Reliability of Surgical Apgar Score (SAS) in Predicting Immediate Post-Operative Extubation and Intensive Care Unit Admission After Major Abdominal Surgeries: A Single Center Three-Year Retrospective Study*

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ABSTRACT

Background: Surgical Apgar Score (SAS) is a simple, inexpensive, and readily available ten-point scoring system using patient's parameters which include surgical blood loss, lowest recorded mean arterial pressure (MAP) and lowest intraoperative heart rate in predicting 30-day post-operative morbidities. This study determined the reliability of SAS in predicting immediate post-operative extubation and immediate intensive care unit (ICU) admission among patients who underwent major abdominal surgeries in a tertiary hospital in Iloilo City.

Methods: A descriptive retrospective cross-sectional study conducted in a tertiary hospital in Iloilo City included patients aged 19 and above who underwent major abdominal surgery from January 1, 2017 to December 31, 2019, and met the study's inclusion criteria. Purposive sampling was utilized. Demographics, clinical data, intraoperative data, management as well as treatment course, post-operative course and patient outcome were extracted, and data collected were utilized for data processing and analysis. Frequency count, mean and standard deviation were utilized for descriptive statistics; T- test and One-way Analysis of Variance (ANOVA) were utilized to determine statistical difference among groups. Logistic regression analysis was employed to assess association between SAS and immediate extubation and post-op ICU admission. Statistical Package of the Social Sciences (SPSS) software version 23.0 was utilized for statistical computations. A probability level of $p<0.05$ was utilized to determine statistical significance.

Results: The study consisted of 221 patients predominantly female 64.3 % (n=142) with the mean age of 55.80 ± 17.53. Mean SAS was 6.79 ± 1.3 with a total of 13 (5.9%) patients who were classified as high risk (SAS 0-4), 152 (68.8%) patients as medium risk (SAS 5-7) and 56 (25.3%) patients as low risk with SAS 8-10. On logistic regression analysis, mean arterial pressure (MAP), lowest heart rate and estimated blood loss were significantly associated with decision to do immediate post-operative extubation and immediate ICU admission ($p<0.001$). Those with higher MAP were 1.19 times more likely to be extubated (OR 1.199, CI: 1.078-1.334, $p<0.001$) and higher estimated blood loss more likely to be admitted in the ICU (OR 1.006, CI: 1.004-1.009, $p<0.001$). Lastly, those with higher heart rates were 1.2 times more likely to be admitted in the ICU post-

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operatively. Low-Risk SAS (Score of 8-10) is predictive of immediate post-operative extubation with 97.7% sensitivity and 75.6% specificity. High Risk SAS (score of 0-4) is predictive of immediate post-operative ICU admission with a sensitivity of 76.1% and 98.3% specificity.`

Conclusion: SAS is a reliable and valid predictive tool in determining immediate post- operative extubation and ICU admission among patients undergoing major abdominal surgeries. Multicentric, longitudinal and prospective studies are further required to confirm results.

Keywords: Surgical Apgar Score (SAS), extubation, intensive care, critical care, abdominal surgery

INTRODUCTION

Major intra-abdominal surgeries include surgeries involving manipulation of the gut either by resection, stoma formation and/or anastomosis1 are associated with high rates of post-operative complications.[2] International studies showed that emergency laparotomy is a common procedure with a high risk for morbidity and mortality. In a study done in UK by Barrow, et al., in 2013, laparotomy carries a 30-day mortality rate of 14.9%.[3] Various complications following these surgeries are very common to see and may require invasive treatment and intensive care management.1 Meanwhile, tracheal extubation in anesthesia and in the critical care setting is an important milestone for patient recovery but carries a considerable risk of complication or failure.[4] Extubation at the end of anesthesia may be associated with complications which may be transient and easily corrected or may be persistent and require intubation.[5] Anesthesia practitioners need to stratify extubation risk pre-emptively and establish an extubation plan.[6] If a patient has had a labile intraoperative course, extubation in the operating room immediately at the end of surgery should be delayed and taken into the Post-anesthesia Care Unit (PACU) or Intensive Care Unit (ICU) for further stabilization prior to extubation.[4] Thus, extubation at the end of surgery and anesthesia is always elective, planned and executed when physiologic, pharmacologic and contextual conditions are optimal.[7]

Admission of post-operative surgical patients to Intensive Care Unit may affect outcomes and prevent post-operative complications and death. Timely ICU admission of high-risk patients improved survival. Tharusan et al., in 2018 found out that a large proportion of post-operative mortality occurs in a small, distinct group of patients with high- risk characteristics, and <15% were admitted to ICU post-operatively.[8] In a study, the overall mortality rate for patients with direct to ICU admission after surgery was 19%, while the initial admission to the ward with ICU transfer had nearly twice the mortality rate (39%).9 In another study by Sobol, et al., in 2013 of the total cohort, 8.7% were transferred directly from operating room to the ICU after surgery with 8.4% of these patients with immediate ICU admission died during hospitalization.10 The capability to predict ICU admission for more than 24 hours after operation would help physicians to define the post- operative patient disposition plan prior to surgery and therefore healthcare resource allocation. This could improve patient's outcome by reducing failure to rescue events and improve efficiency of the valuable ICU bed allocation.[8] With limited resources and increase in demand of ICU admission, the need for precise identification of patients requiring intensive care after surgery may facilitate proper allocation of resources and improve post- operative outcomes.[10] Appropriate triaging of patients is an imperative step in the management of surgical patients. Therefore, intensivists, surgeons, and anesthesiologists must make post-operative triage decisions on whether a patient should need and intensive care, and identify high-risk patients appropriate for ICU admission by the end of surgery.[10]

Pre-operative and intraoperative factors play an important part of the post-operative outcomes of surgical patients. Despite advancement in technology, and various predictive scoring systems to prognosticate post-operative outcomes, the perioperative period still poses an increased risk among patients undergoing major surgery. A surgical risk scoring is a vital parameter in predicting post-operative outcomes in planning admission to the intensive care unit (ICU), to prognosticate general condition of a surgical patient and to plan specific interventions postoperatively.[11] The APACHE and POSSUM scoring systems have been used as clinical measures to predict patient risks. These models are noted to provide adequate predictions. But the numerous data elements needed, and laboratory make these models complex. Surgical Apgar Score (SAS) by Gawande et al., in 2007 is a ten-point scoring system relying on the following patient's parameters: surgical blood loss, lowest recorded mean arterial pressure (MAP) and lowest intraoperative heart rate. This scoring system is simple, inexpensive, and readily available even in low resource settings which can reliably predict post-operative outcomes using only three variables and has been used to accurately predict early and 30-day post-operative complications in major surgeries[12] with scores of 0-4 at high risk, scores 5-7 medium risk and scores of 8-10 as low risk.[13] This study sought to determine the reliability of the Surgical Apgar Score (SAS) as a predictive scoring system in determining immediate post-operative intensive care unit admission and further validate the utilization of SAS as an additional criterion in guiding immediate post-operative extubation.

Materials and Methods

This descriptive retrospective cross-sectional study utilized primary data from the medical records section of a tertiary hospital in Iloilo City. In this study, data of patients who underwent major abdominal surgery between January 1, 2017 to December 31, 2019 who met the inclusion criteria were collected from the medical records section of a tertiary hospital in Iloilo City.

All patients who underwent major abdominal surgery as identified in the study and who met the study's inclusion criteria were included. Purposive sampling was utilized. Relevant patient data were utilized for the study.

Inclusion and Exclusion Criteria

Adult patients 19 years old and above who underwent major abdominal surgery under general anesthesia (intravenous or inhalational) and/or combined general and regional anesthesia. Major abdominal operations as defined in the study include operations done using midline abdominal incision which may include the following: gastric, small and large intestinal surgery, hepatobiliary and pancreatic surgeries, exploratory laparotomies. Only patients with medical records documented in the medical records section of the tertiary hospital in Iloilo City from January 1, 2017 to December 31, 2019 were included.

Patients less than 19 years old, those who underwent surgeries under regional anesthesia were excluded from the study. Patients who underwent exploratory laparotomies for multiple trauma (gunshot, etc), abdominal surgeries for vascular or renal or urologic procedures and those who had abdominal surgeries done using incision other than midline abdominal incision as well as gynecologic abdominal surgeries were not included in the study. Furthermore, patients who were initially admitted to the ICU complex or was planned to be admitted at the ICU complex prior to the surgery and those who were intubated outside of the operating room prior to surgery were not included in the study.

Data Collection Procedure / Maneuver

A descriptive retrospective cross-sectional study was conducted in a tertiary hospital in Iloilo City. The proposal was submitted for evaluation and approval by the Unified Research Ethics Review Committee (URERC). Upon approval, a letter of request was sent to the Department of Surgery to obtain a copy of yearly census of surgical cases from 2017 to 2019. A letter of request was sent to the medical records section head of the tertiary hospital in Iloilo City to authorize the researcher to use and obtain the medical records of the patient. ICD code and/or RVU code of cases were generated from the medical records section. Patients who qualify with the study's inclusion criteria were identified. Individual patient chart was reviewed, and the clinical and laboratory data were extracted for analysis. Demographics, clinical data, intraoperative data, management as well as treatment course, post-operative course, and patient outcome were extracted from the medical records. Data collected was utilized for data processing and analysis. Only the records allowed for disclosure were utilized in the study.

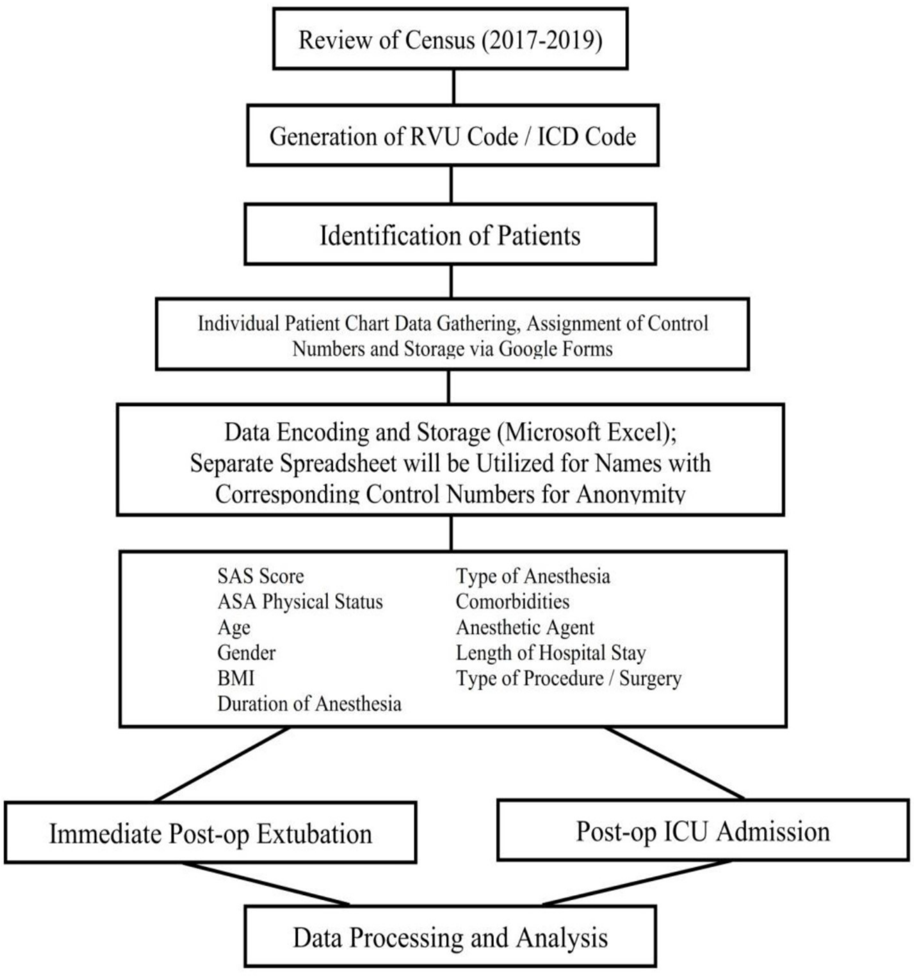

Figure 1. Data gathering algorithm

Data Processing and Analysis

Descriptive statistics was reported as means with standard deviations for continuous quantitative variables while frequency counts and percentages for categorical qualitative variables.

Categorical variables were compared using the Chi-square test or Fisher's exact test as appropriate, and continuous variables were compared using Student's t-test and the Mann-Whitney U test when applicable. For variables with more than 3 groups, one- way ANOVA was utilized. Logistic regression was employed to predict immediate post-operative extubation and ICU admission. Variables with a p value of < 0.05 on univariate analysis were entered into a multivariate logistic regression analysis using backward elimination, with 95% confidence intervals calculated using Bonferroni correction to account for multiple comparisons.

A probability level of p<0.05 was considered to be statistically significant and all tests were two-sided. All statistical analyses and graphs were generated using SPSS 23.0 and GraphPad Prism 5.

RESULTS

Table 1. Clinicodemographic profile of patients who underwent major abdominal surgeries (N=221).

	n	mean±SD or %
Gender		
Male	79	35.7%
Female	142	64.3%
Age		55.80 ± 17.537
Weight (kgs)		54.68 ± 11.78
Height (cm)		159.03 ± 7.63
BMI (kg/m²)		21.14 ± 3.75
ASA Physical Status		
II	126	57.0%
III	82	37.1%
IV	13	5.9%
Urgency of Procedure		
Elective	164	74.2%
Emergency	57	25.8%
Comorbidities		
Hypertension/CAD	22	10.0%
CHF/MI/Ischemic HD	12	5.4%
Diabetes/Obesity/Dyslipidemia	14	6.3%
Respiratory (pneumonia, asthma, tuberculosis, etc.)	28	12.7%
Smoking / Alcohol Use	17	7.7%
Infection / Sepsis	41	18.6%
Anemia/Coagulopathy	4	1.8%

Table 1. Clinicodemographic profile of patients who underwent major abdominal surgeries (N=221).

Comorbidities	n	mean±SD or %
Malignancy	28	12.7%
Malignancy + Hypertension/CAD	12	5.4%
Malignancy + Respiratory	17	7.7%
Malignancy + Anemia /Coagulopathy	17	7.7%
Malignancy + Infection	9	4.1%
Anesthesia Duration		
<2	18	8.1%
2-6	184	83.3%
≥6	19	8.6%
Type of Anesthesia Used		
General (Intravenous)	14	6.3%
General (Inhalational)	97	43.9%
General – Spinal	8	3.6%
General – Epidural	102	46.2%
Anesthetic Agent Used		
Fentanyl+Midazolam+Atracurium	13	5.9%
Sevoflurane + Oxygen	98	44.3%
Ropivacaine + sevoflurane + oxygen	96	43.4%
Bupivacaine + sevoflurane + oxygen	14	6.3%
Length of Hospital Stay		
<7	18	8.1%
7-14	82	37.1%
>14	121	54.8%
Types of Surgery		
Adhesiolysis/Lavage/ Enterolysis	56	25.3%
Small Bowel Surgery	78	35.3%
Large Bowel Surgery	46	20.8%
Omental Biopsy / Patching	19	8.6%
Pancreatic Surgery	4	1.8%
Gastric Surgery	16	7.2%
Splenic Surgery	2	0.9%
SAS Group / Score		
High Risk (0-4)	13	5.9%
Medium Risk (5-7)	152	68.8%
Low Risk (8-10)	56	25.3%
Estimated Blood Loss		268.24 ± 254.32
Lowest MAP		68.25 ± 7.00
Lowest Heart Rate		74.92 ± 14.47
Surgical Apgar Score / SAS		6.79 ± 1.3

This study aimed to determine the reliability of SAS in predicting immediate post- operative extubation and ICU admission in the perioperative setting in a tertiary hospital in Iloilo City. A total of 221 patients met the study's inclusion criteria. All individual patient records were reviewed and necessary data were extracted.

Demographic profile of the patients in the study showed a total of 35.7% (n=79) male and 64.3 % (n=142) female with the mean age of 55.80 ± 17.53. Majority of the patients (46.6%) had an ideal body weight (18.5-22.9). Mean BMI of the total study sample is 21.14 ± 3.75 which is within the ideal body weight category.

According to ASA Physical Status Score, a total of 126 (57%) were classified as ASA-PS II, 37.1% (n=82) and 5.9% (n=13) were classified as ASA-PS III and IV respectively. A total of 57 (25.8%) patients had emergency surgeries while most of the patients had elective surgery (74.2%).

Patients who have sepsis comprised majority of the patients when grouped according to their comorbidities (n=41 or 18.6%). A large portion of the population had a duration of surgery of two to six hours (83.3%) while 8.1% and 8.6% had a surgical duration of <2 hours and >6 hours respectively.

Small bowel surgeries (n=78, 35.3%) followed by adhesiolysis/lavage (n=56, 25.3%) and large bowel surgeries (n=46, 20.8%) were the top three surgery done to the patients. A small portion of the population had splenic (n=2, 0.9%) and pancreatic (n=4, 1.8%) surgeries. As for the length of hospital stay, majority of the patients were hospitalized for >14 days (n=121, 54.8%) while 18 patients (8.1%) had less than seven day hospitalization and 82 patients (37.1%) had 7-14 days of hospital stay.

A total of 102 (46.2%) patients had combined general-epidural anesthetic technique with ropivacaine - sevoflurane - oxygen as anesthetic used for maintenance (n=96, 43.4%). Meanwhile, 97 (43.9%) and 13 (5.9%) patients had general inhalational and general intravenous anesthetic technique respectively using sevoflurane-oxygen as maintenance gas (n=98, 44.3%) and fentanyl-midazolam-atracurium as maintenance intravenous anesthetic (n=13, 5.9%).

When grouped according to Surgical Apgar Score, a total of 13 (5.9%) patients were high risk (SAS 0-4), 152 (68.8%) patients as medium risk (SAS 5-7) and 56 (25.3%) patients were low risk with SAS 8-10.

Estimated blood loss is 268.24 ± 254.32, with mean lowest heart rate and mean lowest MAP of 74.92 ± 14.47 and 68.25 ± 7.00, respectively. Mean surgical apgar score in the study is 6.79 ± 1.3.

Table 2. Patient characteristics as stratified according to SAS category.

Variable	High Risk (SAS 0-4)	Medium Risk (SAS 5-7)	Low Risk (SAS 8-10)	p value
Sex				
Male	5	54	20	
Female	8	98	36	0.978
BMI (kg/m^2)				
Underweight (<18.5)	0	37	12	
Normal (18.5-22.9)	9	66	28	
Overweight (23.0-24.9)	1	28	9	0.337
Obese (≥25)	3	21	7	
ASA Physical Status				
II	1	85	40	
III	10	56	16	<0.001
IV	2	11	0	
Urgency of Surgery				
Emergency	11	119	34	
Elective	2	33	22	0.025
Comorbidities				
Hypertension/CAD	0	12	10	
CHF/MI/Ischemic HD	1	8	3	
Diabetes/Obesity/Dyslipidemia	0	10	4	
Respiratory (Pneumonia, asthma, tuberculosis, etc.)	1	25	2	
Smoking / Alcohol use	0	9	8	
Infection / Sepsis	8	25	8	0.031
Anemia / Coagulopathy	0	4	0	
Malignancy	0	21	7	
Malignancy + Hypertension/CAD	0	8	4	
Malignancy + Respiratory	1	12	4	
Malignancy + Anemia	1	12	4	
Malignancy + Infection	1	6	2	
Anesthesia Duration				
<2 hours	0	11	7	
2-6 hours	11	127	46	0.409
>6 hours	2	14	3	
Type of Anesthesia				
General (Intravenous)	5	9	0	
General (Inhalational)	6	75	16	
General – Epidural	1	63	38	<0.001
General – Spinal	1	5	2	
Anesthetic Agent Used				
Fentanyl + Midazolam + Atracurium	5	8	0	
Sevoflurane + oxygen	6	76	16	
Ropivacaine + sevoflurane + oxygen	2	57	37	<0.001
Bupivacaine + sevoflurane + oxygen	0	11	3	
Length of Hospital Stay				
<7	2	13	3	
7-14	2	50	30	0.030
>14	9	89	23	
Type of Surgery				
Adhesiolysis/Lavage/ Enterolysis	1	38	17	
Small Bowel Surgery	7	47	24	
Large Bowel Surgery	3	37	6	
Omental Biopsy / Patching	0	16	3	0.020
Pancreatic Surgery	1	3	0	
Gastric Surgery	0	10	6	
Splenic Surgery	1	1	0	
Immediate Post-op Extubation				
No	13	32	0	
Yes	0	120	56	<0.001
Post-op ICU Admission				
No	0	119	56	
Yes	13	33	0	<0.001

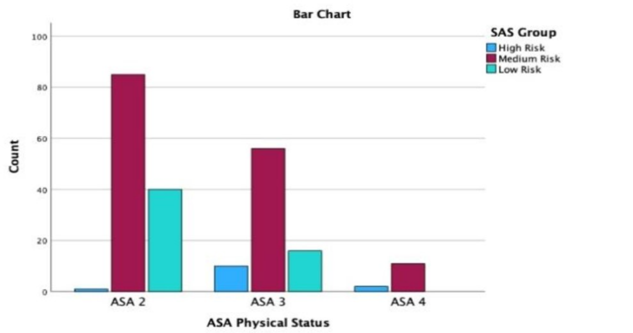

Figure 2. Distribution of patients according to ASA Physical Status and SAS Category.

Of the 221 patients, 126 (57%) were scored as ASA 2, 82 (37.1%) under ASA 3 and 13 (5.9%) as ASA 4. When stratified according to SAS group, ASA score is significantly different between the groups (p<0.001) such that, the higher the ASA score the lower the SAS or categorized as High risk.

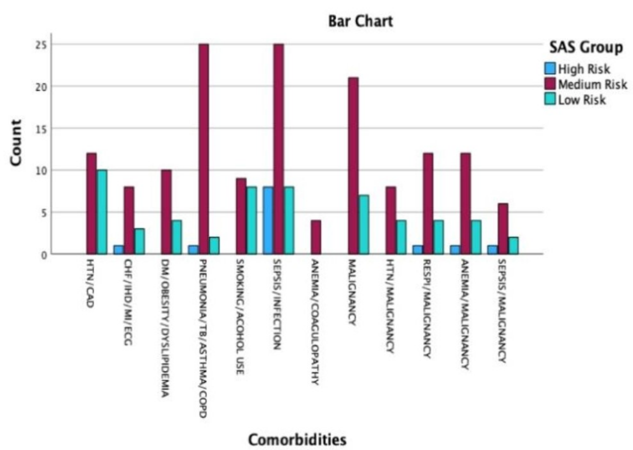

Figure 3. Distribution of patients according to comorbidities and SAS Category.

Stratifying the patients according to comorbidities showed significant difference between the groups (p=0.031) with sepsis more likely associated with high risk SAS.

Furthermore, stratifying the SAS group as to the urgency of surgery revealed a significant difference (p=0.025) showing that Emergency Surgeries have lower SAS (Figure 4.).

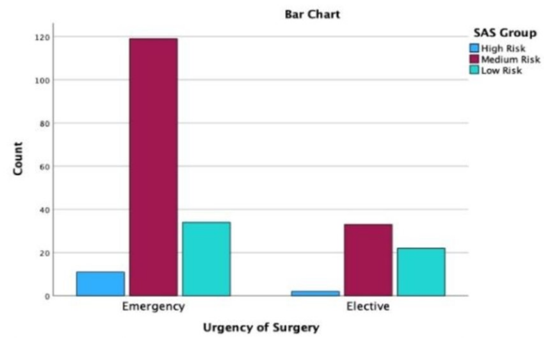

Figure 4. Distribution of patients according to urgency of surgery and SAS category.

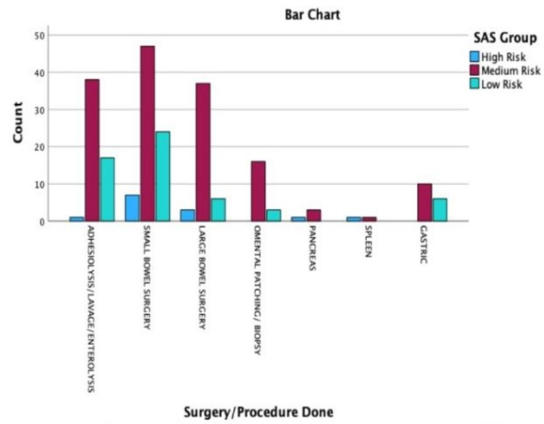

Figure 5. Patient distribution according to procedure and SAS category.

Classifying SAS group as to the type of surgery showed significant difference (p=0.020) with small and large bowel surgeries more likely associated with low surgical apgar score (high risk).

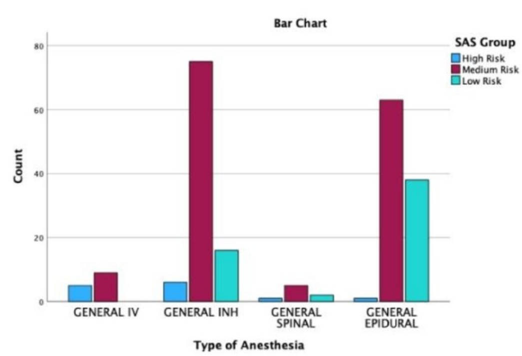

Figure 6. Patient distribution according to type of anesthesia and SAS category.

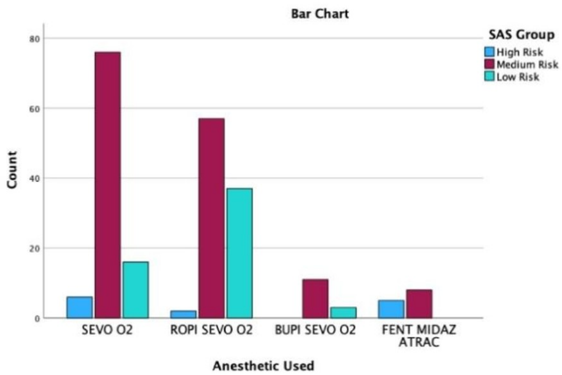

Figure 7. Distribution of patients according to anesthetic agent used and SAS category.

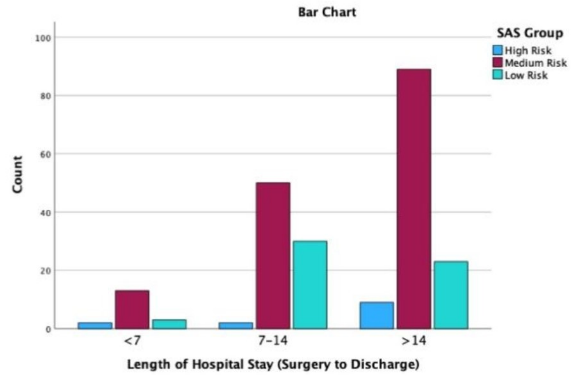

Figure 8. Patient distribution according to length of hospital stay (surgery to discharge).

Consequently, the type of anesthetic technique and anesthetic agents used are significantly different between groups ($p<0.01$). Consistently, High Risk SAS is associated with

General Intravenous and General Inhalational anesthetic technique with fentanyl-midazolam- atracurium and sevoflurane-oxygen anesthetic agents as maintenance, respectively.

Stratifying SAS groups further revealed that length of hospital stay is significantly different between groups, with longer hospital stay (>14 days) linked with high risk SAS (SAS of 0-4).

Variables such as gender, BMI, age as well surgical duration showed no significant difference between groups.

Table 3. Variables when classified according to SAS category.

Variable	High Risk (mean±SD)	Medium Risk (mean±SD)	Low Risk (mean±SD)	p value
Age	46.85 ± 19.39	55.94 ± 17.36	57.50 ± 17.27	0.114
Weight	58.85 ± 9.31	54.44 ± 12.14	54.37 ± 11.27	0.276
Height	159.77 ± 7.15	158.68 ± 7.64	159.80 ± 7.77	0.678
BMI	22.43 ± 3.27	21.21 ± 3.88	20.64 ± 3.47	0.283
Estimated Blood Loss	761.54 ± 459.23	271.51 ± 215.45	144.82 ± 110.43	<0.001
Lowest MAP	59.08 ± 8.48	68.70 ± 6.97	69.16 ± 5.055	<0.001
Lowest Heart Rate	101.15 ± 10.03	76.76 ± 13.35	63.84 ± 5.39	<0.001

Surgical Apgar Score relies on three intraoperative factors: lowest heart rate, lowest mean arterial pressure and estimated blood loss. When stratified according to SAS group, estimated blood loss, lowest MAP and lowest heart rate significantly differed between groups ($p<0.001$).

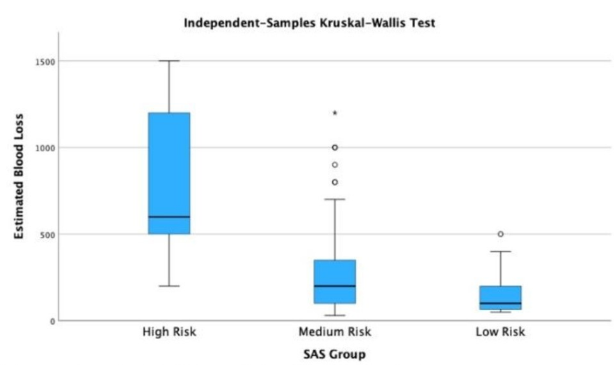

Figure 9. Box plot of Estimated blood loss across SAS group.

Figure 9 revealed that on post hoc analysis, High Risk SAS has higher estimated blood loss than Medium Risk SAS (p<0.001) and Medium Risk SAS has higher estimated blood loss than Low Risk SAS (p<0.001).

Furthermore, post hoc analysis of SAS groups and lowest mean arterial pressure revealed that, High Risk SAS has lower MAP when compared to Medium and Low Risk SAS (p<0.001) but Low Risk to Medium Risk SAS has no significant difference (p=0.582) as shown in Figure 10.

Consistently, post hoc analysis of SAS group and Lowest Heart Rate showed that High Risk SAS has higher heart rate than both Medium and Low Risk SAS (p<0.001) and Medium Risk SAS has higher heart rate when compared to Low Risk SAS (p<0.001) as seen in Figure 11.

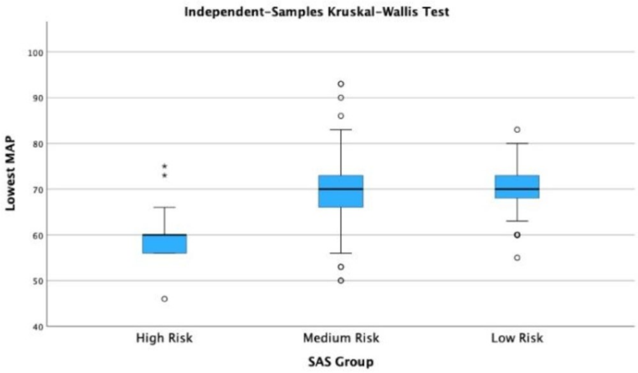

Figure10. Box plot of Lowest MAP across SAS group.

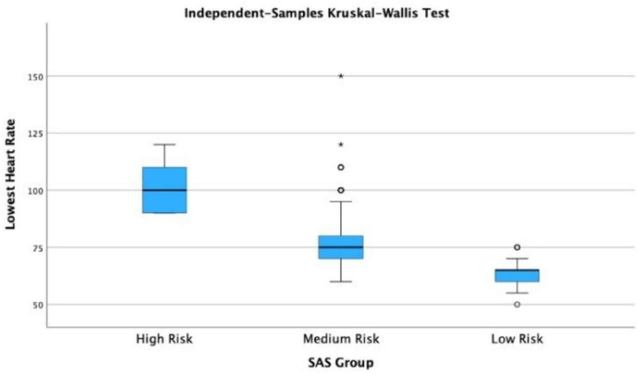

Figure 11. Box plot of Lowest heart rate across SAS group.

Table 4. Variables Associated with Immediate Post-op Extubation by Logistic Regression with Odds Ratio and 95% Confidence Interval (CI).

Variable	Odds Ratio (CI 95%)	p value
Estimated Blood Loss	0.994 (0.991-0.996)	<0.001
Lowest MAP	1.199 (1.078-1.334)	<0.001
Lowest Heart Rate	0.807 (0.754-0.864)	<0.001

Patients with higher mean arterial pressure (MAP) is 1.19 times more likely to be extubated immediately post-op (OR 1.199, CI: 1.078-1.334, p<0.001).

Table 5. Variables Associated with Immediate ICU Admission by Logistic Regression with Odds Ratio and 95% Confidence Interval (CI).

Variable	Odds Ratio (CI 95%)	p value
Estimated Blood Loss	1.006 (1.004-1.009)	<0.001
Lowest MAP	0.809 (0.724-0.902)	<0.001
Lowest Heart Rate	1.247 (1.162-1.338)	<0.001

Patients with higher estimated blood loss more likely to be admitted in the ICU (OR 1.006, CI: 1.004-1.009, p<0.001). Those patients with higher heart rates are 1.2 times more likely to be admitted in the ICU post-operatively.

Table 6. Sensitivity and specificity of SAS in predicting immediate post-op extubation and ICU admission.

Outcome	Sensitivity	Specificity
Immediate Post-op Extubation	97.7%	75.6%
Post-op ICU Admission	76.1%	98.3%

The study revealed that Low Risk SAS (SAS of 8-10) predicts immediate post-operative extubation. This has a 97.7% sensitivity and 75.6% specificity with a positive predictive value of 93.98% and a negative predictive value of 89.47%.

High Risk SAS (score of 0-4) predicts immediate post-operative admission with a sensitivity of 76.1% and 98.3% specificity with a positive predictive value of 92.10% and a negative predictive value of 93.98%.

DISCUSSION

Almost 250 million surgeries are performed worldwide annually and this number is rapidly increasing. With the increasing trend in access to surgery, the rates of post-operative complications increases as well, making delivery of safe surgical care a public health concern. Identifying patients at high risk for morbidity and mortality leads to changes in management and outcome improvements.[14,15]

An ideal scoring system in predicting post-operative outcomes should be simple and readily applicable to all surgical patients.[13] Several risk scoring systems exist in predicting surgical outcomes. Accurate surgical risk prediction is paramount in shared decision making in the clinical setting.[14]

Multiples studies internationally validated the use of SAS as a predictor of 30-day mortality and morbidity among various surgical specialties and subspecialties such as gynecologic, orthopaedic, neurologic and major general surgeries among others. In a local study by Santos, et al., in 2011, SAS is a simple scoring system derived from readily available intraoperative data which can predict high risk patient groups for major post-operative complications among patients who underwent major surgeries.[16]

In the study presented, patients who underwent major abdominal surgeries/ laparotomies using midline incision were included with malignancy and post operative adhesions as the most common indication for surgery. Small and large bowel surgeries such as resection and diversion procedures are among the most common surgery performed.

This study utilized the SAS as a predictor of immediate ICU admission and an adjunct in deciding immediate post-operative extubation and revealed that SAS is a reliable predictive tool in prognosticating immediate post-operative extubation and ICU admission among patients who underwent major abdominal surgeries. Furthermore, it can be used as an additional parameter in decision-making regarding extubation.

Logistic regression analysis of the study revealed that SAS is associated with immediate post-operative extubation and ICU admission such that, low SAS (0-4) or High Risk category is more likely to be admitted in the ICU and warrants the use of ventilator post-operatively. This is consistent with the study of Yusufali, et al., in 2016 citing that low SAS are associated with post-operative complications such as ICU care as well as ventilator use. Furthermore, mortality as well as post-operative need of ICU care was associated with high risk SAS category demonstrating the ability of SAS to predict post-operative ICU admission and ventilator use.[13]

ASA physical status score is a classification system developed by the American Society of Anesthesiologists to offer clinicians a simple categorization of a patient's physiological status that can be helpful in predicting operative risk.17 This study showed that higher ASA score is likely associated with low SAS score. This is consistent with a study by Sobol, et al., wherein higher ASA physical status score were 8 times more likely to go to ICU after surgery.[10]

The presence of comorbidity was found to have association with SAS and adverse outcome post-operatively. This is consistent with Zara Ali's study showing that the presence of comorbidity is likely associated with post-operative complications.[18] As seen in the results, the presence of sepsis among other comorbidities is associated with High Risk SAS category (p=0.031).

Emergency surgeries in the study were found out to be associated with low SAS. This is consistent with previous studies: emergency procedures were almost 5 times as likely to be admitted to ICU 3 and sustain post-operative morbidity and mortality.[15]

In the study, type of surgery (small and large bowel surgeries) were associated with low SAS. This is consistent with the previous study of Sobol et al., stating that the type of surgery was associated with higher probability of ICU admission (esophagectomy, Whipple and hepatectomy among others) as compared to bowel surgery. However in the present study, bowel surgeries (large and small bowel) were more likely associated with high SAS category mainly because the study limited the type of surgery into midline abdominal surgeries and that a smaller sample size was included as compared to the study by Sobol et al.

In the study presented, gender, BMI as well as age were found out to show no significant differences between groups. This finding is somehow in line with a 2016 study by Ali et al., on SAS as a predictor of postoperative complications in gynecologic surgery revealing that age (p=0.114) and BMI (p=0.337) are not associated with the likelihood of postoperative complications.[18] A study by Kinoshita et al., also agreed with the findings in the study: age, gender and BMI are not associated with postoperative events.[19] These findings however are in contrast with Ngarambe, et al., revealing that age is associated with higher mortality risk[15]. This may be due to the association of various comorbidities with older age group.

Various relative indications for intensive care unit admission exists which explain variations in utilization of intensive care unit resources and post-operative admission criteria across institutions. In the surgical populations, initial post-operative triage has important implications for clinical outcomes.[8] Predicting the risk for ICU admission post-operatively aids in determining post-operative disposition and healthcare resource allocation.[14] Objective variables such as mean arterial pressure, lowest heart rate and estimated blood loss intraoperatively among others help in the anesthesiologists and surgeons' clinical judgment on ICU resource allocation and decision on extubation immediately post-op. Surgical risk scoring is important in predicting post-operative outcomes, prognosticate patients' general conditions and plan out specific interventions post-operatively.11 Surgical Apgar Score is a simple risk scoring system easily applicable in low resource setting that can predict post-operative outcomes. In the study presented, SAS is a reliable predictor of immediate post-operative extubation and ICU admission.

Previous studies are consistent with the study's findings. In-hospital mortality and complications increased as SAS decreased with high risk categories more likely associated to sustain morbidity and mortality post-operatively.[15] A SAS of 0-4 was associated with immediate admission to critical care unit.20 Moreover, a Philippine study by Santos, et al., in 2011 showed that major complications were associated with SAS of less than 6.16 Sobol et al., further supports the study findings stating that there was a clear association between SAS and the decision to admit to ICU. Patients with SAS of 0-2 were 14 times more likely to be admitted to ICU compared with SAS 7-8.10 This is consistent with the present study showing that a SAS of 0-4 (High Risk SAS) is more likely to be admitted in the ICU. Factors such as MAP, intraoperative estimated blood loss and heart rate were the factors noted to increase the likelihood of ICU admission.

This present study revealed that Low Risk SAS (Score of 8-10) predicts immediate post-operative extubation with 97.7% sensitivity and 75.6% specificity. High Risk SAS (score of 0-4) predicts immediate post-operative admission with a sensitivity of 76.1% and 98.3% specificity.

The following conclusions were made after conducting the study: First, the Surgical Apgar Score (SAS) is a simple, readily applicable and reliable predictive tool in determining immediate post-operative extubation and Intensive Care Unit (ICU) admission after major abdominal surgeries in a tertiary hospital in Iloilo City. SAS relies on three intraoperative factors: lowest heart rate, lowest mean arterial pressure and estimated blood loss and when grouped according to SAS category these variables significantly differed between groups. High Risk SAS category (SAS of 0-4) is associated with delayed extubation and post-operative ventilator use and immediate post-operative ICU admission. Low Risk SAS category (SAS of 8-10) is associated with immediate extubation post-operatively and ward admission. On the other hand, further correlation with other parameters such as comorbidities, hemodynamic status, extent and complexity of surgical procedure among others, in deciding for immediate extubation and ICU admission is warranted for patients under Medium Risk SAS Category (SAS of 5-7).

Second, Low SAS corresponds to High Risk SAS category which is predictive in prognosticating immediate post-operative ICU admission. The predictive model achieved a sensitivity of 97.7% and a specificity of 75.6%. Third, Low SAS score (High Risk SAS) was also a valid parameter in deciding whether patients can be extubated immediately post-operation. SAS can be utilized in conjunction with other extubation criteria/parameters as an adjunct in determining extubation.

Lastly, SAS is an acceptable tool in predicting post-operative outcomes using intraoperative objective parameters: heart rate, blood loss and mean arterial pressure. SAS is a simple, readily applicable and reliable tool that can be an additional parameter to guide anesthesiologists and surgeons in guiding perioperative decision-making.

In low resource settings, the use of SAS as a predictive tool in guiding extubation and triaging patients in ICU can help mitigate the burden on prioritizing and proper allocation of healthcare resources. Additional studies can be done to further validate the use of SAS in predicting post-operative outcomes in various demographic, clinical and time periods in a prospective study design. Moreover, it is necessary that the tool should be utilized and validated in larger samples and various populations.

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