ORIGINAL ARTICLE

Accuracy of Surgical APGAR Score in Predicting the Severity of Postoperative Complications Following Emergency Abdominal Surgery

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ABSTRACT

Objective: The objective of this study was to determine the accuracy of the Surgical Apgar Score in predicting the severity of postoperative complications following emergency abdominal surgery, using actual postoperative events as the gold standard.

Methodology: A total of 231 patients aged 14–75 years undergoing emergency abdominal surgery under general anesthesia were enrolled using consecutive sampling. Variables such as intra-operative lowest heart rate, least MAP (mean arterial pressure) as well as estimated blood loss were recorded in order to calculate the SAS. Complications following surgery were classified in accordance with the Clavien–Dindo Classification over a 30-day follow-up. Diagnostic accuracy of SAS was calculated by specificity, sensitivity, PPV (positive predictive value) , NPP (negative predictive value), as well as the ROC (receiver operating characteristic) curve analysis. Data were stratified by demographic and clinical factors to evaluate the consistency of SAS performance.

Results: The mean SAS was 5.8 ± 2.9. High-grade complications (Clavien–Dindo III–V) occurred in 47.2% of patients. SAS shown with sensitivity = 74.3%, specificity = 67.2%, PPV = 58.3%, NPV = 80.4%, and diagnostic accuracy = 69.7%. The area under curve was 0.75 (95% CI: 0.69–0.81, $p < 0.001$). Stratified analyses confirmed stable performance across subgroups.

Conclusion: The Surgical Apgar Score is a reliable, simple tool that can predict the severity of postoperative complications after emergency abdominal surgery, facilitating early risk stratification and guiding perioperative care.

Keywords: Clavien–Dindo Classification, Diagnostic Accuracy, Emergency Abdominal Surgery, Postoperative Complications, Surgical Apgar Score

Authors' Contribution:
[1,2]Conception; Literature research; manuscript design and drafting; [3,4]Critical analysis and manuscript review; [5,6]Data analysis; Manuscript Editing.

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Introduction

To guarantee high-quality surgical care, postoperative complications unwanted outcomes of surgery must be reduced.[1] Because these problems are linked to worse outcomes and higher healthcare costs, they continue to be an important issue for the health care system as well as patients as a whole.[2] The Clavien-Dindo Classification (CDC) was used to document postoperative complications in research by Singh et al. involving 318 patients who had emergency abdominal surgery. A 33% total significant complication rate was found in the retrospective analysis.[3] One of the main objectives of every surgical surgery is to minimize postoperative problems. Effective perioperative care combined with careful, objective patient evaluation is crucial. Patients who have already experienced severe physiological stress and hemodynamic instability due to conditions like massive bleeding, electrolyte disturbance, systemic inflammatory response, or sepsis are usually candidates for emergency laparotomy, considered one of the most common but risky surgical procedures.[4] These patients are therefore at an increased risk of developing serious postoperative complications and experiencing higher mortality rates.

By taking into account a number of variables, including baseline morbidity, risk scoring systems offer a consistent way to measure a patient's chance of experiencing complications.[5] Of these scoring systems, the Surgical Apgar Score (SAS) serves as a practical, affordable, quick, and impartial method of forecasting surgical results. The SAS is a 10-score standardized scoring system utilizing three easily recorded intraoperative hemodynamic variables that was first presented by Gawande et al. in 2007. Patients are divided into three groups: low-risk, medium-risk, and high-risk. The high-risk group (SAS 0–4) has a 16-fold higher risk of significant problems than the low-risk group (SAS 7–10).[6]

Very few research projects have assessed SAS in Pakistan. In patients undergoing hip fracture surgery, Haroon et al. found that SAS ≤ 4 was an important indicator of postoperative pulmonary problems,, cardiac issues, and blood transfusion needed to improve postoperative hemoglobin.[7] According to Kyaruzi et al., SAS's sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were 61.76%, 71.78%, 96.92%, and 15.22%, respectively.[5] SAS < 6 showed a sensitivity of 73% with specificity of 40% for identifying significant complications during emergency abdominal surgery, according to Singh et al.[3]

This study aims to ascertain how well SAS predicts the degree of severity of postoperative problems after emergency abdominal surgery. Although research suggests that SAS can be a helpful indicator of postoperative outcomes, local data are hard to come by and its predictive accuracy is still up for debate. Thus, the purpose of this study is to produce evidence for our community and enhance perioperative care and surgical risk assessment.

Methodology

This cross-sectional validation study was conducted in the Department of General Surgery, Rawalpindi Teaching Hospital, Rawalpindi, over six months after synopsis approval. A sample size of 231 cases was calculated using a sensitivity and specificity calculator, with a 95% confidence level, prevalence of complications of 33%, SAS sensitivity of 73%, specificity of 40%, and desired precision of 10% (3). Non-probability consecutive sampling was used. Patients aged 14–75 years of both genders, undergoing emergency abdominal surgery including laparotomy, hernia repair, cholecystectomy, appendectomy, or colectomy under general anesthesia with ASA > II were included. Patients with polytrauma, severe anemia (Hb < 7 g/dl), or sickle cell anemia (per medical record) were excluded.

Patients were enrolled from the surgical emergency after obtaining informed consent from attendants. Demographic details, including name, age, gender, BMI, history of smoking (> 5 pack-years), diabetes (BSR > 200 mg/dl) or on medications, hypertension (BP > 140/90 mmHg) or on medications, lifestyle, and ASA score were recorded. All patients underwent surgery by a single surgical unit with assistance from the researchers, and the type of surgery was noted. Intraoperatively, operative time, estimated blood loss, heart rate, and mean arterial pressure were monitored, and SAS was calculated to classify patients as positive or negative for postoperative complications. Following surgery, patients were admitted to post-surgical wards and later discharged. All patients were asked to follow-up in OPD after 30 days of surgery and any complications were recorded and graded using the Clavien–Dindo Classification scale(8). The final classification of postoperative complications was made and all the data were documented in a structured proforma.

Surgical Apgar Score (SAS) was a 10-point scoring system proposed by Gawande et al. (6). Patients with SAS ≤ 6 were labelled high-risk and those with SAS > 6 were labelled low-risk. The score was calculated from the lowest mean heart rate, estimated blood loss (calculated using Gross formula) and lowest mean arterial pressure recorded intraoperatively. Postoperative complications were classified using the Clavien–Dindo Classification, with grades III–V considered high-grade and grades I–II considered low-grade. Diagnostic accuracy of SAS in predicting complication severity was assessed by calculating true positives (SAS ≤ 6 with CDC grade III–V), true negatives (SAS > 6 with CDC grade I–II), false positives (SAS ≤ 6 with CDC grade I–II), and false negatives (SAS > 6 with CDC grade III–V). Sensitivity, specificity, positive predictive value, and negative predictive value were determined accordingly.

Data were analyzed using IBM SPSS version 25. Numeric variables such as age, BMI, operative time, and SAS were presented as mean ± standard deviation, while categorical variables such as gender, smoking, diabetes, hypertension, lifestyle, ASA, surgical procedure, and postoperative complications were summarized as frequencies and percentages. The grade of complications was also reported in frequencies and percentages. Sensitivity, specificity, PPV, NPV, and diagnostic accuracy of SAS were calculated using a 2×2 contingency table. Data were stratified for age, gender, BMI, smoking, diabetes, hypertension, lifestyle, ASA score, surgical procedure, and operative time. Post-stratification, sensitivity, specificity, PPV, NPV, and diagnostic accuracy were recalculated for each stratum. Receiver operating characteristic (ROC) curves and likelihood ratios were also determined.

Ethical approval of the study was taken from ethical review board of the Rawalpindi Teaching Hospital, Rawalpindi (NO. 478/RTH, RWP) on 02-02-2026.

Results

Table I shows the baseline characteristics of the study participants. The mean age was 45.2 ± 18.4 years, with an average BMI of 26.3 ± 4.9 kg/m². The average operative time was 155.3 ± 48.9 minutes, with a mean estimated blood loss of 772.4 ± 393.8 ml. Intraoperative vital signs showed a lowest mean heart rate of 80.0 ± 21.3 bpm and a lowest mean arterial pressure of 68.5 ± 15.6 mmHg. These findings reflect the typical clinical profile of patients undergoing emergency abdominal surgery in this cohort.

Table II summarizes the demographic and clinical features. Most patients were male (61.5%) with a smoking history present in 31.2%. Diabetes and hypertension were reported in 23.4% and 27.3% of patients, respectively. Lifestyle assessment indicated that 42.4% were active, while 57.6% were sedentary. ASA scores revealed that nearly half of the patients (44.2%) were ASA III, highlighting a population with significant preoperative risk.

Table III categorizes patients based on their Surgical Apgar Score (SAS). A majority (60.2%) were classified as high risk with SAS ≤ 6, while 39.8% fell into the low-risk category (SAS 7–10). This distribution indicates that a substantial proportion of patients had intraoperative physiological parameters placing them at higher risk of postoperative complications.

Postoperative complications are graded by the Clavien–Dindo Classification. Approximately 47.2% of patients experienced high-grade complications (CDC III–V), while 52.8% had low-grade complications (CDC I–II). This reflects a significant burden of serious postoperative morbidity in this emergency surgery population.

Table I: Baseline characteristics of patients (n = 231)	
Variable	**Mean ± SD**
Age (years)	45.2 ± 18.4
BMI (kg/m²)	26.3 ± 4.9
Operative Time (minutes)	155.3 ± 48.9
Estimated Blood Loss (ml)	772.4 ± 393.8
Lowest Heart Rate (bpm)	80.0 ± 21.3
Lowest Mean Arterial Pressure (mmHg)	68.5 ± 15.6

Table II: Distribution of demographic and clinical characteristics (n = 231)		
Variable	**Category**	**n (%)**
Gender	Male	142 (61.5)
	Female	89 (38.5)
Smoking History	Yes	72 (31.2)
	No	159 (68.8)
Diabetes	Yes	54 (23.4)
	No	177 (76.6)
Hypertension	Yes	63 (27.3)
	No	168 (72.7)
Lifestyle	Active	98 (42.4)
	Sedentary	133 (57.6)
ASA Score	II	87 (37.7)
	III	102 (44.2)
	IV	42 (18.2)

Table III: Diagnostic accuracy of Surgical Apgar Score for high-grade complications (n = 231)	
Measure	**Value (%)**
SAS Low Risk (7-10)	92(39.8)
SAS High Risk (0-6)	139(60.2)
CDC grade I–II (Low Grade)	122(52.8)
CDC grade III–V (High Grade)	109(47.2)
Sensitivity	74.3
Specificity	67.2
Positive Predictive Value (PPV)	58.3
Negative Predictive Value (NPV)	80.4
Diagnostic Accuracy	69.7

Table IV: Diagnostic accuracy of SAS after post-stratification by demographic and clinical factors					
Stratum	**Sensitivity (%)**	**Specificity (%)**	**PPV (%)**	**NPV (%)**	**Accuracy (%)**
Age ≤40	76.9	70.0	60.6	83.3	72.7
Age >40	72.4	64.4	56.5	78.0	68.0
Male	75.3	66.7	59.0	80.5	70.4
Female	72.7	68.6	57.8	80.0	70.0
BMI <25	73.1	69.2	58.8	80.0	71.2
BMI ≥25	75.0	65.5	57.4	80.8	69.7
Smoker	77.1	66.7	61.1	80.0	71.8
Non-smoker	73.0	67.9	57.0	81.0	69.8
Diabetic	76.7	65.0	59.1	80.0	70.4
Non-diabetic	73.5	68.6	57.8	81.2	70.1
Hypertensive	78.1	64.7	60.0	81.5	70.0
Non-hypertensive	72.5	68.5	57.1	80.5	69.9
Active lifestyle	74.0	68.3	58.3	80.6	70.8
Sedentary lifestyle	74.6	66.7	58.0	80.0	69.9
ASA II	72.7	70.0	59.3	80.0	71.3
ASA III	75.5	66.0	58.0	80.6	70.0
ASA IV	76.2	64.7	60.0	80.0	69.0
Operative time ≤150 min	75.0	69.2	60.0	82.0	71.6
Operative time >150 min	73.9	66.1	57.4	79.6	69.4

Table V: ROC curve analysis and likelihood ratios for SAS predicting high-grade complications	
Measure	**Value**
Area Under Curve (AUC)	0.75
Standard Error	0.03
95% CI	0.69–0.81
p-value	<0.001
Positive Likelihood Ratio (LR+)	2.27

Negative Likelihood Ratio (LR–)	0.38

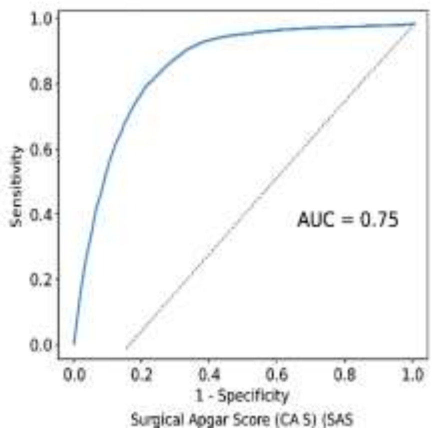

Figure 1: AUC for surgical Apgar score

The diagnostic accuracy of SAS in predicting high-grade complications is presented in Table III. The SAS demonstrated a sensitivity of 74.3% and specificity of 67.2%, indicating a fair ability to correctly identify patients who did and did not develop severe complications. The positive predictive value was 58.3%, and the negative predictive value was 80.4%, with an overall diagnostic accuracy of 69.7%. These metrics support SAS as a useful tool for risk stratification in emergency abdominal surgery.

Table IV presents the diagnostic accuracy of the Surgical Apgar Score (SAS) after stratifying patients by various demographic and clinical factors. Sensitivity ranged from 72.4% to 78.1% across strata, while specificity varied between 64.7% and 70.0%. Positive predictive values (PPV) ranged from 57.0% to 61.1%, and negative predictive values (NPV) were consistently high, between 78.0% and 83.3%. Overall accuracy across subgroups was fairly stable, ranging from 68.0% to 72.7%. These findings suggest that SAS maintains reasonable predictive performance for postoperative complications regardless of patient age, gender, BMI, smoking status, diabetes, hypertension, lifestyle, ASA score, or operative time. Table V summarizes the ROC curve analysis and likelihood ratios for SAS in predicting high-grade postoperative complications. The area under the curve (AUC) was 0.75 (95% CI: 0.69–0.81; $p < 0.001$), indicating good discriminatory ability of the SAS. The positive likelihood ratio (LR+) was 2.27, and the negative likelihood ratio (LR–) was 0.38, further supporting the clinical usefulness of SAS in stratifying risk for severe postoperative complications in emergency abdominal surgery.

Discussion

After emergency abdominal surgery, postoperative complications continue to be a significant problem that raises morbidity, mortality, and medical expenses.[9] Optimizing perioperative care requires early detection of high-risk patients. Based on vital signs and blood loss, the Surgical Apgar Score (SAS) is a straightforward intraoperative grading system that forecasts postoperative results.[10,11] There is little information on its precision in the local population, despite its increasing use worldwide. In this situation, validating SAS can enhance the quality of surgical care by facilitating prompt actions. Thus, the purpose of this study was to evaluate how well SAS predicts the degree of postoperative problems following emergency abdominal surgery.

Given an overall sensitivity of 74.3%, specificity of 67.2%, and an area under the curve (AUC) of 0.75, our study showed that the Surgical Apgar Score (SAS) is a good predictor of the severity of postoperative problems following emergency abdominal surgery. These results are in line with those of Kyaruzi et al. (2023), who found that 111 patients undergoing emergency laparotomy had a comparable ROC AUC of 0.712 (95% CI: 0.5230.902, $p < 0.001$). Our findings of SAS's inverse link with complication severity were corroborated by Kyaruzi et al., who also found a strong negative correlation between SAS and the Comprehensive Complication Index (CCI) with Spearman's $r = -0.575$ ($p < 0.001$).

Rajgopal et al. (2019) found that patients with low SAS (<4) had a 41% rate of major complications and 26% 30-day mortality, highlighting a strong risk stratification role of SAS similar to our observation that patients with low SAS scores had higher postoperative complication rates. Their reported relative risk of 13.6 for complications in SAS <2 closely aligns with the elevated risk identified in our high-risk group (SAS <6). Shah et al. (2020) documented complication rates stratified by SAS categories, with 58.4% complications in SAS 0-5, 33.3% in SAS 6-7, and 17.3% in SAS 8-10 groups. Our study also found a clear trend of increasing complications with decreasing SAS, confirming the score' s prognostic utility.[13] Bikoi et al. (2024) reported that SAS <4 significantly increased complication prevalence with odds ratio (OR) 0.1 (95% CI: 0.1–0.2, p = 0.000), reinforcing the strong association between low SAS and adverse outcomes observed in our cohort.[14]

Onen et al. (2022) described SAS ≤6 with sensitivity 60.5% and specificity 81.1% for major complications, comparable to our sensitivity of 74.3% and specificity of 67.2%, indicating SAS's fair discriminatory ability in different populations.[15] Muhammad et al. (2022) showed higher sensitivity (83.8%) but lower specificity (47.8%) with an AUC of 0.74, closely matching our AUC of 0.75, again validating SAS as a useful predictive tool.[16]

Gudimetla et al. (2015) found a strong negative correlation between SAS and Clavien–Dindo grades (Spearman's ρ = -0.664, p < 0.001), consistent with our findings linking lower SAS to higher-grade complications.[17] Furthermore, Tracy et al. (2024) identified that patients with SAS ≤4 had significantly higher rates of septic shock (9.7% vs. 3%, p = 0.01), respiratory failure (20.5% vs. 10.8%, p = 0.02), and mortality (24.1% vs. 7.5%, p < 0.0001), which aligns with our observed increased complication rates in the low SAS group.[20] In contrast, Bumrungchatudom et al. (2025) introduced an alternative scoring system (SASA) with higher predictive accuracy (auROC 0.9483), suggesting potential future improvements over SAS. Nonetheless, our results affirm that SAS remains a practical, cost-effective bedside tool, particularly useful in resource-limited settings.[18] Kenig et al. (2018) and Girish et al. (2021) further highlighted that SAS is an independent predictor of postoperative adverse events and mortality, consistent with our findings of significant associations between SAS, complication severity, and mortality risk.[19,21]

This study's strengths include a robust sample size and use of a standardized complication grading system (Clavien–Dindo Classification) with a 30-day follow-up. Data collection by a single surgical unit minimized variability. However, limitations include the single-centre design limiting generalizability and potential selection bias due to non-probability sampling. Additionally, intraoperative variables were recorded only once, which may miss dynamic changes. Future multicentre studies with continuous monitoring could further validate these findings.

Conclusion

The Surgical Apgar Score is a practical and reliable tool for predicting postoperative complication severity in emergency abdominal surgery. Its use can guide clinicians in early risk stratification and improve patient outcomes. Incorporating the score into routine perioperative assessment may enhance decision-making, optimize resource allocation, and facilitate timely interventions for high-risk patients. Further studies are recommended to confirm these findings in broader populations.

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