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Analysis of Surgical APGAR Score in Prediction of Post Operative Morbidity and Mortality

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Abstract: ***Background: The Surgical APGAR Score (SAS) is a straightforward metric designed to predict postoperative morbidity and mortality using intraoperative data, including lowest heart rate (HR), lowest mean arterial pressure (MAP), and estimated blood loss (EBL). This study aimed to analyze the effectiveness of SAS in forecasting postoperative outcomes and enhancing patient management. Methods: This prospective study was conducted at MVJ Medical College and Research Hospital over 12 months, involving 180 patients. Ninety patients were assessed using SAS, while 90 were not, with one patient lost to follow - up in the non - segregated group. Patients ranged from 18 to 70 years, with a mean age of 57 years in the control group and 56.6 years in the intervention group. Data on intraoperative metrics and postoperative outcomes were collected and analyzed. The primary study endpoint was the occurrence of major complications or death within 30 days post - surgery. Results: In the control group, 16.9% of patients had an SAS of 0 - 4, indicating high risk, compared to 21.1% in the intervention group. A significant majority of patients had scores in the intermediate range (5 - 8), with 60.7% in the control group and 53.3% in the intervention group. Patients with low - risk scores (9 - 10) comprised 22.5% of the control group and 25.6% of the intervention group. Major complications or death occurred in 20/89 (22.5%) patients in the control group and 21/89 (23.6%) in the intervention group. The study found that SAS is a useful tool in predicting postoperative morbidity and mortality, with significant differences observed in critical care admissions and complication rates between the groups. Conclusion: The Surgical APGAR Score is an effective and reliable method for predicting postoperative outcomes. Its implementation in routine surgical practice can enhance patient management and resource allocation. Further research is recommended to validate and refine SAS across diverse surgical populations and settings. Recommendations: Implementation of SAS in Routine Surgical Practice: Integrate SAS into standard practice to better identify high - risk patients and improve postoperative care. Training and Education: Develop comprehensive training programs for surgical teams to ensure accurate SAS calculation and interpretation. Further Research and Validation: Conduct large - scale, multicenter studies to validate and refine SAS across various surgical types and patient demographics.***

Keywords: Surgical APGAR Score (SAS), postoperative morbidity, postoperative mortality, intraoperative metrics, risk stratification, patient outcomes, hemodynamic, estimated blood loss (EBL), perioperative care, surgical risk assessment.

1. Introduction

The Surgical Apgar Score (SAS) is a straightforward metric designed to forecast postoperative morbidity and mortality using intraoperative data on hemodynamic and blood loss. Introduced as a means to objectively assess surgical outcomes, the SAS incorporates three parameters: the lowest heart rate (HR), the lowest mean arterial pressure (MAP), and the estimated blood loss (EBL). By evaluating these critical intraoperative factors, the SAS provides a quick and effective way to predict patient outcomes, enabling surgical teams to implement timely and appropriate postoperative management strategies. (1)

Effective postoperative management is crucial in reducing morbidity and mortality, necessitating an objective assessment of the patient's condition. Risk scoring systems are developed to quantify a patient's risk of adverse outcomes based on the severity of illness derived from data available at an early stage of the hospital stay. While conventional evaluation tools like the Acute Physiology and Chronic Health Evaluation (APACHE) and the Simplified Acute Physiology Score (SAPS) have been widely used to assess morbidity in surgical patients, they come with certain limitations. Although the American Society of Anaesthesiologists (ASA) classification has been proven to be a predictive pre - operative risk factor in mortality models, its subjective nature and inconsistent scoring between providers reduce its effectiveness for evidence - based postoperative risk calculations. (2)

More accurate and objective predictive algorithms, such as the Physiological and Operative Severity Score for the enumeration of Mortality and morbidity (POSSUM), APACHE, and SAPS, along with their later derivations (Portsmouth POSSUM, colorectal POSSUM, APACHE II and III, and SAPS II), provide better risk assessments (3) . However, these tools require numerous variables that are not always easily or consistently attainable in an operating room setting, thus limiting their practicality as predictive tools in the immediate surgical environment. Instead, they are more suited for their initial role as critical care auditing tools. (4)

Globally, the parameters included in the SAS—lowest HR, lowest MAP, and EBL—are commonly monitored and documented across surgical settings. Studies have demonstrated that these parameters are critical indicators of surgical outcomes, with variations in HR and MAP being closely associated with intraoperative and postoperative complications. In India, the prevalence of these parameters in surgical practice is also notable. Indian surgical settings routinely measure HR, MAP, and EBL, recognizing their importance in assessing patient stability and risk during surgery. However, despite the widespread monitoring of these parameters, there is a need for standardized tools like the SAS to effectively utilize this data for predicting postoperative

outcomes. By incorporating the SAS into routine surgical practice, both globally and in India, healthcare providers can enhance their ability to anticipate and mitigate postoperative complications, ultimately improving patient care and outcomes (5) .

In contrast, the SAS offers a pragmatic approach by focusing on easily obtainable intraoperative data, making it a valuable tool for surgical teams to predict and manage postoperative complications.

Aim and objectives

This study aims to analyze the effectiveness of the Surgical Apgar Score in predicting postoperative morbidity and mortality, emphasizing its utility in improving surgical outcomes and patient care.

2. Materials and Methods

Study Design

This is a prospective study conducted at MVJ Medical College and Research Hospital (MVJ MC and RH) over a period of 12 months. The study aims to analyze the effectiveness of the Surgical Apgar Score (SAS) in predicting postoperative morbidity and mortality. A total of 180 patients were included in the study, determined using an appropriate sample size calculation formula. The study endpoint was set as the 30th post - operative day after surgery.

Inclusion Criteria

The inclusion criteria for the study were as follows: Patients aged between 18 and 70 years undergoing elective or emergency surgeries that required intensive care and perioperative monitoring were included. Additionally, these patients needed to require outpatient follow - up.

Exclusion Criteria

Patients with certain conditions were excluded from the study. These exclusion criteria included comorbid conditions such as ischemic heart disease and patients who were on beta - blockers. Surgeries performed under local anesthesia were also excluded from the study.

Methodology

Surgical Apgar Score Calculation

The SAS was calculated using three parameters: Estimated Blood Loss (EBL), Lowest Heart Rate (HR), and Lowest Mean Arterial Pressure (MAP). These parameters were collected intraoperatively from the anesthesiologist's records. The SAS was categorized into three groups for simplicity: High Risk (0 - 4), Medium Risk (5 - 7), and Low Risk (8 - 10).

Blood Loss Calculation

Blood loss was calculated using the following formula: Blood Loss = EBV × (HBi - HBf) / ((HBi + HBf) / 2) + (500 × Tu). In this formula, EBV represents the estimated blood volume (calculated as body weight in kg × 70 ml/kg). HBi is the pre - operative hemoglobin (g/dl), and HBf is the post - operative hemoglobin (g/dl) around 24 hours after surgery. Tu is the sum of whole blood and packed red blood cells transfused.

Follow - up and Complications Monitoring

Patients were followed up for 30 days postoperatively for the occurrence of any major complications or deaths. Major complications included acute renal failure, bleeding requiring a transfusion of 4 units or more of red blood cells within 72 hours after surgery, cardiac arrest requiring cardiopulmonary resuscitation, coma of 24 hours or longer, deep vein thrombosis, myocardial infarction, unplanned intubation, ventilator use for 48 hours or more, pneumonia, pulmonary embolism, stroke, wound disruption, deep or organ - space surgical site infection, sepsis, septic shock, systemic inflammatory response syndrome, and vascular graft failure.

All deaths were assumed to include major complications. Superficial surgical site infection and urinary tract infection were not considered major complications. Other occurrences involving complications of Clavien Class III and greater (those requiring surgical, endoscopic, or radiological intervention, or intensive care admission, or that are life - threatening) were also considered major complications. The occurrence of major complications and mortality within 30 days postoperatively was based on follow - up data in the admitting ward and surgical outpatient clinic notes. Major complications definitions were according to the National Confidential Enquiry into Patient Outcome and Death classification. Patients were subsequently grouped into three categories based on their SAS for purposes of risk stratification: High Risk (0 - 4), Medium Risk (5 - 7), and Low Risk (8 - 10).

3. Results

The study involved two groups: the control group with 89 patients and the intervention group with 90 patients. The mean age of patients in the control group was 57 ± 2.5 years, while in the intervention group, it was 56.6 ± 3.2 years.

In terms of gender distribution, the control group comprised 49 males (55.1%) and 40 females (44.9%), whereas the intervention group had 53 males (58.9%) and 37 females (41.1%).

The distribution of ASA grades was as follows: In the control group, 27 patients (30.3%) were ASA grade I, 33 patients (37.1%) were grade II, 20 patients (22.5%) were grade III, 9 patients (10.1%) were grade IV, and none were grade V. In the intervention group, 30 patients (33.3%) were ASA grade I, 35 patients (38.9%) were grade II, 16 patients (17.8%) were grade III, 8 patients (8.9%) were grade IV, and 1 patient (1.1%) was grade V.

Regarding the urgency of the surgeries, 25 patients (28.1%) in the control group underwent emergency procedures compared to 27 patients (30.0%) in the intervention group. The remaining patients underwent elective procedures.

The operative class distribution showed that in the control group, 10 patients (11.2%) underwent minor surgeries, 25 patients (28.1%) had intermediate surgeries, 50 patients (56.2%) underwent major surgeries, and 4 patients (4.5%) had extensive surgeries. In the intervention group, 12 patients (13.3%) underwent minor surgeries, 13 patients (14.4%) had intermediate surgeries, 55 patients (61.1%) underwent major

surgeries, and 10 patients (11.1%) had extensive surgeries. (Table 1)

The distribution of Surgical APGAR Scores among the control and intervention groups shows varying levels of predicted postoperative risk. In the control group, 15 patients (16.9%) had a Surgical APGAR Score of 0 - 4, indicating a high risk of postoperative complications. In the intervention group, 19 patients (21.1%) fell into this high - risk category.

The majority of patients in both groups had a score in the intermediate range of 5 - 8, with 54 patients (60.7%) in the control group and 48 patients (53.3%) in the intervention group. This suggests that over half of the patients in each group had a moderate risk of postoperative complications.

Patients with a score of 9 - 10, indicating a low risk of complications, comprised 20 patients (22.5%) in the control group and 23 patients (25.6%) in the intervention group. This distribution highlights that a significant portion of patients in both groups were at a lower risk of postoperative complications, with the intervention group having a slightly higher percentage of patients in this low - risk category. (Figure 1)

Table 1: Patient Characteristics

Patient Characteristics	Control (n=89)	Intervention (n=90)
Age (in years)	57 ± 2.5	56.6 ± 3.2
Gender		
Male	49 (55.1%)	53 (58.9%)
Female	40 (44.9%)	37 (41.1%)
ASA Grade		
I	27 (30.3%)	30 (33.3%)
II	33 (37.1%)	35 (38.9%)
III	20 (22.5%)	16 (17.8%)
IV	9 (10.1%)	8 (8.9%)
V	0 (0%)	1 (1.1%)
Emergency		
Yes	25 (28.1%)	27 (30.0%)
No	64 (71.9%)	63 (70.0%)
Operative Class		
Minor	10 (11.2%)	12 (13.3%)
Intermediate	25 (28.1%)	13 (14.4%)
Major	50 (56.2%)	55 (61.1%)
Extensive	4 (4.5%)	10 (11.1%)

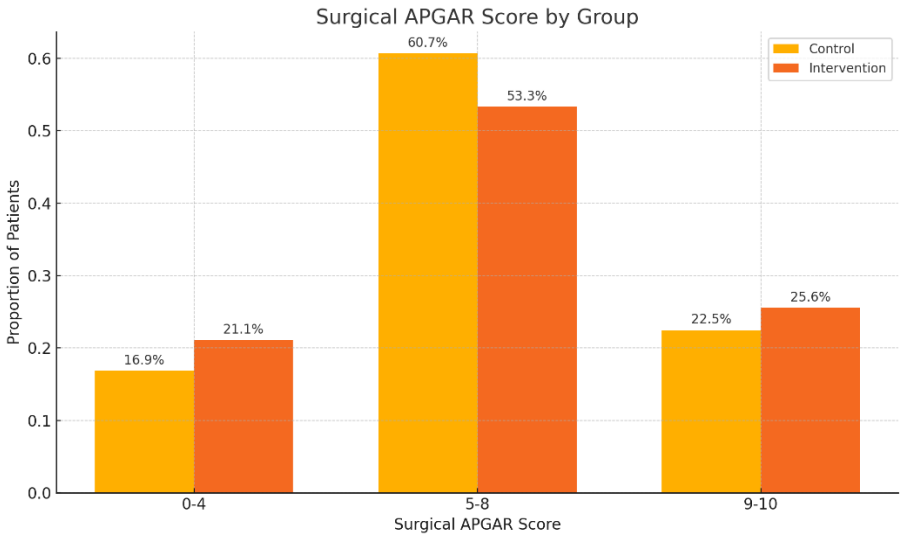

Figure 1: Surgical APGAR Score

The outcomes of patients in terms of immediate admissions to critical care, major complications/death, and delayed admissions to critical care are compared between the control and intervention groups. For immediate admissions to critical care, among patients with a Surgical APGAR Score (SAS) of 0 - 4, 4 out of 14 patients in the control group and 17 out of 19 patients in the intervention group were admitted immediately, with a significant test statistic of 11.47 and a p - value of 0.0001, indicating a statistically significant difference. Among patients with an SAS of 5 - 8, 15 out of 54 patients in the control group and 2 out of 48 in the intervention group required immediate critical care, also showing a significant difference with a test statistic of 8.57 and a p - value of 0.0001. For those with an SAS of 9 - 10, 3 out of 20 patients in the control group and none in the intervention group required immediate critical care.

Regarding major complications or death, the total number of events was similar between the control (20 out of 89) and intervention (21 out of 89) groups, with a test statistic of 0.018 and a p - value of 0.8909, indicating no significant difference overall. However, within the SAS 0 - 4 category, 9 out of 14 patients in the control group and 17 out of 19 in the intervention group experienced major complications or death, with a test statistic of 4.047 and a p - value of 0.022, indicating a significant difference. For patients with an SAS of 5 - 8, 10 out of 54 in the control group and 4 out of 48 in the intervention group had major complications or death, with a test statistic of 2.223 and a p - value of 0.135, showing no significant difference. In the SAS 9 - 10 category, 1 out of 20 patients in the control group and none in the intervention group experienced major complications or death.

For delayed admissions to critical care, 7 out of 89 patients in the control group and 4 out of 90 in the intervention group had delayed admissions, with a test statistic of 0.4116 and a p - value of 0.521, indicating no significant difference

between the groups. The statistical test used for these comparisons was the Fisher exact test, and a p - value of less than 0.05 was considered statistically significant. (Table 3)

Table 3: Outcomes of Patients

Patients' Characteristics	Control (n=89)	Intervention (n=90)	Test Statistics	P Value
Immediate Admissions to Critical Care				
SAS 0 - 4	4/14	17/19	11.47	0.0001*
SAS 5 - 8	15/54	2/48	8.57	0.0001*
SAS 9 - 10	3/ 20	0/23	- -	- - -
Major Complications/Death				
Total	20/89	21/89	0.018	0.8909
SAS 0 - 4	9/14	17/19	4.047	0.022*
SAS 5 - 8	10/54	4/48	2.223	0.135
SAS 9 - 10	1/20	0/23	- -	- - -
Delayed Admission to Critical Care				
Delay	7/ 89	4/90	0.4116	0.521
Statistical Test Used: Fisher exact test				
Note: *p - value < 0.05 is considered statistically significant				

Table 4 presents the risk analysis for major complications or death among patients with a Surgical APGAR Score (SAS) of 0 - 4, indicating high risk. The risk of major complications or death in the exposed group (those with an intervention) was 34.62%, while the risk in the unexposed group (those without intervention) was higher at 42.42%. The overall risk across both groups was 38.98%. The risk ratio, which compares the probability of complications or death between the exposed and unexposed groups, was 0.8159. This suggests that the intervention group had a lower risk of major complications or death compared to the control group. The risk difference between the two groups was - 7.809%, indicating that the intervention reduced the risk by this margin.

Prevented fraction in control (pfp) was 8.111%, meaning that 8.111% of potential complications or deaths were prevented in the control group. The prevented fraction in the intervention group (pfe) was higher at 18.41%, indicating a more substantial reduction in risk due to the intervention. These results highlight the potential effectiveness of the intervention in reducing major complications or death among high - risk surgical patients.

Table 4: Major Complications/Death (SAS 0 - 4)

Type	Value
Risk in Exposed	34.62%
Risk in Unexposed	42.42%
Overall Risk	38.98%
Risk Ratio	0.8159
Risk Difference	-7.81%
Prevented Fraction in Control (pfp)	8.11%
Prevented Fraction in Intervention (pfe)	18.41%

Table 5 outlines the risk analysis for major complications or death among patients with a Surgical APGAR Score (SAS) of 5 - 8, indicating moderate risk. The risk of major complications or death in the exposed group (those with an intervention) was 71.43%, significantly higher than the 52.94% risk observed in the unexposed group (those without intervention). The overall risk across both groups was 55.17%.

The risk ratio, comparing the probability of complications or death between the exposed and unexposed groups, was 1.349. This suggests that the intervention group had a higher risk of major complications or death compared to the control group. The risk difference between the two groups was 18.49%, indicating an increased risk in the intervention group by this margin.

The etiologic fraction in control (EFp) was 4.044%, signifying the proportion of complications or deaths attributable to the intervention in the control group. The etiologic fraction in the intervention group (EFe) was higher at 25.88%, indicating a substantial proportion of complications or deaths in the intervention group that can be attributed to the intervention itself. These results suggest that, unlike the high - risk group, the intervention may be associated with a higher risk of major complications or death among patients with moderate risk, warranting further investigation into the underlying factors.

Table 5: Major Complications/Death (SAS 5 - 8)

Type	Value
Risk in Exposed	71.43%
Risk in Unexposed	52.94%
Overall Risk	55.17%
Risk Ratio	1.349
Risk Difference	18.49%
Etiologic Fraction in Control (EFp)	4.04%
Etiologic Fraction in Intervention (EFe)	25.88%

4. Discussion

In this study, we included 180 patients, with 90 patients segregated by the Surgical APGAR Score (SAS) and 90 patients not segregated. One patient in the non - segregated group was lost to follow - up. The mean age of the control group was 57 years, while that of the intervention group was 56.6 years. The youngest patient was 18 years old, and the oldest was 70 years old. There was a male predominance noted in both groups.

In our study, 30% of the cases were emergencies, and 70% were elective surgeries. The most common emergency cases included open appendectomy, exploratory laparotomy with Graham's patch repair, colostomy, ileostomy, and resection and anastomosis. Elective cases comprised laparoscopic appendectomy, laparoscopic cholecystectomy, open appendectomy, hemorrhoidectomy, lateral anal sphincterotomy, and hernioplasty. Most surgeries were elective, with the majority of emergency surgeries performed within 2 - 3 hours after admission. Capewell's study on emergency surgical admissions showed that 46 - 57% of all surgical admissions are emergency in nature, highlighting a higher emergency admission rate compared to our findings. General anaesthesia was the most common form of anaesthesia used. The most common comorbidities noted were diabetes mellitus, hypertension, and obesity, which were significantly associated with postoperative morbidity and mortality.

The findings of our study align with and expand upon existing literature on the use of the Surgical APGAR Score (SAS) for predicting postoperative outcomes. Regenbogen

et al. (2008) reported a mean patient age of 64.2 years, slightly older than our study's mean age of 57 years in the control group and 56.6 years in the intervention group. This age difference may contribute to variations in postoperative complications, as older age is generally associated with higher surgical risk. Similarly, JB Sabool et al. (2013) found a mean age of 63.6 years in their cohort. (6, 7)

In terms of comorbidities, our findings are consistent with the literature, which commonly identifies diabetes, hypertension, and obesity as significant risk factors for postoperative complications. The Surgical APGAR Score proved to be a useful tool in predicting postoperative outcomes, with our study reinforcing its value in both elective and emergency surgical settings. However, the variations in immediate admissions to critical care and major complications/death rates between our study and others indicate the need for further research to optimize the use of SAS and tailor it to specific patient populations and surgical types.

5. Conclusion

In conclusion, this study demonstrated the utility of the Surgical APGAR Score (SAS) in predicting postoperative morbidity and mortality. Among the 180 patients included in the study, the SAS was shown to be an effective tool for stratifying risk, with clear distinctions observed in outcomes between those with low, intermediate, and high scores. The data corroborate previous findings in the literature, emphasizing the importance of intraoperative metrics such as heart rate, mean arterial pressure, and estimated blood loss in determining patient prognosis. Our study reinforces the value of SAS as a straightforward and reliable method to enhance postoperative management and improve patient outcomes.

6. Recommendations

Implementation of SAS in Routine Surgical Practice: It is recommended that the Surgical APGAR Score be integrated into routine surgical practice across healthcare facilities. By systematically applying SAS, surgical teams can better identify high - risk patients and allocate resources more effectively to those in need of intensive postoperative care.

Training and Education: Comprehensive training programs should be developed for surgical teams to ensure accurate calculation and interpretation of the SAS. This includes workshops and continuous education initiatives to familiarize healthcare providers with the score's application and its impact on patient outcomes.

Further Research and Validation: While the SAS has shown promise, further research is needed to validate its applicability across diverse surgical populations and settings. Large - scale, multicenter studies should be conducted to refine the score and adapt it to various types of surgeries and patient demographics, ensuring its broader utility and effectiveness in improving surgical care worldwide.

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