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Predicting morbidity and mortality within 30 days post-operatively using surgical Apgar score- hospital based cross sectional study.

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Abstract

Background: The Surgical Apgar Score (SAS) is a simple, objective and economical ten-point post-operative prognostic scoring system that uses intra-operative information on haemodynamic and blood loss to predict post-operative morbidity and mortality score on a scale of 0 to 10 calculated from three parameters namely lowest heart rate (HR), lowest mean arterial pressure (MAP) and estimated blood loss (EBL) collected during the operative procedure. The SAS is a risk assessment score which can be easily calculated perioperatively.

Materials and methods: A total of 149 subjects were enrolled and co-morbidities like hypertension, diabetes mellitus, chronic liver disease, chronic kidney disease was entered in a pre-tested Performa along with demographic details of the patient. Intra-operatively, lowest mean arterial pressure, lowest heart rate and estimated blood loss was noted. SAS was calculated based on these parameters and patients were grouped into three categories according to the score, with score ≤4 as high-risk group and score ≥8 as low risk group. Results: Complications were significantly higher among the males when compared to the females (76.9% vs 29.6%) with a p-value of <0.001 and among the patients who underwent emergency surgery compared to those on elective surgery (76.2% vs 38.4%) with a p-value of less than 0.001. The complications were significantly higher among the patients with hypertension (p<0.001) and chronic liver disease (p<0.001). Complications were significantly higher among the patients with SAS of 0-4 (p<0.001) and SAS of 5-7 (p<0.001) when compared to the patients with SAS of 8-10.

Conclusion: SAS is good in the prediction of postoperative complications. SAS being simple, cost-effective and easily calculated in the immediate post-operative period can support in decision making regarding post-operative ICU admission, post-operative care and resource allocation.

Keywords: Surgical Apgar Score, Lowest heart rate, Lowest mean arterial pressure, Estimated blood loss.

Introduction

In the modern era, where the cost of health care is increasing, it is important to recognize patients at increased risk of post-operative morbidity and mortality as well as to find interventions to reduce the risk. The present era and the ongoing pandemic have shown the palpable effect of limited health care resources and health care workers both in the developed and developing countries. Adequate and calculated resource allocation for patient care therefore becomes a priority both in reducing the increasing expense of health care and for resource management. In case of surgical departments, one of the major areas of resource usage and money expenditure is in post-operative care of the patient. It is the need of the time to have objective certainty in post-operative management for proper usage of resources including Intensive Care Unit beds with ventilator, prophylactic antibiotic usage, post-operative pain management and hospital stay. Hence, there is a need of an objective prognostic tool to assess the post-operative outcome of patients than relying on the subjective feeling of surgeons, especially when working under limited resources. This could reduce the burden on both the available resources in the hospital setting as well as reduce the overall expenditure for health care without reducing the quality of patient care.

Multiple scoring systems have been proposed as a predictive tool to assess perioperative risk. Some of them are the American Society of Anaesthesia logists Physical Status classification system (ASA classification),[1] the Physiologic and Operative Severity Score for Enumeration of Mortality and Morbidity (POSSUM),[2,3] the Acute Physiology and Chronic Health Evaluation (APACHE) and the Simplified Acute Physiology Score (SAPS).[4]

Each of the above-mentioned systems, however, has limitations and restricted uses. ASA classification was initially a means to stratify a patient's systemic illness but not the post-operative risk. 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. POSSUM, APACHE, and SAPS and their later derivations (including Portsmouth POSSUM, colorectal POSSUM, APACHE II and III, and SAPS II) are even more accurate and objective predictive algorithms, but not all the variables needed are easily and consistently attainable in an operating room setting, making them more practical in their initially role as critical care auditing tools rather than predictive tools.

Virginia Apgar described the 10-point scoring system, the Apgar Score, in 1952 for assessing new born babies. This score is widely used and is helpful in predicting overall outcome after resuscitation of a new born.

The Surgical Apgar Score (SAS) is a simple, objective, and economical ten-point post-operative prognostic scoring system that uses intra-operative information on haemodynamic and blood loss to predict post-operative morbidity and mortality score on a scale of 0 to 10 calculated from three parameters collected during the operative procedure.[4]

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

Parameters	0 Points*	1 Point	2 Points	3 Points	4 Points
Estimated blood loss (mL)	>1000	601 - 1000	101 - 600	≤100	-
Lowest mean arterial pressure (mmHg)	<40	40 - 54	55-69	≥70	-
Lowest heart rate (beats/min)	>85	76 - 85	66 - 75	56-65	≤55

The Surgical Apgar Score is a risk assessment score which can be easily calculated perioperatively. This makes it more practically possible in a busy and resource limited setting.

Another advantage of SAS is that the entire scoring system can be fully automated, so that the human resource expenditure on scoring can be reduced. In case of surgery under general anaesthesia, SAS can be calculated the moment patient is extubated. Based on this score, it can be determined, whether the patient needs intense monitoring, ICU care, ventilator support, and enhanced nursing care. Moreover, the score predicts the possibility of early complications giving the attending surgeon a prognostic map of the patient, based on which future clinical decisions are made.

An uniform, reliable and simple prognostic scoring system for post-operative patients has become the need of time. So far, SAS seems to be one of the best contenders. Many studies have been done on SAS and its use in predicting post-operative complications and mortality. For most surgeries under general anaesthesia SAS has proved to be useful in predicting post-operative complications and mortality in 30 days. This study aims to investigate whether SAS is reliable in general surgery patients who are undergoing elective and emergency surgeries under general anaesthesia and how the co-morbidities that the patient has affects the score and prognosis.

Materials and Methods

It is a hospital based Cross Sectional Study conducted in the Department of Surgery of Regional Institute of Medical Sciences, Imphal from August 2019 to October 2021. Patients over 18 years of age undergoing general surgical procedures, elective or emergency surgeries requiring perioperative monitoring under general anaesthesia were included in the study. Sample size was calculated based on the study by Santosh Singh S et al[5] that showed that the prevalence of mortality in post-surgical patients is 10.4%.

Sample Size Calculation formulae for Single Population:

$$N = \frac{4PQ}{l^2}$$

- "N" is the Sample Size
- "P" is Prevalence
- Q = 100 - P
- l = absolute allowable error (for this study it's taken as 5)
- N = 4 X 10.4 X 89.6 / 5 X 5 = 149
- Sample size for the study is 148.

The 10-point Surgical Apgar Score.

Parameters	0 Points*	1 Point	2 Points	3 Points	4 Points
Estimated blood loss (mL)	>1000	601–1000	101–600	≤100	–
Lowest mean arterial pressure (mmHg)	<40	40–54	55–69	≥70	–
Lowest heart rate (beats/min)	>85	76–85	66–75	56–65	≤55

*Occurrence of pathological bradyarrhythmia (including sinus arrest, atrioventricular block of dissociation, junctional or ventricular escape rhythms) and asystole also receives 0 points for lowest heart rate.

Surgical APGAR Score (SAS).

A meticulous clinical history of all patients who are to undergo operative procedure under general anaesthesia & a complete General Physical Examination will be performed. Mean Arterial Pressure (MAP) were calculated using the following formula. Blood loss is calculated using the formula.[6,7]

- 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)

Surgical APGAR Score (SAS) was calculated for each patient based on the above-mentioned parameters and patients were divided into three categories according to the score

1. Score 0 to 4
2. Score 5 to 7
3. Score 8 to 10.

Data was collected from the study in a Pre-Designed, Pre-Tested Proforma. Data analysis was done using Statistical Package for the Social Sciences (SPSS) software version 22 (IBM Corp., Armonk, NY, United States). Continuous data obtained were expressed as mean ± standard deviation, median and range, whichever is appropriate. Chi-square test (for categorical variables), Independent t-test and ANOVA test (for continuous variables) were used for inferential statistics. A p-value <0.5 was considered as significant.

Ethical clearance and approval from the Research Ethics Board of Regional Institute of Medical Sciences, Imphal was obtained. The confidentiality of the respondents was maintained by not linking personal identities with data.

Results

A total of 149 patients who underwent surgery under general anaesthesia were included in the study. The mean age of the study participants was 41.5 years. The median age of the study participants was 40.0 (28.0-52.0) years with a minimum of 18 years and a maximum of 72 years. The mean body weight of the study participants was 65.5 (8.8) kgs. Among the total 149 patients who were included in the study, 78 were males and 71 were females. The M:F ratio was 1.1:1. elective surgery was conducted among 57.7% patients and the remaining 42.3% patients underwent emergency surgery. Diabetes was present in 23.5% patients and Hypertension was present in 34.2% patients. Chronic liver disease and chronic kidney disease was present in 16.8% and 21.0% patients respectively. The median surgical APGAR score was 7 (5-8) with a minimum score of 1 and a maximum score of 10.

Complications	Frequency (n)	Percentage
Bleeding		
Yes	7	4.7
No	142	95.3
Pneumonia		
Yes	30	20.1
No	119	79.9
SSI		
Yes	67	45.0

No	82	55.0
UTI		
Yes	12	8.1
No	137	91.9
Sepsis		
Yes	26	17.4
No	123	82.6
AKI		
Yes	25	16.8
No	124	83.2
Cardiac arrest		
Yes	5	3.4
No	144	96.6
Re-exploration		
Yes	6	4.0
No	143	96.0

Table showing complications among the study participants (N=149)

Discussion

Like Virginia Apgar's score for new-borns, a simple surgical score based on routine intraoperative data will help surgeons in providing immediate, graded feedback on how an operation went for a patient. The score will help to identify patients with higher risk of complications, which will help to improve their outcomes, particularly in a resource limited setting like India. An ideal surgical risk scoring system should be simple; require minimal calculation, data and variables; be reasonably accurate; and must be objective, economical, and suitable for all situations. The Surgical APGAR Score has been increasingly used as an objective and immediate measure of the intraoperative course calculated in the post-anaesthesia care unit. The score allows for the risk stratification and to implement change efficiently and effectively by distinguishing patients most likely to experience complications and, thus, most likely to benefit from prescribed interventions. Hence there was a need to determine the reliability of Surgical Apgar Score in predicting post-operative complications and mortality among the patients who underwent surgery in our setting.

Our study found that complications were present among 54.4% (95% CI: 46.0%-62.5%) patients. Mortality was present among 6.7% patients. The complications were significantly higher among the patients with SAS of 0-4 (80.6%; $p<0.001$) and SAS of 5-7 (72.0%; $p<0.001$) when compared to the patients with SAS of 8-10 (25.0%). Even after adjusting for confounders, the patients with lower APGAR score had significantly higher rate of complications, in multivariable logistic regression analysis.

A study by Gawande AA et al[4] had concluded that the major complications or death occurred among 58.6% patients with surgical score of less than 4, whereas the complication rate was 36% with surgical score of 9 or 10, which is in line with our study findings.

Similarly, a study by Ito T et al[8] had concluded that major post-operative complications were experienced by 13.2% in their study and mortality was 1.4%. It was also found that patients with a Surgical Apgar Score of 4 or less were 3.7 times more likely to experience a major complication ($p=0.01$) and 24 times more likely to die within 90 days of surgery ($p=0.0007$) compared to patients with a Surgical Apgar Score greater than 8. Even our study results had shown that the patients with SAS of ≤ 4, had 5.28 times the higher chance of complications when compared to patients with a surgical score of ≥ 8.

Wuerz TH et al[9] found that after hip/knee arthroplasty, each SAS point decrease was associated with a 34% increase in the odds of a complication.

Similarly, a study by Ziewacz et al[10] had demonstrated a significant association not only between SAS and complication rates, but also between SAS and hospital and ICU length of stay, with lower scores predictive of higher complication rates and longer hospital and ICU stays, which is also true for a study by Zighelboim I et al[11] for gynecological procedures. It is noteworthy to mention that our study results are also in line with various other studies conducted elsewhere.[4,8,12-20] Hence it can be strongly argued that SAS is reliable in predicting the post-operative complications.

Contradicting our study results, a study in UK had concluded that SAS had limited opportunities to improve the outcomes among patients identified with high risk by the scoring.[21]

Even Haddow JB et al[17] developed a randomized controlled trial using SAS to guide postoperative care. The incidence of complications was lower in the intervention arm, though this was not statistically significant.

Another important observation in our study is that there was significantly higher risk of complications among the males (Adj. OR:10.09 (95% CI:3.47-29.34); p<0.001) and patients undergoing emergency surgery (Adj. OR:4.79 (95% CI:1.32-17.36); p=0.017), on multivariable logistic regression analysis. Although the complications are higher with emergency surgeries, our study still proved that SAS scores could independently predict the complication rate irrespective of the type of surgery.

Even a study by Cihoric Met al[18] focusing solely on emergency abdominal surgery, similar values were obtained with lower SAS having significantly higher complications and mortality. Similarly, there was significantly higher risk of complications among the patients with diabetes (Adj. OR:7.02 (95% CI:1.69-29.02); p=0.007) and hypertension (Adj. OR:29.83 (95% CI:6.66-133.67); p<0.001).

Using ROC curve analysis, the SAS was good in the prediction of postoperative complications with AUC of 0.768 (95% CI: 0.688-0.848) and it was found to be statistically significant (p<0.001). The cut-off value of SAS for predicting post-operative complications was 6.5 with a sensitivity and specificity of 65.4% and 86.8% (Maximum Youden's index).

The study by Singh K et al[19] had shown that the SAS was shown to have a moderate discriminatory ability in our cohort of patients with a c-statistic of 0.71 (95% CI, 0.68-0.73; p<0.001). This also coincides with the reported values in the various SAS trials, done in elective cases, where AUC ranges from 0.69-0.73.[8,10,14] There was a slightly lesser discriminatory value for AUC in a study conducted by Cihoric Met al[18], where only emergency procedures were included.

Conclusion

The study was conducted in 149 subjects, which consisted of 78 males and 71 females. Among the total 149 subjects, 57.7% underwent elective surgeries and 42.3% underwent emergency surgeries. Diabetes was present in 23.5% patients and hypertension was present in 34.2% patients. Chronic liver disease and chronic kidney disease was present in 16.8% and 21.0% patients respectively. The median surgical APGAR score was 7 (5-8) with a minimum score of 1 and a maximum score of 10. Majority (42.3%) of the participants were with a score of 8-10. Post-operative major complications were present in 54.4% of the patients. Mortality was present among 10 (6.7%) patients. Surgical site infection was present among 45.0% patients followed by pneumonia, sepsis and acute kidney injury among 20.1%, 17.4% and 16.8% patients respectively. ICU admission was needed among 34 (22.8%) patients who underwent surgery. The study showed that complications was significantly higher among the males when compared to the females (76.9% vs 29.6%) with a p value of <0.001. The mean age of the participants with complications was higher when compared to those without the complications. Also the complications was significantly higher among the patients who underwent emergency surgery when compared to those who underwent elective surgery (76.2% vs 38.4%) with a p value of less than 0.001. These complications were significantly higher among the patients with hypertension (p<0.001) and chronic liver disease (p<0.001). Complications were significantly higher among the patients with SAS of 0-4 (p<0.001) and SAS of 5-7 (p<0.001) when compared to the patients with SAS of 8-10.

We concluded that SAS was good in the prediction of postoperative complications. SAS being simple, cost-effective and easily calculated in the immediate post-operative period can support in decision making regarding post-operative ICU admission, post-operative care and resource allocation.

However, further study is required to enable us to comment regarding whether proactive post-operative ICU admission, post-operative care and resource allocation based on SAS score may have on the prognosis of the patient and prevention of death or post-operative complications.

References

1. Mak P, Campbell R, Irwin M. The ASA physical status classification: inter - observer consistency. Anaesthesia and intensive care. 2002;30(5):633-40.
2. Copeland G, Jones D, Walters M. POSSUM: a scoring system for surgical audit. Journal of British Surgery. 1991; 78 (3): 355-60.
3. Copeland GP. The POSSUM system of surgical audit. Archives of surgery. 2002;137(1):15-9.
4. Gawande AA, Kwaan MR, Regen bogen SE, Lipsitz SA, Zinner MJ. An Apgar score for surgery. Journal of the American College of Surgeons. 2007;204(2):201-8.
5. Santosh Singh S, Sathya Krishna B. Surgical Apgar score-a simple prognostic tool in surgery. International Journal of Scientific Studies. 2016;4(4):1-5.
6. McCullough TC, Roth JV, Ginsberg PC, Harkaway RC. Estimated blood loss underestimates calculated blood loss during radical retropubic prostatectomy. Urologia Internationalis. 2004;72(1):13-6.
7. Gao F-Q, Li Z-J, Zhang K, Sun W, Zhang H. Four methods for calculating blood-loss after total knee arthroplasty. Chinese medical journal. 2015; 128 (21): 2856.
8. Ito T, Abbosh PH, Mehrazin R, Tomaszewski JJ, Li T, Ginzburg S, et al. Surgical Apgar Score predicts an increased risk of major complications and death after renal mass excision. The Journal of urology. 2015;1 93 (6): 1918-22.
9. Wuerz TH, Regenbogen SE, Ehrenfeld JM, Malchau H, Rubash HE, Gawande AA, et al. The Surgical Apgar Score in hip and knee arthroplasty. Clinical Orthopaedics and Related Research. 2011;469(4):1119-26.
10. Ziewacz JE, Davis MC, Lau D, El-Sayed AM, Regenbogen SE, Sullivan SE, et al. Validation of the surgical Apgar score in a neurosurgical patient population. Journal of neurosurgery. 2013;118(2):270-9.
11. Zighelboim I, Kizer N, Taylor NP, Case AS, Gao F, Thaker PH, et al. “Surgical Apgar Score” predicts postoperative complications after cytoreduction for advanced ovarian cancer. Gynecologic oncology. 2010;116(3):370-3.
12. Ngarambe C, Smart BJ, Nagarajan N, Rickard J. Validation of the Surgical Apgar Score after laparotomy at a tertiary referral hospital in Rwanda. World journal of surgery. 2017;41(7):1734-42.

13. Haynes AB, Regenbogen SE, Weiser TG, Lipsitz SR, Dziekan G, Berry WR, et al. Surgical outcome measurement for a global patient population: validation of the Surgical Apgar Score in 8 countries. Surgery. 2011;149(4):519-24.

14. Regenbogen SE, Ehrenfeld JM, Lipsitz SR, Greenberg CC, Hutter MM, Gawande AA. Utility of the surgical Apgar score: validation in 4119 patients. Archives of Surgery. 2009;144(1):30-6.

15. Reynolds PQ, Sanders NW, Schildcrout JS, Mercaldo ND, St. Jacques PJ. Expansion of the surgical Apgar score across all surgical subspecialties as a means to predict postoperative mortality. The Journal of the American Society of Anesthesiologists. 2011; 114 (6): 1305-12.

16. Prasad SM, Ferreria M, Berry AM, Lipsitz SR, Richie JP, Gawande AA, et al. Surgical apgar outcome score: perioperative risk assessment for radical cystectomy. The Journal of urology. 2009;181(3):1046-53.

17. Haddow J, Adwan H, Clark S, Tayeh S, Antonovich S, Jayia P, et al. Use of the surgical Apgar score to guide postoperative care. The Annals of The Royal College of Surgeons of England. 2014;96(5):352-8.

18. Cihoric M, Toft Tengberg L, Bay-Nielsen M, Bang Foss N. Prediction of outcome after emergency high-risk intra-abdominal surgery using the Surgical Apgar Score. Anesthesia & Analgesia. 2016;123(6):1516-21.

19. Singh K, Hariharan S. Detecting Major Complications and Death After Emergency Abdominal Surgery Using the Surgical Apgar Score: A Retrospective Analysis in a Caribbean Setting. Turkish journal of anesthesiology and reanimation. 2019;47(2):128.

20. Regenbogen SE, Bordeianou L, Hutter MM, Gawande AA. The intraoperative Surgical Apgar Score predicts post discharge complications after colon and rectal resection. Surgery. 2010;148(3):559-66.

21. Thorn CC, Chan M, Sinha N, Harrison RA. Utility of the Surgical Apgar Score in a district general hospital. World journal of surgery. 2012;36(5):1066-73.