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Surgical APGAR Score - A Simple Prognostic Tool In Surgery

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Abstract
Introduction:
In today's era cost of health care is of growing importance and it is important to recognize patients at increased risk of post-operative morbidity and mortality and to find interventions to reduce the risk. Hence, there is a need of an objective prognostic tool to assess the post-operative outcome of patients, than the subjective gut feeling of surgeons. The surgical Apgar score (SAS) is a simple score that uses intraoperative information on hemodynamics and blood loss of patient to predict post-operative morbidity and mortality. Score on a scale of 0-10 calculated from three parameters collected during the operative procedure, lowest heart rate (HR), lowest mean arterial pressure (MAP), and estimated blood loss.
Materials and Methods:
It is an 18 months prospective study done in Government Dharmapuri Medical College and Hospital. Emergency and elective major cases were included in this study. SAS calculated based on intraoperative parameters lowest MAP, lowest HR, and amount of blood loss.
Results:
A total of 100 patients studied, age ranged from 18 to 70 years. 61 elective and 39 emergency surgeries, the majority were gastrointestinal surgeries. SAS was significantly associated with post-operative morbidity and mortality within 30 days (P < 0.001). Of 100 patients, 30 had SAS 4 or less. Complications noted in 16 out of 30 patients. By comparison among 5 patients with SAS 9 or 10 none experienced complications. Conclusion: SAS is a simple prognostic tool for assessing post-operative outcome in general surgical patients.
Key words: *Estimated blood loss, Mean arterial pressure, Surgical Apgar score*

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I. Introduction

The surgical Apgar score (SAS) is a simple score that uses intraoperative information on hemodynamic and blood loss to predict post-operative morbidity and mortality score on a scale of 0-10 calculated from three parameters collected during the operative procedure.

1. Lowest heart rate (HR)
2. Lowest mean arterial pressure (MAP)
3. Estimated blood loss (EBL).

Post-operative morbidity and mortality reduction is the basic aim of any surgical procedure.The key to reduce post-operative morbidity and mortality is by effective perioperative management of patients for which objective assessment of the patient is needed, which can be assessed with the risk scoring system. Risk scoring seeks to quantify a patient's risk of adverse outcome based on the severity of illness derived from data available at an early stage of hospital stay. Ideally, risk-scoring systems should provide objectivity and mortality prediction enabling communication and understanding of the severity of illness. The possible outcome of surgical operation is needed to ensure appropriate resource allocation and for the evolution of more effective treatment regimens and also enable informed decision making by the recipient.

Surgeons have a need for predictive tools to assess perioperative risk. Several algorithms have been used or developed for risk stratification such as the American Society of Anesthesiologists Physical Status classification system (ASA classification), the physiologic and operative severity score for enumeration of mortality and morbidity (POSSUM),the Acute Physiology and Chronic HealthEvaluation (APACHE),1 and the simplified acute physiology score (SAPS).5,6 However, each of these systems has limitations and restricted uses. The ASA classification was initially intended as a means to stratify a patient's systemic illness but not post-operative risk. Although the ASA classification has proved to be a predictive pre-operative risk factor in mortality models, its subjective nature and inconsistent scoring between providers make it less than ideal for performing evidence-based post-operative risk calculation. The POSSUM, APACHE, and SAPS and their later derivations (Portsmouth POSSUM, colorectal POSSUM, APACHE II and III, and SAPS II) are more accurate and objective predictive algorithms, but not all of the variables needed are easily and consistently attainable in an operating room setting, making them more practical in their initially intended role as critical care auditing tools rather than predictive tools.

The SAS because of its availability in real time, simplicity, inexpensively collected in any hospital, and immediately usable for clinical decision has made it a powerful tool for broad safety improvement in surgery. SAS provides a readily available "Snapshot" of how an operation went by rating the condition of a patient after surgery from 0 (indicating heavy blood loss, hypotension, and an elevated HR or asystole) to 10 (indicating minimal blood loss, normal blood pressure, and a physiologically low to normal HR).

	0	1	2	3	4
ESTIMATED BLOOD LOSS (ml)	>1000	601-1000	101-600	<100	-
LOWEST MEAN ARTERIAL PRESSURE (mm of hg)	<40	40-54	55-69	>70	-
LOWEST HEART RATE (beats/min)	>85	76-85	66-75	56-65	<55

Figure 1: Surgical Apgar score

II. Materials And Methods

This is a prospective study was undertaken at Government dharmapuri medical college and hospital over a period of 18-month, sample size 100 patients.

Study Endpoint

The patient follow-up was up to the 30th post-operative day after surgery.

Inclusion Criteria

1. Age-18-70 years
2. Elective or emergency surgeries requiring intensive perioperative monitoring
3. Outpatient follow-up required
4. ASA class two and above.

Exclusion Criteria

1. Comorbid condition like ischemic heart disease, patients on beta blockers, etc.,
2. Surgeries under local anesthesia.

Methodology

Using EBL, lowest HR, and lowest MAP during the surgical procedure, the SAS is calculated (Figure 1). (occurrence of pathologic bradyarrhythmia, including sinus arrest, atrioventricular block or dissociation, junctional or ventricular escape rhythms, asystole, and also receives 0 points for lowest HR). Scores are categorized into 0-4, 5-7, 8-10 for simplicity

Data such as lowest HR and lowest MAPs are noted intraoperatively are collected from an anesthesiologist's records (manual/electronic).

Blood loss is calculated using the formula:

Blood loss = EBV × (HBi -HBf) ÷ {(HBi + HBf)/2} + {500×Tu} where,

EBV = Estimated blood volume (body weight in kgs × 70 ml/kg)

HBi = Pre-operative hemoglobin (g/dl),

HBf = Post-operative hemoglobin (g/dl) around 24 h after surgery

Tu = Sum of whole blood, packed red blood cell transfused.

Note: 500 constant changes according to hospital blood bank protocols.

Patients are followed up for the occurrence of any major complications or deaths within 30 days of surgery. The following events are considered major complications: Acute renal failure, bleeding that requires a transfusion of 4 U or more of red blood cells within 72 h after surgery, cardiac arrest requiring cardiopulmonary resuscitation,

coma of 24 h or longer, deep vein thrombosis, myocardial infarction, unplanned intubation, ventilator use for 48 h 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 are assumed to include major complications. Superficial surgical site infection and urinary tract infection are not considered major complications. Other occurrences that involve complications of Clavien Class III and greater (those that require surgical, endoscopic, or radiological intervention or intensive care admission or are life threatening) are also considered major complications.
The occurrence of major complications and mortality within 30 days postoperatively was based on follow-up data in admitting ward and surgical outpatient clinic notes. Major complications definitions were according 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. Thus,

• Risk group: Surgical Apgar score
• High: 0-4
• Medium: 5-7
• Low: 8-10.

III. Results

A total of 100 patients studied, 42/females and 58/males, 61 were elective surgeries, and 39 were emergency. Most of the surgeries were gastrointestinal surgeries; open/ laparoscopic.

• A total of 21 complications were seen (3 deaths and 18 major complications)
• Out of 18 major complications, 15 were observed in patients operated on emergency basis while 3 were seen in an elective case
• Of the 18 major complications:

a. 9 had deep wound infection
b. 7 had pneumonia
c. 1 had sepsis
d. 1 on prolonged ventilator.

IV. Discussion

In this study, 100 patients were included. There was male predominance noted with 58% male and 42% female. Most patients were between 40 and 50 years of age (27%) mean age 42.8 years. The youngest patient was (18) years old and oldest was 70 years old and distribution of surgical apgar score as shown in Table 1. In the study by Regenbogen et al. (2009), the mean age was 64.2 years. Gawande et al. (2007) had a patient population with a mean age of 63.6 years.

In this study, 61% surgeries were elective in nature and 39% surgeries emergency. The most common indication for surgery was cholecystectomy (27%) as an elective while appendectomy (17%) as emergency procedure. The timing of most surgeries was elective. The majority of the emergency surgeries were operated within 2-3 h after admission. A study on emergency surgical admission by Capewell showed that 46-57% of all surgical admissions are emergency in nature. The general anesthesia was the most common form of anesthesia.

Most common comorbidities noted were diabetes mellitus followed by hypertension and obesity and were significantly associated with post-operative morbidity and mortality.

In this study, (18%) morbidity and (3%) 30 days mortality was noted, (79%) patient's made an uneventful recovery.

Wound infection was most frequent morbidity noted, followed by pneumonia. Similarly, in the study by Regenbogen et al. 3 in patients undergoing laparotomy for gastrectomy or colectomy the mortality was 5.2%. Gawande et al. 1 observed a mortality rate of 4% in patients undergoing colectomy.

The majority of complications were noted in age group >60 years. 42% (8 out of 19) patients in age group >60 had low Apgar score of<4.Only 5.5% (4 out of 72) in the younger group of <50 years have low Apgar score of <4.Moreover , all patients with higher SAS (9-10)belong to <60 years group. A study by Gawande et al. showed significantly high rate of major complications of 16% with a mean age of 64.2 years. Emergency surgery in aged carries a higher morbidity and mortality than a elecetivesurgery . In the study by Regenbogen et al. ,patients with scores between 0 and 4 had complications rates of 54 -75 % while those with scores of 7 – 10 had rates of 5 – 13 %. This demonstrates the ability of the SAS in identifying patientsat higher than average risk of major post-operative complications.

Table 1: SAS distribution in patients studied

SAS	Gender		Total
	Female (%)	Male (%)	
0-4	10 (23.8)	20 (34.5)	30 (30)
5-7	19 (45.2)	25 (43.1)	44 (44)
8-10	13 (31)	13 (22.4)	26 (26)
Total	42 (100)	58 (100)	100 (100)

44% patients showed SAS between 5 and 7 while 30% between 0 and 4.
SAS: Surgical Apgar score

Table 2: Post-operative complications in patients studied

Post-operative complications	Gender		Total (*n*=100)
	Female (*n*=42)	Male (*n*=58)	
Wound infection	2 (4.8)	7 (12.1)	9 (9)
Pneumonia	4 (11.9)	3 (5.2%)	7 (8)
Ventilator	0 (0)	1 (1.7)	1 (2)
Sepsis	0 (0)	1 (1.7)	1 (1)
Uneventful	38 (83.3)	46 (79.3)	84 (80)
Total	42 (100)	58 (100)	100 (100)

Total 18 complications were observed out of which wound infection and pneumonia were predominant

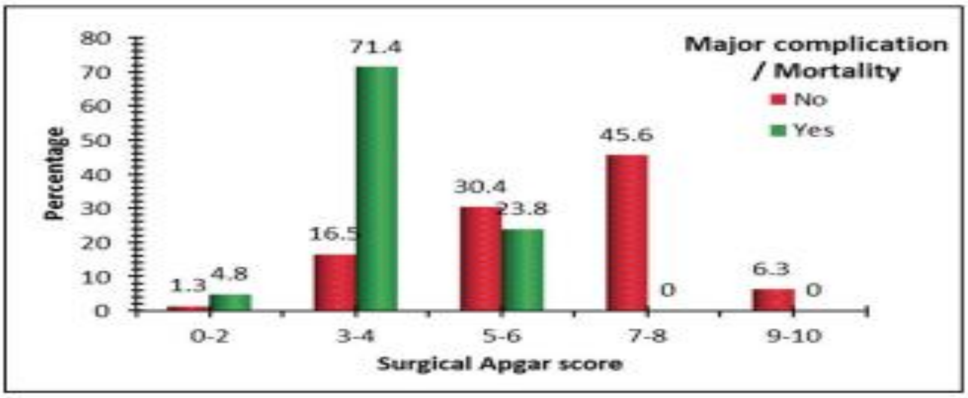
Most common complication noted in this study (Table 2) was deep wound infection followed by pneumonia. Prolonged ventilator and sepsis are other complications. Three mortality noted out of three-two deaths secondary to septic shock and one secondary to cardiopulmonary arrest.

Of the 100 patients, there was (3%) 30 days mortality and (18%) major complications and (79%) no complication. The difference in surgical outcome between patients in different score group was also statistically significant. Among the patient with SAS 0-4, major complications occurred in (50%) 15 out of 29 patients and 30 days mortality in (10.3%). In contrast patients with SAS of >8 no major complications or mortality seen. A study by Regenbogen et al. 2 showed among major surgeries, patient with score of 4 or less were 6.5 times more likely to have major complications (95% confidence interval [CI], 4.7-8.9, P < 0.001), Moreover, 112 times more likely to die within 30 days of surgery

It was also noted that in every 2 point score category the incidence of both major complications and death was significantly greater than that of patients in next higher category (Graph 1). A similar result with relative risk of major complications among low scored operations was 16.1 (95% CI, 7.7-34, P < 0.0001), compared with those in high scored operations was noted in a study by Gawande et al.

The long duration of surgery as a factor in the occurrence of major complication as has been established in most studies on the SAS.This may be a reflection complexity of surgery necessitated by possibly extensive disease. However, long duration surgery was not associated with a lower mean SAS in our study.

The burgeoning literature on the SAS also identifies potential weakness of the scoring system. For example, calculation of the score relies on EBL, which critics have often tagged as imprecise. However, the previous studies have shown that the broad categories used to calculate the amount of blood loss (0-100 ml, 101-600 ml, 60-1000 ml, >1000 ml) are easily within observers' range of precision. Another hypothetical weakness lies in the fact that intraoperative hemodynamics maybe affected by anesthetic medications and interventions such as induction and intubation, and therefore, alter the computation of the SAS. For example, a transient episode of hypotension associated with anesthetic induction would be treated the same as prolonged hypotension and resulting a lower (worse) SAS. On the other hand, a transient bradycardic episode would contribute to a higher (better) score. Nevertheless, several studies demonstrate that persistent HR elevation and hypotension are strongly associated with poorer outcomes, regardless of their cause.Finally, other potentially predictive perioperative variables such as coronary artery disease, volume of intravenous fluids administered, patient age, surgical time, functional status, renal function, and chronic steroid use are excluded from the SAS. The exclusion of these potentially predictive preoperative risk factors could be interpreted as a weakness of the score. The prevalence of cardiovascular disease increases with age. Unfortunately, this is the same age group in which the largest number of surgical procedures is performed. However as previously mentioned, an important aspect of the usefulness of the SAS is its simplicity.



Graph 1: Surgical Apgar score in relation to major complications and mortality. *P* < 0.001, significant, Fisher exact test. As the surgical Apgar score decreases more complications and death seen

V. Conclusion

The SAS shows how intraoperative events affect postoperative outcomes. Calculating the SAS in the operating theater provides immediate, reliable, real-time feedback information about patient post-operative risk. Strengths of the SAS include the ability to calculate the score quickly and objectively. The provider could then anticipate the need for further or more aggressive interventions. Ultimately, the score may also prove useful in guiding preventive strategies such as optimizing intraoperative HR or blood pressure.

The SAS could be incorporated into electronic documentation packages for real-time calculation either during or at the end of surgery, providing an automated warning to clinicians. This prognostic value may alert the provider that additional diagnostic testing, further resuscitation, or more intensive monitoring is indicated.

1.The SAS is strongly associated with clinical decisions regarding immediate intensive care unit (ICU) admission after high-risk surgery.

2. The SAS, despite using simple and widely available intraoperative parameters, is adequate in stratification of post-operative risk of major complications following major surgery.

3. For patients with scores ≥7, very few complications noted hence can consider usual care. The patients with a score of 6 or less are high risk for major complication, and patients with a score of 4 or less are very high risk and should be considered at high risk of decompensation and monitored very closely, often in an ICU setting. It may also be useful to make nursing staff aware of these patients who are particularly high risk, so the care team can be notified early of any signs of decompensation.

4. Patients with comorbidities such as diabetes mellitus, hypertension, and anemia found to have a higher risk of complications.

5. Complication rates are higher in emergency surgeries as compared to elective surgeries.

6. Emergency surgery in elderly carries a higher morbidity than elective surgery, elderly should be strongly motivated to undergo elective surgery rather than put off surgery until the disease gets worse.

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