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General Surgery

KEY WORDS: Surgical Apgar score, Risk prediction models, Mortality prediction, Morbidity prediction model.

A PROSPECTIVE STUDY TO DETERMINE POST OPERATIE MORBIDITY AND MORTALITY USING SURGICAL APGAR SCORE

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ABSTRACT

Introduction: Predicting the post-operative complication earlier will help surgeons take necessary precautions Pre and Peri-operatively. It reduces the direct as well as indirect medical cost. The main risk factors which have effect on morbidity as well as mortality are Age ,Type of surgery, History of Diabetes, Hypertension, Smoking, Renal disease, Cardiovascular disease, COPD, Asthma, steroid intake etc. Atul Gawande et al developed a scoring system as a boon for surgeons termed as surgical Apgar scoring system. Though initially devised for Colorectal surgeries this scoring system can be applied for general surgical procedures and predicts major complications as well as mortality using Lowest Heart Rate intra operatively, Lowest Mean Arterial Pressure intra operatively and Estimated Blood Loss. Existing prediction scoring system that involve lab investigation needs meticulous procedure. Hence this study is being carried out to evaluate the ability of Surgical APGAR score to predict post-operative morbidity and 30 days for General Surgical procedures.

Materials and methods: Descriptive longitudinal study carried out at Department of General surgery, Meenakshi Medical College & Research Institute, Kanchipuram, Tamil Nadu, for a period of 12 months With a sample size of 200

Inclusion criteria: Patients aged between 15-75 years undergoing Emergency or Elective General surgical procedures under General, Spinal or Epidural anesthesia.

Exclusion criteria: Patient on Beta Blockers and those undergoing procedures under Local Anesthesia were excluded.

Results: Among the comorbid conditions COPD, Asthma and Renal failure have statistically significant association with Surgical Apgar score. There is statistically significant association between type of surgery and Surgical Apgar score. There is statistically significant association between Surgical Apgar score and complications. There is statistically significant association between surgical Apgar score and mortality. Among 8 individuals who had high risk score 6 individuals had mortality.

Conclusion: The 10-point Surgical Apgar Scoring system is an easy and fairly accurate method of identifying the patients at risk of complications and mortality in the post-operative period. Patients with low surgical Apgar score would require more intensive monitoring in the postoperative period even if they are undergoing a minor procedure.

INTRODUCTION

The surgeons with their team and the hospital management strive hard to minimise the morbidity and mortality arising due to surgery. One of the best way to reduce it is to predict and prevent it. Early diagnosis and prompt treatment is definitely going to help surgeons in the patient care.

A risk prediction scoring system should be easily available, accessible and should be easily administered by surgeons and should be non-invasive and cheap. In a resource constrained country like India, financial burden of health care should be borne in mind before administering any predictive scoring system.

Ideal prediction score should be
1. Simple
2. Easily available
3. Accessible
4. Non-invasive
5. Cheap
6. Accurate

Atul Gawande et al developed a scoring system as a boon for surgeons termed as surgical Apgar scoring system. This system satisfies all the above criteria. This scoring system predicts major complications as well as mortality. Even though many factors influence the outcome, three parameters are independent risk factors.

1. Estimated blood loss
2. Lowest heart rate
3. Lowest Mean arterial pressure

The first one is calculated based on pre and post-operative haemoglobin, amount of blood transfused and body weight. The second and third parameter data is collected from anaesthetist record. Hence it is easily calculated.

METHODOLOGY

Descriptive longitudinal study carried out in Department of General surgery, Meenakshi Medical College & Research Institute, Kanchipuram, Tamil Nadu, for a period of 12months.
Sample size:200

INCLUSION CRITERIA

Age-15-75 years
Patients undergoing Emergency or Elective General Surgical procedures under General, Spinal or Epidural anesthesia.

EXCLUSION CRITERIA

Patient on Beta Blockers and those undergoing procedures under Local Anesthesia were excluded from the study.

Patient vitals were assessed pre-operatively along with History of DM, Hypertension, Smoking, Cardiac disease, COPD, Asthma, Renal failure. Intra operatively they were assessed for,

- Lowest heart rate
- Lowest mean arterial pressure
- Estimated Blood Loss

Estimated blood loss formula

Blood loss = EBV × $(HB_i - HB_f) \div \{(HB_i + HB_f)/2\}$ + {500×Tu} where,

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

HB_i = Pre-operative hemoglobin (g/dl),
HB_f = Post-operative hemoglobin (g/dl) around 24 h after surgery
Tu = Sum of whole blood, packed red blood cell transfused.

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

Risk stratification
High risk group: Scores 0-4
Medium risk group: Scores 5-7
Low risk group: Scores 8-10
Data analyzed using SPSS Version 22.

RESULTS

Majority of the study population are in the age group of less than 40 years(37.5%).About 25% are in the age group of 41-50 years.17.5% are in the age group of 51-60 years and 21% are in the age group of more than 6o years [Table 1, Fig 1]; In our study 33% had diabetes,30% had hypertension,16% had cardiac disease 10% had COPD and other 10% had asthma and 8% had renal failure [Table 2, Fig 2]; In our study 61% had elective surgeries and 39% had emergency surgeries [Table 3]; In our study 84% had no complication,9% had wound infection ,5% had pneumonia,1% had sepsis and 1% of study participant was on ventilator [Table 4]; In our study, there were 6 deaths [Table 5, Fig 5]; About 27.5% had heart rate ranging from56-65,17.5% had heart rate of 76-85.Only 11.5% had heart rate of less than 55 [Table 6]; About 52% had Mean arterial pressure of more than 70.45.5% had Mean arterial pressure from 55-69 [Table 7]; One patient had blood loss in excess of 1000ml (0.5%), two patients had blood loss between 600-1000ml (2%) and majority had blood loss less than 600ml (98.5%) [Table 8]; About 24% had Surgical Apgar score of 9, 22.5% had score of 8.Majority i.e. 25%had score of 6 [Table 9]; Among the comorbid conditions COPD, Asthma and Renal failure has statistically significant association with Apgar score [Table 10];

There is statistically significant association between type of surgery and surgical apgar score (X2=4.54 P=0.05) [Table 11, Fig 6]; Statistical significance also noted between type of surgery, complications and mortality [Tables 12,13,14; Fig 7,8,9].

Table 1: Age wise distribution of the participants in Years

Age	Frequency	Percent	Mean±S.D
≤40years	75	37.5	44.68±15.68
41-50years	48	25	
51-60years	35	17.5	
≥61 years	42	21	
Total	200	100	

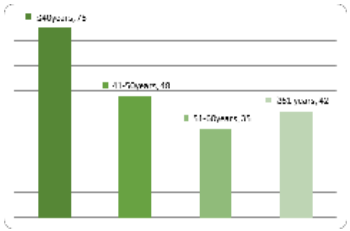


Figure 1: Age wise distribution of the participants in Years

Table 2: Co-Morbid Conditions

Conditions	Frequency	Percentage
Cardiac disease	32	16
Diabetes Mellitus (DM)	66	33
Hypertension (HT)	60	30
COPD	20	10
Asthma	20	10
Renal failure	16	8

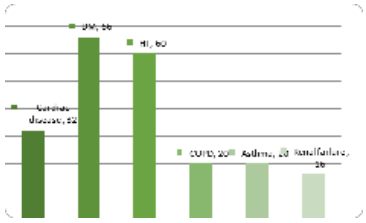


Figure 2: Co-Morbid Conditions

Table 3 : Type of Surgery

Type	Frequency	Percentage
Elective	122	61
Emergency	78	39
Total	200	100

In our study 84% had no complication,9% had wound infection ,5% had pneumonia,1% had sepsis and 1% of study participant was on ventilator.

Table 4: Major complication following surgery

Complication	Frequency	Percentage
Wound infection	18	9
Sepsis	2	1
Pneumonia	10	5
Ventilator support	2	1
Uneventful	168	84
Total	200	100

In our study, there were 6 deaths .

Table 5: Mortality among study participants

Status	Frequency	Percentage
Yes	6	3
No	194	97
Total	200	100

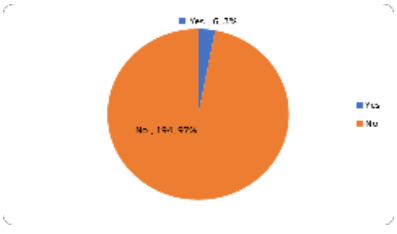


Figure 5: Mortality among study participants

About 27.5% had heart rate ranging from56-65,17.5% had heart rate of 76-85.Only 11.5% had heart rate of less than 55.

Table 6: Lowest heart rate among study participants

Heart rate	Points	Frequency	Percentage
>85	0	13	6.5
76-85	1	35	17.5
66-75	2	74	37

56-65	3	55	27.5
≤55	4	23	11.5
Total		200	100

About 52% had Mean arterial pressure of more than 70.45.5% had Mean arterial pressure from 55-69 .

Table 7: Lowest Mean arterial pressure

MAP	Points	Frequency	Percentage
40-54	1	5	2.5
55-69	2	91	45.5
≥70	3	104	52
Total		200	100

One patient had blood loss in excess of 1000ml (0.5%), two patients had blood loss between 600-1000ml (2%) and majority had blood loss less than 600ml (98.5%)

Table 8: Estimated blood loss

Blood loss in ml	Points	Frequency	Percentage
>1000	0	1	0.5
601-1000	1	2	1
101-600	2	82	41
≤100	3	115	57.5
Total		200	100

About 24% had Surgical Apgar score of 9, 22.5% had score of 8. Majority i.e. 25%had score of 6.

Table 9: Surgical apgar score

Score	Frequency	Percentage
1	1	0.5
2	2	1
3	1	0.5
4	4	2
5	5	2.5
6	50	25
7	44	22
8	45	22.5
9	48	24
Total	200	100

Table 10: Correlation between Surgical Apgar score and Comorbid conditions

Comorbid condition	0-4	5-7	8-9	Total	Chisquare	P Value
Diabetes	5	31	30	66	3.29	0.19
Nondiabetic	3	68	63	134		
Hypertension	5	28	27	60	4.20	0.12
Non- HT	3	71	66	140		
Cardiac disease	2	19	11	32	2.43	0.296
No	6	80	82	168		
COPD	1	15	4	20	6.33	0.04
No	7	84	89	180		
Asthma	1	15	4	20	6.33	0.04
No	7	84	89	180		
Renal failure	1	14	1	16	11.35	0.003
No	7	85	92	184		

Among the comorbid conditions COPD, Asthma and Renal failure has statistically significant association with Apgar score.

Table 11:Association between type of surgery and surgical apgar score

Type	0-4	5-7	8-9	Total	Chisquare	P value
Elective	2	61	59	122	4.54	0.05
Emergency	6	38	34	78		
Total	8	99	93	200		

X2=4.54
P=0.05

There is statistically significant association between type of surgery and apgar score.

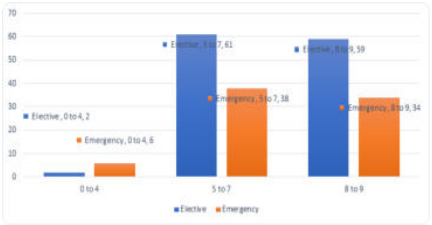


Figure 6: Association between type of surgery and surgical apgar score

Table 13:Association between surgical Apgar score and complications

Apgar score	Wound infection	sepsis	Pneumonia	Ventilator	Uneventful
0-4	2	1	4	1	0
5-7	15	1	5	1	77
8-9	1	0	1	0	91
Total	18	2	10	2	168

X2=381.65
P=0.0001

There is statistically significant association between surgical Apgar score and complications

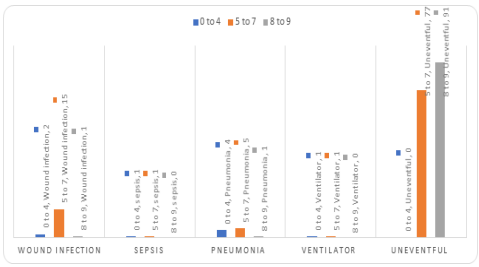


Figure 8:Association between surgical Apgar score and complications

Table 14:Association between surgical Apgar score and mortality

Apgar score	Mortality		Total	X2	P
	Yes	No		165.63	0.0001
0-4	6	2	8		
5-7	0	99	99		
8-9	0	93	93		
Total	6	194	200		

There is statistically significant association between surgical Apgar score and mortality

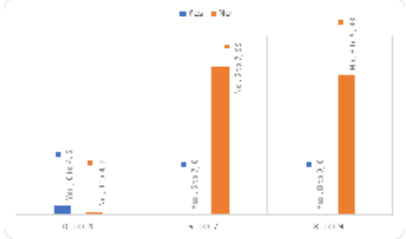


Figure 9:Association between surgical Apgar score and mortality

DISCUSSION

Traditionally, peri-operative mortality has been defined as any death, regardless of cause, occurring within 30 days after surgery in or out of the hospital, and after 30 days during the same hospitalization subsequent to the operation.

Operative mortality rates are used as a universal metric for the surgical quality assessment and is of great interest to the surgeon, patient and policy makers. The perioperative death rate is a measure of the quality of surgical care system and improving this rate is the global priority.

Perioperative morbidity & mortality is an important public health problem, because of its impact on patient's short & long term of survival, and also resource utilization within the health care service.

The ideal risk prediction method should be the one that is simple, reproducible, accurate, objective, and available to all patients. Many hospitals lack the resources to run expensive tests, so ideally it should be cheap, and possible to perform at the bedside.

Virginia Apgar, an anaesthesiologist, described the 10-point scoring system, the Apgar score, in 1952 for assessing new-born babies. Scoring is done at 1 min and 5 min after birth. The score is helpful in predicting overall outcome after resuscitation of a child. Anaesthesiologists and surgeons anticipate the perioperative events involved after major surgeries (laparotomies, resection/anastomosis, vascular surgery, neurosurgeries, emergency or urgent surgery) on the basis of factors like,

- Age,
- Associated co-morbidities,
- Surgical blood loss,&
- Surgery duration.

In relation to the Surgery, risk scoring system can be grouped into three category.

1. Preoperative assessment
2. Perioperative assessment
3. Postoperative score

Pre-operative Risk Assessment Scores

American Society of Anesthesiologists Score (ASA)

The ASA score was initially devised as a system to collect and tabulate statistical data in anesthesia, applicable in almost any circumstance. This system, proposed in 1940-41 is attributed to three physicians (Ivan Taylor, Emery Rovenstine and Meyer Saklad).

This score, widely used for the risk assessment, was originally aimed at grading the patients "in relation to the physical status only". This score is based on clinical evaluation alone and is subjective, although the clinician's assessment can be indirectly influenced by the patient's test results which are objective.

Code	Patient Pre-operative Physical Status
1	Normally healthy patient
2	Patient with mild systemic disease
3	Patient with severe systemic disease that is not incapacitating
4	Patient with an incapacitating systemic disease that is a constant threat to life
5	Moribund patient who is not expected to survive for 24 hours with or without operation

Factors which limit its applicability are subjectivity, wide inter-observer variability and lack of specificity in its design. The assumption by this system that the physical fitness of a patient is not related to age is not true

The ASA score can be used to categorize preoperative risk and it is a good indicator of the postoperative morbidity and mortality. This score is better for stratifying risk than as a postoperative mortality indicator.

Surgical Risk Scale (SRS):

The Surgical Risk Scale was devised by Sutton et al as an audit tool for comparing surgical procedures. This has been identified to be a good predictor of mortality. This risk scoring system is a combination of the American Society of Anaesthesiologists(ASA) Score, the British United Provident Association operative grade and the Confidential Enquiry into Peri-operative Deaths category. The Surgical Risk Scale is graded from 3 - 15, each value corresponding to a mortality score. Including the ASA score makes the SRS a partially a subjective score.

Peri-Operative Physiological Score

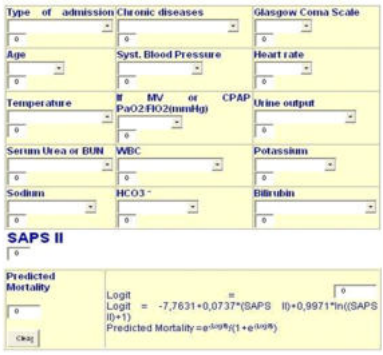
Acute Physiology and Chronic Health Evaluation (APACHE)

The Acute Physiology and Chronic Health Evaluation (APACHE) II was established using a database of North-American ICU patients at 1985. It uses the score derived from the 12 routine physiological measurements taken during the first 24hrs after admission, age & previous medical issues to provide information about the severity of disease. A score from 0 to 71 is derived based on these measurements. A higher score indicates a more severe disease with greater risk of mortality. The APACHE II has been applied to predict acutely ill patients and has aided researchers to compare the effectiveness of various treatment modalities. However, APACHE II led to an overestimation of mortality as physiological variables considered were dynamic and kept changing during the course of treatment. Later, APACHE IV was introduced in which another five variables were added: mechanical ventilation, thrombolysis, impact of sedation on Glasgow Coma Score (GCS), re-scaled GCS, and PaO2/FiO2 (arterial oxygen tension and fractional concentration of inspired oxygen) ratio.

Simplified Acute Physiology Score (SAPS):

Another score used to predict outcomes in medical and surgical patients is the Simplified Acute Physiology Score (SAPS). The SAPS II is used to assess the risk the status of patients admitted in the ICU(intensive care unit). It comprises 17 variables: 12 physiological variables - age, type of admission, and 3 disease-related variables.

The SAPS II score records the lowest value of selected variables within the first 24hrs after admission and can have a score between 0 and 163 points (0–116 points for physiologic variables, 0–17 points for age, and 0–30 points for previous diagnosis). Logistic regression is used to calculate the probability of death.



The SAPS and APACHE were more dependable in calculating severity of condition and outcomes in the medical patients when compared to surgical patients. Rapsang et al. have described nine normally used risk scoring methodology for assessing the morbidity and mortality of patients admitted in the ICU. The authors felt that choosing an inappropriate risk scoring system could lead to a significant waste of time, unwanted investigations, increased cost, and unwarranted extrapolations. Anaesthetist uses the American Society of Anaesthesiologists–Physical Status (ASA-PS) classification for labelling patients based on co-morbidities, functional status, & emergency / elective surgery. The ASA-PS was not intended to predict the mortality of a surgical patient. The ASA classification, with a positive predictive value of 57% for complications and a negative predictive value of 80%, is not considered reliable for predicting the 30-day postoperative course accurately

Post-Operative Scores

The Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity (POSSUM)

Copeland et al. originally described POSSUM in 1991, for assessing morbidity and mortality of patient undergone surgical procedure. In 1998, the Portsmouth's modifications or the P-POSSUM was defined. The P-POSSUM was more dependable and accurate when compared to the POSSUM described by Copeland. POSSUM used twelve physiological variables and six operative variables. Although P-POSSUM also uses the same variables that are used for POSSUM, the equation used to calculate the score is different. All the values have to be entered, and the score is derived either by adding up or by using software. Moreover, many investigations such as Haemoglobin, Urea, White Blood Cell count, Serum Sodium, Serum Potassium, and ECG are required. Surgical events are also used for risk scoring (peritoneal soiling, multiple surgeries). There could be a lot of personal differences when certain entries are made like assessment of surgery and respiratory status. In addition, POSSUM is not applicable for trauma patients, and an overestimation of POSSUM is possible in hepato-pancreato-biliary surgeries.

The 12 Physiologic Indices and Six Operative Indices Used for Calculating the POSSUM Score.

Physiologic Indices		Operative Indices
Age	Hemoglobin	Operative severity
Cardiac history	White cell count	Multiple surgeries
Respiratory history	Urea	Total blood loss
Pulse rate	Sodium	Peritoneal spillage
Blood pressure	Potassium	Malignancy
Glasgow coma scale	Electrocardiogram	Mode of surgery

A total of 18 indices must be entered to derive a POSSUM score. The score could be unreliable if any one index is missing.

Estimation of Physiologic Ability and Stress (E-PASS):

Estimation of Physiologic Ability and Stress (E-PASS) developed by the Japanese as a comparative surgical audit tool uses co-efficient and combines pre-operative and operative factors. E-PASS also takings into account the age and the ASA score. This Risk scoring model has been validated in elective gastro-intestinal surgery. The post-operative morbidity rate directly increases as the CRS (Comprehensive Risk Score) increases. A CRS of less than 0.5 corresponds to a postoperative mortality rate of only 0.13%, CRS between 0.5 to less than 1 has a mortality rate of 9.7%, and CRS greater than 1 has a rate of 26.9%. This infers that the E-PASS score is better in predicting post-operative risk, calculating the approximate medical expenses, and in comparing the surgical procedure quality. These results suggest E-PASS may be useful in predicting postsurgical risk, estimating medical expense, and comparing surgical quality. Though partly identical to POSSUM and P- POSSUM, this method is very complex to calculate risk

THE SURGICAL APGAR SCORE (SAS)

Gawande et al. defined the Surgical Apgar Score (SAS) in 2007. The score was formulated from a retrospective analysis of 303 patients who underwent colorectal surgeries at Brigham and Women's Hospital, Boston, MA. This 10-point score is depend on the patient's s intra-operative blood loss, the lowest intra-operative heart rate, and lowest recorded mean arterial pressure. The authors perceived that as the score increases, outcomes improved at the end of 30 days. Many papers were subsequently published that interpreted prospective and retrospective data and concluded that SAS could accurately calculate morbidity and complications in several surgical sub-specialties. The SAS uses a 10-point scoring system that has been used to accurately predict early and 30-day postoperative complications in all major surgeries in the last decade. The 10-point SAS is shown in.

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.

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

Patients were subsequently grouped into three categories based on their SAS for purposes of risk stratification. Thus,

- High risk group: Score 0-4
- Medium risk group: Score 5-7
- Low risk group: Score 8-10.

All Retrospective Studies Using SAS Scores for Various Surgeries to Predict Immediate and Delayed Postoperative Complications (30 days)

Surgery Type (# of Patients) Ref.	Prognostic Value (Y/N)	Remarks
Knee arthroplasty (3,511)[13]	No	The authors felt SAS was insufficient for prognostication
Colectomy (795)[14]	Yes	SAS predicted inpatient as well as late post-discharge complications
General/vascular surgery (4,119)[14]	Yes	
Major intra-abdominal surgeries (8,501)[14]	Yes	
Esophagectomy (189)[15]	Yes	SAS predicted major morbidity associated with longer hospital stay
Esophagectomy (168)[16]	Yes	
Ivor Lawis (234)[16]	No	SAS could not predict adverse outcomes
Esophagectomy (399)[20]	Yes	
Gastrectomy (328)[21]	No	Original SAS not found useful; modified SAS was helpful in predicting complications
Hysterectomy for malignancy (632)[22]	No	SAS uncorrelated with postoperative events
Pancreatoduodenectomy (2012)[23]	Yes	
Intracranial and spine neurosurgery (918)[24]	Yes	
Surgery for spinal metastasis (97)[25]	No	SAS an insignificant predictor of major perioperative complications following spinal metastasis surgery; preoperative functional status and age were stronger predictors
Lower extremity amputations (228)[26]	Yes	Predicted potential development of complications
Wide surgical subspecialties (123,864)[27]	Yes	
Intracranial meningioma excision (999)[28]	Yes	SAS predicted early and late complications
Pancreatoduodenectomy (103)[29]	Yes	SAS was a significant independent risk factor for overall and recurrence-free survival
Radical prostatectomy (994)[30]	Yes	
Lumbar spine fusion (199)[31]	Yes	
Gastrectomy (191)[32]	Yes	SAS predicted survival after surgery
Major intra-abdominal surgery (629)[33]	Yes	SAS predicted survival after surgery
Kidney transplant (204)[34]	Yes	SAS correlated with ICU stay and overall cost of treatment
Microvascular head and neck reconstruction (154)[35]	No	SAS uncorrelated with postoperative complications
Surgery for traumatic hip fractures (43)[36]	Yes	
Pancreatic resection (143)[37]	Yes	SAS along with hypoalbuminemia and blood transfusion correlated well with hospital stay and complications
Major gastrointestinal surgeries (1,833)[38]	Yes	The authors modified SAS by including intraoperative blood transfusion and assigned zero estimated blood loss (EBL) score to patients who received transfusion; they concluded that intraoperative transfusion improved risk stratification of SAS

Prospective Studies Using SAS Scores for Various Surgeries to Predict Immediate and Delayed Postoperative Complications (30 days).

Surgery Type (# of Patients) Ref.	Prognostic Value (Y/N/Insignificant)	Remarks
General/vascular surgery (143)[39]	Insignificant	Suggested conducting randomized control trial
Spine (268)[40]	Yes	
General orthopedic (723)[41]	No	SAS did not predict 30-day major complications after general orthopedic surgery
Radical cystectomy (155)[42]	Yes	
General surgery (2,125)[43]	Yes	
Laparotomy (218)[44]	Yes	
Non-cardiac surgeries (5,909)[45]	Yes	
General and vascular surgeries (224)[46]	Yes	
General, vascular, and orthopedic surgeries (223)[47]	Yes	SAS uncorrelated with orthopedic patients who had major events
Renal mass excision (886)[48]	Yes	
High-risk intra-abdominal surgeries (355)[49]	Yes	SAS was significantly predictive but weakly discriminative for adverse events

Surgeons need a predictive tools to assess perioperative risk. Several algorithms have been used or developed for risk prediction 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 Health Evaluation (APACHE), and the simplified acute physiology score (SAPS). However, each of these systems has limitations and restricted uses. The ASA classification was originally 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).

CONCLUSION

The surgical Apgar score has proved to be an important tool in predicting post-operative morbidity and mortality. Patients with low surgical Apgar score would require more intensive monitoring in the postoperative period even if they are undergoing a minor procedure.

Mortality rates are twelve times higher in emergency surgeries in comparison to elective cases. In case of laparotomy, the rate is two times higher for emergency laparotomy.

The 10-point Apgar scoring system is an easy and fairly accurate method of identifying the patients at risk of complications and mortality in the post-operative period.

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