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Surgical Apgar Score Predicts Outcome of Abdominal Surgeries in Indian Setting

KEYWORDS: safe surgery; surgical triage; surgical outcome score

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ABSTRACT *Surgical teams need an objective metric to support their "gut feeling" about surgical outcome. Gawande et al developed a simple, reproducible Surgical Apgar Score (SAS) based on easily available intra-operative parameters to predict the occurrence of major complications. The SAS has been validated in different international settings and has rightly found its place in The WHO guidelines for safe surgery.*

All the previously available peri-operative scores are not easily calculated or are based on the use of complex investigations or formulae.

We prospectively studied 100 patients undergoing abdominal surgeries and calculated their SAS. We studied the outcome of these patients over 30 day period and recorded the occurrence of major complications.

Twenty five of 100 patients in our study suffered major complications. We found the SAS to be a significant predictor (p<0.001) and hence, conclude that SAS is a useful metric in prediction of postoperative complications in open abdominal surgeries in Indian settings.

Introduction –
Efforts to reduce surgery's overall 3 to 17 % major complication and death rate [1] have been hampered in the past. This is because surgical departments in most hospitals have no easily applied tool for routine measurement and monitoring of surgical results. The present day surgical teams remain in dark regarding prediction of the outcome of their surgical procedure to guide clinical practice and still rely on the surgeon's "gut feeling" for prediction of subsequent outcomes [2]. It is important that we, as surgeons understand that the subjective assessment of the patient's outcome should be supplemented by an objective metric to improve surgical triage. The surgical teams will then be able to apply risk modification strategies to a patient predicted at risk by the metric.

Various critical care and outcome scoring systems are used for outcome assessment of a surgical patient - American Society of Anaesthesiologists score (ASA) [3], The Physiological and Operative Severity Score for the enUmeration of Mortality and Morbidity (POSSUM) [4] ,Acute physiological and chronic health evaluation (APACHE)[5], The Biochemistry and Haematology Outcome Model (BHOM) [6] and Charlson's scoring system [7], are a few of them.

However, these scores are not calculated easily at the bedside and require numerous data elements not uniformly collected, with their other limitations making them more practical in their initially intended role as critical care auditing tools rather than predictive tools[8].

The Surgical Apgar Score (SAS) was developed by Gawande et al [9] in 2007 by modifying and adjusting the National Surgical Quality improvement program (NSQIP) [10,11] variables. It was developed in terms with the obstetric Apgar score developed by Virginia Apgar in 1952 which is a simple score based on easily available parameters. The Obstetric Apgar score is predictive of natal outcome and has stood the test of time till date [12 -17]. SAS addresses its predecessor's deficits- It is a simple, reproducible, accurate, objective scoring system available to all patients, in all settings.

We calculated the Surgical Apgar Score in 100 patients undergoing open abdominal surgeries. The outcome studied was occurrence of any major complication (including death) till 30th post operative day.

Materials and methods –
The present study is a Longitudinal observational prospective study of 100 patients aged more than 16 years undergoing emergency or elective open abdominal surgeries from September 2010 to September 2012 at a tertiary care teaching institute and hospital.

The study protocol was approved by the Ethical Committee of our hospital and was therefore performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments..

A detailed history of the patient was recorded with specific enquiries for pulmonary co-morbidities, cardiovascular co morbidities and history of stroke or Transient ischemic attack (TIA). Cardiovascular co-morbidity was defined as prior myocardial infarction, angina, congestive heart failure, or coronary revascularization. Patients with history of transient ischemic attack or stroke with or without residual neurologic deficit were pooled into a single group called "history of stroke or TIA". Pulmonary co-morbidity was defined as preexisting COPD, ventilator dependence, or pneumonia [9].

Using Estimated blood loss (EBL), lowest heart rate (PR) and lowest mean arterial pressure (MAP) during the surgical procedure, the SAS was calculated as devised by Gawande *et al* [9]. We chose these categories as an interval of 2 points because these have been described as statistically significant by Regenbogen et al [18].The Surgical Apgar Score [9]-

Intraoperative parameter	0 Points	1 Point	2 Points	3 Points	4 Points
EBL(ml.)	>1000	601-1000	101-600	≤100	-
Lowest MAP (mmHg)	<40	40-54	55- 69	≥70	-
Lowest P.R. (per min.)	>85	76-85	66-75	56-65	≤55

The SAS is calculated at the end of any open abdominal surgery from the EBL, lowest MAP and lowest P.R. recorded during the operation. The score is the sum of the points from each category. Occurrence of pathologic bradyarrhythmia, including sinus arrest, atrioventricular block or dissociation, junctional or ventricular escape rhythms, and asystole, also receives 0 points for lowest heart rate.

EBL was calculated by considering the number of blood soaked mops and gauze pieces with suction bottle contents [19]. The blood loss calculated by the surgeon and the anaesthesiologist were discussed mutually at the end of the surgical procedure and recorded [20]. The lowest Mean arterial pressure reading was taken from the electronic monitor and from hand written observed anaesthesia records. We preferred electronic data over hand written anaesthesia data [21]. We excluded extraphysiologic values of HR (<20/min. or >200/min) and MAP (<25mmHg or >180mmHg). Surgeries performed were elective and emergency (common bile duct explorations, subtotal gastrectomy with roux-en-y procedures, cholecystectomies, radical cystectomy with ilieal conduit, nephrectomies, adhesiolysis , intestinal perforation repairs, resection and anastomoses for intestinal obstruction, obstructed hernias, and meckel's diverticulum , hemicolectomies etc.)

Patients were followed up for occurrence of any major complications or deaths within 30 days of surgery – telephonically if discharged. Hundred percent follow up of patients enrolled was maintained.

Outcome studied was occurrence of major complications till 30^{th} postoperative day. Major complications were defined as Clavein class III [22] or more complications- acute renal failure, bleeding that requires a transfusion of 4 units or more of red blood cells within 72 hrs. after surgery, cardiac arrest requiring cardiopulmonary resuscitation, coma of 24 hrs or longer, deep vein thrombosis, myocardial infarction, unplanned intubation, ventilator use for 48hrs or more, pneumonia, pulmonary embolism, stroke, wound disruption, deep or organ-space surgical site infection, sepsis, septic shock, systemic inflammatory response syndrome.

Clavein class III and greater - those that require surgical, endoscopic, or radiological intervention or intensive care admission or are life threatening) were also considered as major complications. All deaths were also considered as major complications. Superficial surgical site infection and urinary tract infection were not considered major complications [9].

These outcomes were recorded and analyzed at the end of the study using the Statistical Package for Social Sciences (SPSS) software version 17.0.

Results –
Hundred patients were enrolled in the study. Youngest patient in our series was 16 years of age and the eldest was 84 years old. Median age of our study group was 62 years. 82% patients in our series did not have any preoperative co-morbidity.15% patients suffered from a pulmonary co-morbidity and 3% had cardiovascular co-morbidity preoperatively. However, the SAS is calculated independent of preoperative comorbidity [9,10].

Of hundred, 10% patients had a SAS of four or less than four, 39% patients had a score of 5 or 6 and 51% patients had an SAS of more than or equal to 7. Of hundred patients, 25% in our study developed major complication including death (table 1). Using Chi-square test for determining statistical association between SAS and occurrence of complication, p-value was found to be < 0.05 (table 2). Using Fisher's exact test for association of occurrence of complications with individual parameters of Apgar score i.e., EBL, MAP and lowest P.R. the p value was found to be <0.05, >0.05 and <0.05 respectively. Binary logistic regression for dependent variable occurrence of complication and predictors are EBL, MAP and PR the p-value was < 0.05 (table 4).

Discussion –
We studied the utility of the SAS in predicting outcome in 100 patients undergoing abdominal operations at our hospital – a tertiary care teaching institute. The Surgical Apgar score since its inception by Gawande *et al* in 2007[9] has been validated in general and vascular surgery [9,10], colectomies [23,24], pancreaticoduodenectomies [25] , Cytoreduction for advanced ovarian cancers[26] and across diverse surgical sub-specialities [27]. The SAS has also been validated in diverse international settings across the world [28]. Validity of the Surgical Apgar Score is yet to be proven in Orthopaedic procedures [29] minimally invasive procedures and Paediatric age group.

The limitations of the study by Gawande *et al* in their original article [9] have all been addressed at this point of time and SAS has also found its place in WHO guidelines for safe surgery [30].

We chose to study the SAS at our hospital in patients undergoing open abdominal surgeries because it represents the major bulk of operative procedures at our institute. Surgeries performed were both elective and emergency and patients of age <16 years at the time of operation were excluded. Of the hundred patients enrolled in the study, ten patients in our series had a SAS of ≤ 4 and fifty one patients had a score of 7 or more. The predictive value of Surgical Apgar Score to predict the complications was found to be <0.001 (significant). Two deaths occurred from multi-organ failure and sepsis. Thus, SAS was useful in predicting complications in the present series. The Odds ratio on comparison of patients with a score of ≤ 4 was found to be 3.5 i.e., patients who had a score of ≤ 4 were 3.5 times more prone to develop post operative complications. Twenty five patients suffered major complications including 3 deaths post operatively. Seventy five patients recovered uneventfully or with minor complications like urinary tract infections, superficial surgical site infections etc.

We found amount of blood loss during the surgery and lowest pulse rate during the surgical procedure to be significantly related with post operative complication (p =0.045) and (p=0.005) respectively. MAP was not found a significant predictor of major complications. (p=0.478). Mean arterial pressure readings in our series were derived from hand written anaesthesia records as well as electronic monitor readings taken at 5 min intervals intra-operatively.

Fluctuations in arterial pressure in these 5 min intervals could probably have been better studied by more frequent vigilance. This could be possible by using a parameter that can give a more constant overview of tissue perfusion example – Intra-operative Lactic acid levels.

On multivariate analysis we found that there is association between occurrence of complication with EBL and PR. The odd of EBL and PR is more than 1 (Significant).

The surgical apgar is a useful parameter for predicting post operative outcome of patients. The score may have use in several areas. For example, during the handoff process (the communication between physician services or physician and nursing team members) it can signal the provider taking over care to the overall risk the patient is facing and may indicate the need for additional care measures to minimize the risk.

Improving surgical mortality and morbidity is only speculative at this time. However the score provides an objective adjunct to facilitate discussions of the surgeon, anesthesiologist and the intensive care physician in determining the need for heightened postoperative care strategies that additional diagnostic testing (arterial blood gases, serum lactate or hematocrit determinations), further resucitation, one-on-one nursing, or more invasive monitoring is indicated.

The original model of Gawande *et al* was kept simple so that a human could compute the score. Although the simplicity of the original model is reasonable and in fact, a major point of the score, the broad adoption of automatic peri-operative information systems could facilitate a more complex and improved model. The Surgical Apgar Score 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. The additional complexity would be acceptable because the score would then be computed in real time using the computer.

The Surgical Apgar Score developed by Gawande *et al* is is a simple, reproducible, accurate, objective scoring system available to all patients, in all settings. It serves a useful objective metric to supplement the subjective assessment of postoperative outcome of patients.

Future work should be directed towards improving the surgical apgar score for elective and minimally invasive surgeries and in paediatric population. Its use can be examined in guiding intra-operative techniques and postoperative interventions, such as intensive care admissions or other escalations in diagnosis or therapy.

Conclusion –

Our results from the study

- Validate the use of Surgical Apgar Score for predicting post operative outcomes in patients undergoing open abdominal surgeries.
- Estimated blood loss and lowest pulse rate during the surgery are significant predictors of major postoperative complications whereas lowest mean arterial pressure was not.

Based on our findings, we conclude that the Surgical Apgar Score is simple, easily calculated and a reproducible objective metric for open abdominal surgeries in Indian settings.

Table 1 : Distribution of patients with respect to APGAR score.

APGAR score	Number of patients
≤ 4	10
5 – 6	39
≥ 7	51
Total	100

Table 2: Distribution of patients with respect to occurrence of complication and APGAR score.

APGAR score	Complication		Total	p-value
	Major complication	No complication		
≤ 4	5	5	10	0.001
5 – 6	15	24	39	
≥ 7	5	46	51	

Table 3: Distribution of patients with respect to occurrence of complication and APGAR score with respect to type of surgery.

Surgery	APGAR score	complication		Total	p-value
		Major complication	No Complication		
Emergency	≤ 4	5	3	8	0.001
	5 - 6	13	20	33	
	> 7	3	24	27	
Elective	≤ 4	0	2	2	0.367
	5 - 6	2	4	6	

Table 4 : Multivariate Analysis of parameters of the present study

Parameters	B	S.E.	Wald	df	Sig.	Odds ratio	95% C.I. for Odds	
							Lower	Upper
EBL	0.652	0.309	4.459	1	0.035	1.919	1.048	3.513
MAP	-0.547	0.595	0.846	1	0.358	0.578	0.180	1.857
PR	0.753	0.247	9.283	1	0.002	2.123	1.308	3.446
Constant	-3.670	1.957	3.517	1	0.061	0.025		

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