447
n (0)	384	65	16.93%			0.8638351	0.5957888	1.2524756
ucasian (1)	669	114	17.04%	0.0701	0.460%	0.6068796	0.3594466	1.0246387
n-Caucasian	87	22	25.29%			1.6477733	0.9759538	2.7820547
Surgery	687	128	18.63%	0.1275	0.330%	1.745975	0.8152253	3.7393695
Surgery	69	8	11.59%			0.5727459	0.2674248	1.2266548
urgent (1)	158	19	12.03%	0.0226*	0.730%	0.5619504	0.3340147	0.9454323
n-emergent	598	117	19.57%			1.7795164	1.0577172	2.9938801
A Classes (1)	101	18	17.82%	0.9867	0.000%	0.9953661	0.575752	1.7207993
A Classes /5 (0)	654	117	17.89%			1.0046555	0.5811253	1.736859
> 65 (1)	308	45	14.61%	0.0429*	0.580%	0.671249	0.4539816	0.9924966
> 65+ (0)	448	91	20.31%			1.4897602	1.0075602	2.2027325
n- cardiovascular procedures (0)	613	99	16.15%	0.0086*	0.970%	0.551793	0.3583472	0.8496664
cardiovascular procedures (1)	143	37	25.87%			1.8122737	1.1769325	2.7905899

***Statistically Significant**

Table 4. Use of named risk assessment tools in 756 surgical patient charts.

Risk Assessment Tool Name	Anesthesiologist Note	Surgeon Note	Total
ACS	2	1	3
NSQIP	2	0	2
STS	0	5	5
Total	4	6	10

Figures

A**B****Figure 1**

Perioperative Risk Assessment Literature. Panel A depicts the increase in peer reviewed publications focused on preoperative risk assessment between 1960 and 2018. Panel B depicts the breakdown of this literature by key words. As can be seen in both panels, there is near exponential growth in peer reviewed surgical risk assessment literature between 1960 and 2018.