Surgical Apgar Score Predicts Postoperative Complications in Traumatic Brain Injury

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Abstract

Background: Predicting complications in neurotrauma patients by using an effective scoring system can reduce morbidity and mortality while facilitating objective clinical decision making during recovery. Compared to existing morbidity and mortality predictive scores, the Surgical Apgar Score (SAS) is simple and effective. We carried out this study to determine the utility of SAS in predicting postoperative complications in neurotrauma patients. **Methods**: A prospective study was carried out at the Kenyatta National Hospital. The SAS was derived using intra-operative lowest mean arterial pressure, lowest heart rate and total blood loss for each patient. Major complications were determined during the thirty day post operative period. **Results**: Two hundred and one patients were reviewed. One hundred and sixteen (56%) of the patients developed major complications. The mean SAS for patients without complications was 7.04 while for patients with complications was 4.80. SAS was found to have a strong correlation with occurrence of major complication during the 30 day post surgery period. **Conclusion**: The SAS is useful in predicting complications and mortality following surgery in patients with traumatic brain injury. The score is recommended in triaging post operative patients and as a guide for patient referral.

Keywords: Surgical Apgar Score (SAS), Traumatic Brain Injury, Complications

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Introduction

An ideal model to predict postoperative complications should be simple and readily applicable to almost all surgical patients. It should properly define the complications, accurately estimate their incidence and have a low threshold to detect them (1). Intra-operative factors altering a patients' condition include extremes in blood pressure, heart rate, body temperature and the amount of blood loss during surgery. A trend of increased complication is observed among patients whose intra-operative mean arterial pressure (MAP) decreases to less than 70mmHg (2). Bradycardia and hypotension are also independently linked to poor outcomes in the recovery period (2-5). A higher wound class and the American Society of Anesthesiologists (ASA) class are also linked to an increase postoperative mortality and morbidity (6). No consensus exists on how to directly evaluate performance and safety during an operation using these variables (7). For the score to be a clinically useful predictor of postoperative complications, each component should independently and collectively contribute to outcome prediction. In the operating room, the surgeon usually relies principally on his "gut feeling" instead of objective assessment to predict postoperative events (8). Operative management contributes heavily to the overall outcome of the patient although there is no available quantitative measure of the operative care provided (1). A simple surgical outcome score, which would allow the surgical team to collect data immediately on completion of an operation, regardless of available resources and technological capacity was derived by Gawande et al. This is the ten point Surgical Apgar score (SAS) and it uses the lowest heart rate, the lowest mean arterial pressure and estimated blood loss during the surgery (9). The SAS, POSSUM and P-POSSUM have been validated at Kenyatta National Hospital in patients undergoing laparotomy and were found to be adequate in predicting major postoperative complication (10,11). In neurosurgery, there has been no comparative tool to quickly assess and objectively determine the status of patients using intra-operative physiological parameters. Previous efforts have been made to validate the POSSUM and P-POSSUM scores in neurosurgical patients using peri-operative parameters but due to their complexity, they have not gained widespread acceptance (12). Local studies have mainly linked the admission clinical parameters with the outcomes of head injury but none of the intra-operative parameters has so far been evaluated for predicting mortality and morbidity in neurosurgical patients (13). We conducted a study to evaluate the utility of the SAS in predicting post operative complications among patients who had undergone surgery for traumatic head injury.

Methods

This prospective study was carried out from December 2014 to March 2015 at the Kenyatta National Hospital (KNH). The target population was patients above 13 years of age undergoing surgery for traumatic brain injury. We excluded patients who underwent other major surgical procedures on other body regions. Patients were followed up for 30 days. The primary researcher and a trained assistant recorded the required variables in a data collecting sheet. Anesthetic notes were used to collect the intra-operative blood pressure and heart rate which were monitored every fifteen minutes from induction to reversal of general anesthesia. The mean arterial pressure (MAP) was calculated by using a formula [(2 x diastolic pressure) + systolic pressure]/3.

Blood loss was calculated using a mathematical formula (16): Blood loss = {EBV (assumed 70 cm^3/kg) x (Pre-op Hb - Post-op Hb) / (Pre-op hematocrit + Post-op hematocrit)/2} + (500 x Units Transfused)

Post operative follow up notes for thirty days after surgery were used to determine occurrence of any major postoperative complications. Major complications definitions were according to American College of Surgeons' National Surgical Quality Improvement Program (6). 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).

Data collected was coded and analyzed using SPSS 17 software. The Student T test and ANOVA were used to compare means, while the Chi square and where applicable the Fischer's exact test were used to compare proportions. A p value of < 0.05 was considered significant. Ethical approval was sought from the KNH Ethics and Research Committee. Patients or the next of the kin received a briefing on the study title, its objectives and its rationale. Thereafter an informed consent was obtained from the patient or the next of kin in instances where the patient was found to have altered consciousness or found incompetent to give consent. For patients aged less than18 years informed consent was obtained from their parents or guardians after obtaining an assent from the minor.

Results

Two hundred and seven patients were recruited of which six were lost on follow up. Their ages range from 13 to 85 years with a mean of 32.7 years (Figure 1). There were 198 (95.7%) male patients and 9 (4.3%) female patients resulting in a male: female ratio of 22:1. The most common diagnoses were extradural hematoma (EDH) 82 (39.6%) and skull fractures 81 (39.1%) while only 1 (0.5%) patient had intra-ventricular hemorrhage (Figure 2). The mean SAS score was 5.72(±0.26) Most patients 40 (19.32%) had a SAS score of 6. Only 1 (0.48%) patient had a SAS score of 0 (Figure 3).

Figure 1. Age distribution

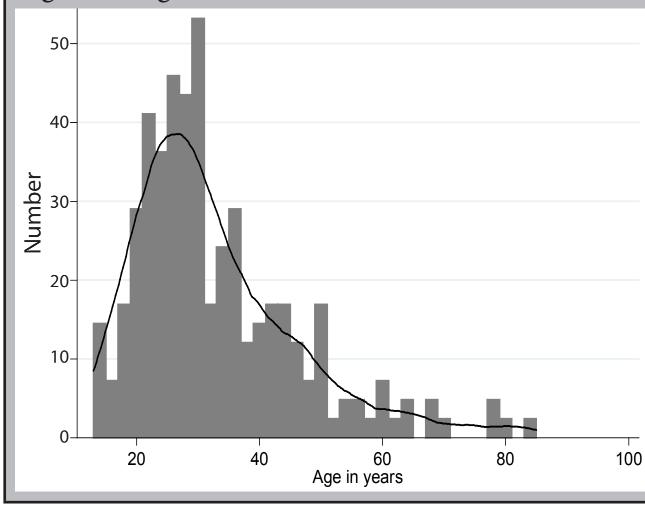
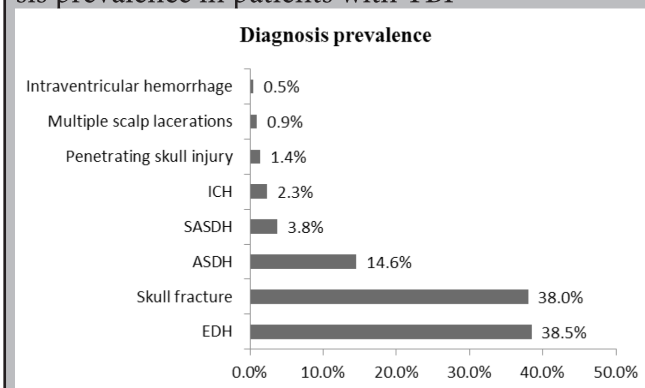
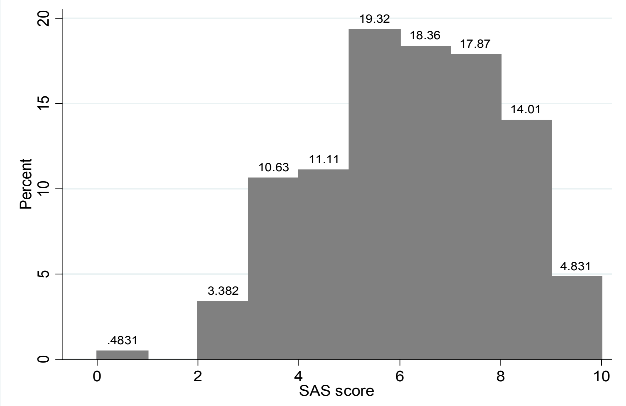


Figure 2: Intra-operative diagnosis prevalence in patients with TBI



ASDH - Acute subdural hemorrhage
EDH - Extradural hemorrhage
ICH - Intra-cerebral hemorrhage
SASDH - Sub acute subdural hemorrhage.

Figure 3: Distribution of SAS scores



Major Postoperative Complications

Majority 116 (56%) of the patients developed one or more major complications during the thirty day postoperative period while 85 (41.1%) did not. The mean SAS score for patients without complications was 7.04 (±0.29) while that for patients with complications was 4.80 (±0.30) ($p < 0.001$).

After stratification, 115 (55.6%) of patients were categorized as medium risk while 53 (25.6%) and 39 (18.8%) were high and low-risk respectively. Majority (64.6%) of patients who had 0 or 1-3 complications were in the medium risk category while most (78%) of those with more than 4 complications were in the high risk category ($p<0.001$). The lower risk category was also associated with lower complications compared to the medium risk category while the medium risk category had lower complications compared to the high risk category ($p<0.001$).

Majority 19(82.6%) of the patients who died had high risk SAS category while majority 108(60.3%) of the patients who did not die had medium risk SAS strata ($p<0.001$) (Figure 4). The most prevalent complications were ICU care (15.0%), neurological deficit (13.5%), and ventilator use for 48 hours (12.9%) (Table 1)

Figure 4: Risk stratification by death occurrence and ICU care need

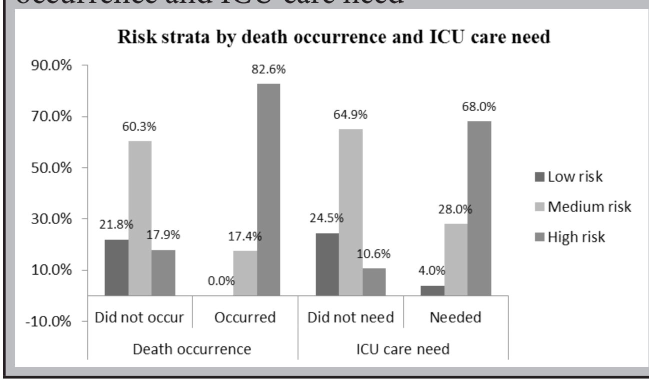


Table 1: Prevalence of major complications in postoperative period

Complications	Frequency	Percent (N=334)
Intensive unit care	50	15.0%
Neurological deficit	45	13.5%
Ventilator use for 48 hours	43	12.9%
Coma for 24 hours after surgery	32	9.6%
Hemorrhage requiring transfusion	30	9.0%
Surgical site infection	24	7.2%
Death	20	6.0%
Pneumonia	18	5.4%
Convulsions (seizures)	16	4.8%
Sepsis or Septic shock	15	4.5%
Acute Kidney Injury	11	3.3%
Unplanned Intubation	9	2.7%
Unplanned return to the operating room	8	2.4%
Prolonged confusion	6	1.8%
Others	6	1.8%
Cardiac arrest requiring cardiopulmonary resuscitation	1	0.3%
Pulmonary embolism/ Deep Venous Thrombosis	0	0.0%
Myocardial infarction	0	0.0%

Discussion

The purpose of this study was to determine the utility of the SAS in predicting major postoperative complications in patients undergoing surgery for traumatic brain injury. Craniotomy for traumatic brain injury is one of the common surgeries at KNH and previous studies have demonstrated the significant morbidity and mortality associated with this surgery (15,17). The median age in our study was 30 years (mean 32.7 years) while males accounted for 95.7% of patients. This is comparable to the study by Kithikii et al (19). The two major studies done in the western countries had a median age of 51 years. These were however retrospective and not restricted to traumatic conditions (15,17). Our finding of EDH being the most common indication for craniotomy is similar to findings by other authors (19).

Post operative complications are common after craniotomies for trauma. The rate of postoperative complications seen in our study is similar to that observed by Reynolds et al (15).

The observed 30-day mortality in our study of 17.2% is slightly higher than that observed by Kithikii et al (19). In contrast however, other authors have reported mortality figures as low as 2.6% (15,17). Surgical mortality is frequently used as a surrogate marker for performance to enable comparisons between individual surgeons and units. This can sometimes be misleading due to differences in case mix as can be seen in differences between patients in our study and that from Reynolds and Johns study in which both trauma and non trauma neurosurgery patients were evaluated.

Majority of patients who developed few or no major complications fell into medium risk category of SAS while high risk patients developed more complications. Mortality and postoperative need of ICU care was also associated with high risk SAS category. This demonstrates the ability of the SAS in identifying patients at a higher than average risk of major post-operative complications or death. Reynolds and John also showed a similar relationship where poor scores correlate with higher morbidity and mortality (15,17).

In a developing country like Kenya, a simple tool like the SAS would be useful in routine post-operative risk stratification thereby facilitating easier identification of high-risk patients. This would allow for prudent allocation of our limited resources for post-operative monitoring and follow up. Studies indicating a link between intra-operative anesthetic and surgical performance and SAS suggest possibility of its use in surgical audit (9,14). Serial monitoring of SAS within a unit may be used as a tool for improving performance. However, more studies in other surgical specialties on this aspect are required.

Conclusion

Surgery for neurotrauma is still associated with significant morbidity and mortality and the SAS is a useful tool to predict their occurrence. The score can guide hospitals with limited facilities (lack of intensive care unit) to facilitate early referrals of patients at risk of adverse outcomes. Further research is recommended in evaluating the use of this score in other surgical specialties.

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