ORIGINAL ARTICLE

Use of a modified surgical APGAR score for prediction of postoperative complications in emergency surgery: An observational retrospective study

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ABSTRACT

BACKGROUND: The surgical Apgar score (SAS) was defined by Gawande et al. in 2007. It has been shown that this scoring system was highly effective for predicting the incidence of post-operative complications and mortality. In this study, we aimed to define a new, modified SAS (mSAS) for predicting the incidence of post-operative complications and mortality in emergency surgery. We also wanted to quantify the effectiveness of this modified scoring system, comprising of the duration of the operation in addition to the three intraoperative parameters of the SAS score.

METHODS: Five hundred and seventy-nine patients who underwent emergency surgery were enrolled in this retrospective observational study. At the end of the operation, the SAS was calculated from the data obtained from the examination of the patients and the mSAS was calculated by adding the duration of the operation to data used in the calculation of the SAS (Surgical duration >8 h; –4 points; 7.01–8 h; –3 points; 5.01–7 h; –2 points; 3.01–5 h; –1 points; 0–3 h; 0 points added).

RESULTS: There was a statistically significant relationship between the mSAS and the total number of complications (as operative time [OT] increased, the number of complications increased) (r=0.360; p=0.001). The compliance levels of the SAS and mSAS were 98.4% and they have been found as statistically significant (ICC: 0.984; p=0.001; p<0.01).

CONCLUSION: We suggest that the OT should be included as a simple, objective and practical indication of the SAS risk score in major operations. The mSAS was an independent predictor of post-operative mortality and complications. With the widespread use of electronic medical record systems and the effective use of pre-operative medical data, the mSAS can be used as an easy and new scoring system to predict prognosis.

Keywords: Apgar score; morbidity; mortality; perioperative care; post-operative complications.

INTRODUCTION

Hospitals and surgical teams strive to provide the occurrence of low major complications for patients undergoing surgery. Marked variability in outcomes is inevitable due to differences in patients' pre-operative risks. Nevertheless, the degree of which intraoperative performance provides a further contribution to variation in patients' risk of complications remains unclear.[1] When the patient safety and medical economics are taken into consideration, reduction of the incidence of perioperative complications and mortality is an important issue.[2]

While selecting a method for risk assessment, clinicians should consider the prognostic accuracy, simplicity, ease of access and cost. In addition, the parameters associated with perioperative risk should be observable earlier to affect the clinical decision process in optimal time.[3] For this purpose, many assessment methods have been developed to predict post-operative complications and post-operative mortality.[2]

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American Society of Anesthesiologists Physical Status Classification System (ASA-PS) is a widely known traditional assessment method with its simplicity. It includes some limitations for the prediction of post-operative outcomes due to no consideration of conditions such as age, gender, weight or pregnancy, enabling to make a classification based on the only physical status of patients without considering scheduled surgery or post-operative care.[4,5] The Physiological and Operative Severity Score for the enUmeration of Mortality and Morbidity (POSSUM scale) is a scoring system that is used to predict risk-adjusted mortality and morbidity rates in a wide variety of surgical procedures; however, the inclusion of intra- and postoperative variables precludes validation for preoperative risk prediction.[3,6] The Charlson-Age Comorbidity Index has an advantage of comprising of pre-operative variables alone, but its validity shows a variance in different patient groups.[7–12]

Gawande et al.[13,14] have defined a 10-point Surgical Apgar Score (SAS) inspiring from obstetric Apgar Score to present a simple, objective and direct evaluation for the surgeons. The SAS is a score predicting postoperative complications and mortality with intraoperatively defined three independent variables - lowest heart rate, lowest mean arterial pressure, and estimated amount of blood loss. It has been shown that it was highly effective for the prediction of the incidence of post-operative complications and mortality. While low levels of SAS do not demonstrate specific mechanisms causing the patients considered to be at high-risk, they determine which patients need intensive monitoring during the early postoperative period.[15] Virtually, do these predicted risks result from preoperative predicted risks of the patient or reflect the measurements in the operating room?[16] In this study, it was aimed to define a new modified SAS (mSAS) for predicting the incidence of postoperative complications and mortality comprising of the duration of the operation in addition to the three intraoperative parameters of the SAS in emergency surgery and to investigate the efficacy of the duration of the operation on postoperative surgical outcomes.

MATERIALS AND METHODS

Study Design

Five hundred and seventy-nine patients undergoing emergency surgery between 2017 and 2019 were included in this retrospective observational study.

Registration

The study was approved by The Ethics Committee of Okmeydani Training and Research Hospital of the University of Health Sciences with a decision number of 1192, dated March 19, 2019.

Study Population

Patients over 18 years of age, undergoing emergency surgery and giving written informed consent were included in the study.

Patients undergoing elective surgery and children under 18 years of age were excluded from the study.

Study Protocol

Definition of mSAS

The lowest HR, lowest MAP, amount of bleeding, and the SAS were calculated from the data obtained from the examination of the patients. After the operation, the mSAS was calculated by adding the duration of the operation to the data used in the calculation of the SAS (Table 1).

Intraoperative Data Collection

Before the operation, demographic data, ASA score, and diagnosis of the patient, operation type, whether a pre-operative blood product was given or not, and the anesthetic method was recorded. At the end of the operation, estimated blood loss and operative time (OT) that calculated from the induction time to the end of the surgical procedure were recorded in the case report form.

Table 1. Distribution of the descriptive characteristics

	n	%
Age (years)		
18–65	454	78.4
66–75	71	12.3
76–85	33	5.7
>85	21	3.6
Gender		
Male	359	62.0
Female	220	38.0
Surgical branch		
Gastrointestinal emergencies	378	65.3
CNS emergencies	61	10.5
Urological-gynecological emergencies	30	5.2
Orthopedic emergencies	110	19.0
ASA		
ASA I	320	55.3
ASA II	142	24.5
ASA III	93	16.1
ASA IV	19	3.3
ASA V	5	0.9
Type of anesthesia		
General anesthesia	545	94.1
Regional anesthesia	34	5.9
Total	579	100.0

ASA: American Society of Anesthesiologists; CNS: Central nervous system.

Definition of Outcomes

Our primary outcome was to compare the SAS versus the mSAS. The secondary outcomes were death or major complications within 30 days after the operation. The following events were defined as major complications: Mental change (coma for 24 h or longer), acute renal failure, bleeding requiring 4 U red cell transfusion within 72 h after the operation, cardiac arrest requiring CPR, unplanned reoperation, deep venous thrombosis, sepsis, septic shock, MI, new cardiac arrhythmia, unplanned intubation, ventilator use for at least 48 h, pneumonia, pulmonary embolism, vasopressor use, albumin replacement, wound disruption, deep or organ-space surgical site infection,, according to National Surgical Quality Improvement Program established definitions. All deaths were considered as major complications5 (superficial surgical site infection and urinary tract infection were not major complications).

The total duration of the post-operative hospitalization, the length of stay in the intensive care unit (ICU) and the Glasgow coma scale (GCS) score at the end of 24 h were recorded. Observed complications and related conditions were also noted. In revision surgeries, if wound site infection was present, and the infectious agent was the same with the results of pre-operative samples, it was not accepted as a new wound site infection. The patients who were given only fresh frozen plasma (without any other blood products) after the surgery including hepatic resection were classified as negative in terms of bleeding requiring a blood transfusion.

Statistical Analysis

Number Cruncher Statistical System 2007 Statistical Software (Kaysville, Utah, USA) program was used for the statistical analysis. The Mann–Whitney U test was used to compare descriptive statistical methods (mean, standard deviation, median, frequency, and ratio, minimum, and maximum) as well as the intergroup comparisons of data without normal distribution. Pearson's Chi-square test and Fisher-Freeman-Halton test were used to compare the qualitative data. Spearman's correlation analysis was used to evaluate the relationships between variables. The intraclass correlation coefficient was used to evaluate the agreement between the SAS and mSAS risk levels. Significance was evaluated at a level of $p<0.05$.

Table 2. Distribution of diagnoses

Diagnosis	n	%
Appendicitis	212	36.6
Acute cholecystitis/Cholangitis	42	7.3
Ileus	36	6.2
Incarcerated hernia	22	3.8
Acute abdomen	20	3.5
PUP	17	2.9
Penetrating abdominal injury	16	2.8
Fournier gangrene	13	2.2
Subdural hematoma	21	3.6
Epidural hematoma	9	1.6
Hydrocephalus	9	1.6
Intracerebral hemorrhage	7	1.2
Intraventricular hemorrhage	5	0.9
Drop foot	4	0.7
Compression fracture	3	0.5
Cerebellar hematoma	1	0.2
Epidural/Subdural abscess	2	0.3
Femoral fracture	40	6.9
Tibial fracture	17	2.9
Vertebral fracture	11	1.9
Ankle fracture	11	1.9
Humeral fracture	9	1.6
Extremity injury/Amputation	8	1.4
Forearm fracture	6	1.0
Extremity compartment syndrome	4	0.7
Peripheral vascular disease	3	0.5
Pelvic fracture	1	0.2
Ectopic pregnancy rupture	13	2.2
Ovarian torsion	5	0.9
Vaginal hemorrhage	2	0.3
Testicular torsion	9	1.6
Urinary bladder rupture	1	0.2
Total	579	100.0

RESULTS

The study was performed with a total of 579 patients. Sixty-two point zero percent of them (n=359) were males and 38.0% of them (n=220) were females. The descriptive characteristics of patients are shown in Table 1. While the diagnoses of patients presenting to the emergency room are shown in Table 2, it was determined that the most common diagnosis was acute appendicitis with a rate of 36.6%. While the GCS scores of eight patients before surgery could not be determined, the GCS score measurements of 571 patients ranged between 3 and 15, the mean GCS score was found to be 14.55±1.69. Durations of surgeries ranged between 10 and 390 min, the mean duration of surgery was 99.82±58.38 min; the duration of surgeries of 0.9% (n=5), 9.8% (n=57), and 89.3% (n=517) of patients was 5.01–7.00, 3.01–5.00, and ≤3 h, respectively.

Twenty-eight point three percent of patients (n=164) were admitted to the ICU and the mean hospitalization duration of these patients was 7.48±15.08 days. The number of MV days of 48 patients with the need for mechanical ventilation during the first 48 h postoperatively ranged between 1 and

103 days and the mean number of MV days was 14.73±22.44 days. An intraoperative blood and blood product transfusion were observed in 6.2% (n=36) of patients (Table 3). The SAS points of patients ranged between 0 and 10 points and the mean SAS point was 6.858±1.84 points. Nine point three percent (n=54), 49.6% (n=287), and 41.1% (n=238) of patients were observed to be in very-high risk, medium risk, and low-risk groups, respectively. The mSAS points of patients ranged between 0 and 10 points and the mean mSAS point was 6.74±1.930 points. Eleven point 7% (n=68), 48.6% (n=281) and 39.7% (n=230) of patients were observed to be in very-high risk, medium risk, and low-risk groups, respectively (Table 4). The complications observed in patients are shown in Table 5.

Table 3. Distributions of GCS Scores, operative time, and hospitalization periods

	n (%)
GCS before surgery (n=571)	
Min-Max (Median)	3–15 (15)
Mean±SD	14.55±1.69
Postoperative 24 h GCS (n=553)	
Min-Max (Median)	3–15 (15)
Mean±SD	14.64±1.69
Operative time (minute)	
Min-Max (Median)	10–390 (85)
Mean±SD	99.82±58.38
5–7 h	5 (0.9)
3–5 h	57 (9.8)
≤3 h	517 (89.3)
Post-operative hospitalization	
Absent	1 (0.2)
Present	578 (99.8)
Total post-operative hospitalization period (day) (n=578)	
Min-Max (Median)	1–128 (2)
Mean±SD	6.02±12.13
Post-operative ICU admittance	
Absent	415 (71.7)
Present	164 (28.3)
Total post-operative ICU admittance period (day) (n=164)	
Min-Max (Median)	1–105 (3)
Mean±SD	7.48±15.08
The number of MV day for the first 48 h postoperatively (n=48)	
Min-Max (Median)	1–103 (6.5)
Mean±SD	14.73±22.44
Intraoperative blood and blood product transfusion	36 (6.2)

GCS: Glasgow coma scale; ICU: Intensive care unit; SD: Standard deviation.

The total number of complications of patients ranged between 0 and 16. The mean and median number of complications of patients was 1.52±3.16 and 0, respectively. A statistically significant relationship was determined between the mSAS risk scores and the total number of complications of patients (p=0.001; p<0.01) (Table 6). The rate of not observation of complications is significantly higher in patients with low-risk scores compared to other risk groups.

A statistically significant negative relationship was determined between the mSAS and the total number of complications (as the mSAS decreased, the number of complications increased) (r=–0.451; p=0.001; p<0.01) and a statistically significant positive relationship between the duration of surgery and the total number of complications (as the duration of surgery increased, the number of complications also increased) (r=0.360; p=0.001; p<0.01).

The mSAS risk levels of 54 patients with very-high SAS risk levels were also very high. The mSAS risk levels of 273 of 287 patients with medium SAS risk levels were also medium and 14 patients were observed to have very-high mSAS risk levels. The mSAS risk levels of 230 of 238 patients with medium SAS risk levels were low, eight patients were observed to have medium mSAS risk levels. Accordingly, there was a compliance level of 95.6% between the SAS and mSAS risk levels of patients and this was found to be statistically significant (ıntraclass correlation coefficient: 0.956; p=0.001; p<0.01).

Table 4. Distribution of the SAS and mSAS

	n (%)
SAS	
Min-Max (Median)	0–10 (7)
Mean±SD	6.85±1.84
Very-high risk	54 (9.3)
Medium risk	287 (49.6)
Low-risk	238 (41.1)
mSAS	
Min-Max (Median)	0–10 (7)
Mean±SD	6.74±1.93
Very-high risk	68 (11.7)
Medium risk	281 (48.6)
Low-risk	230 (39.7)
Total	579 (100.0)

SAS: Surgical Apgar Score: mSAS: Modified Surgical Apgar Score; SD: Standard deviation.

Table 5. Distributions of complications and mortality

	n	%
Complications		
Impaired consciousness	43	7.4
The need for intensive care unit	159	27.5
The need for mechanical ventilation during the first 48 h postoperatively	48	8.3
Unplanned intubation	23	4.0
Unplanned reoperation	22	3.8
Bleeding requiring transfusion	97	16.8
Postoperative blood and blood product transfusion	98	16.9
Surgical site infection	10	1.7
Newly-emerging cardiac arrhythmia	19	3.3
Myocardial infarction	9	1.6
Pneumonia	27	4.7
Sepsis or septic shock	35	6.0
Bacteriemia	37	6.4
Acute renal failure	20	3.5
Deep vein thrombosis	1	0.2
Pulmoner tromboemboli	1	0.2
Cardiac arrest	33	5.7
Cardiopulmonary resuscitation	32	5.5
Albumin replacement	113	19.5
Inotropic support	52	9.0
Exitus	39	6.7

The compliance level of the SAS and mSAS points was 98.4% and this condition was found to be statistically significant (intraclass correlation coefficient: 0.984; p=0.001; p<0.01).

A statistically significant difference was determined between the rates of impaired consciousness, the need for ICU, the need for MV during the first 48 h postoperatively, unplanned intubation, bleeding requiring transfusion, post-operative blood, and blood product transfusion, newly-emerging cardiac arrhythmia, pneumonia, sepsis or septic shock, bacteriemia, ARF, cardiac arrest, albumin replacement, and inotropic support of patients according to the mSAS risk levels (p=0.001; p<0.01).

A statistically significant difference was determined between the observation rates of unplanned reoperation in patients according to the mSAS risk level (p=0.005; p<0.01). The observation rate of unplanned reoperation in patients with very-high mSAS risk levels was higher than patients with medium and low mSAS risk levels. There was no statistically significant difference between the observed rates of surgical site infection, MI, DVT, and PTE (p>0.05).

A statistically significant difference was determined between the observation rates of CPR in patients according to the mSAS risk level (p=0.001; p<0.01).

The observation rate of CPR in patients with very-high mSAS risk levels was higher than patients with medium and low mSAS risk levels. The rate of observation of mortality in patients with very-high mSAS risk levels was higher than patients with medium and low mSAS risk levels (p=0.001; p<0.01) (Table 7).

The observation rate of impaired consciousness, the need for MV during the first 48 h postoperatively, bleeding requiring transfusion, post-operative blood and blood product transfusion, ARF, cardiac arrest, CPR, albumin replacement, and inotropic support were higher in patients with the duration of surgery of 5–7 h and 3–5 h than patients with the duration of surgery of ≤3 h (p=0.001; p<0.01).

The observation rate of the need for ICU was significantly higher in patients with the duration of surgery of 3–5 h than patients with the duration of surgery (OT) of ≤3 h (p=0.001; p<0.01).

A statistically significant difference was determined between

Table 6. Association between the mSAS risk levels and the total number of complications

		The mSAS risk			p
		Very-high risk	Medium risk	Low-risk	
		n (%)	n (%)	n (%)	
The total number of complications	Absent	15 (22.1)	172 (61.2)	188 (81.7)	0.001**
	1 complication	5 (7.4)	38 (13.5)	22 (9.6)	
	2 complications	9 (13.2)	20 (7.1)	10 (4.3)	
	≥3 complications	39 (57.4)	51 (18.1)	10 (4.3)	

Pearson's Chi-square Test. **P<0.01. mSAS: Modified Surgical Apgar Score

Table 7. Association of the mSAS risk level with complication and mortality

Complications	The mSAS risk level			p
	Very-high risk (n=68)	Medium risk (n=281)	Low-risk (n=281)	
	n (%)	n (%)	n (%)	
Impaired consciousness	20 (29.4)	19 (6.8)	4 (1.7)	[a]0.001**
The need for intensive care unit	47 (69.1)	81 (28.8)	31 (13.5)	[a]0.001**
The need for mechanical ventilation during the first 48 h postoperatively	27 (39.7)	17 (6.0)	4 (1.7)	a0.001**
Unplanned intubation	11 (16.2)	10 (3.6)	2 (0.9)	[a]0.001**
Unplanned reoperation	7 (10.3)	11 (3.9)	4 (1.7)	[a]0.005**
Bleeding requiring transfusion	40 (58.8)	46 (16.4)	11 (4.8)	[a]0.001**
Postoperative blood and blood product transfusion	38 (55.9)	48 (17.1)	12 (5.2)	[a]0.001**
Surgical site infection	1 (1.5)	7 (2.5)	2 (0.9)	[b]0.334
Newly-emerging cardiac arrhythmia	8 (11.8)	8 (2.8)	3 (1.3)	[a]0.001**
Myocardial infarction	2 (2.9)	5 (1.8)	2 (0.9)	[b]0.328
Pneumonia	10 (14.7)	15 (5.3)	2 (0.9)	[a]0.001**
Sepsis or septic shock	15 (22.1)	16 (5.7)	4 (1.7)	[a]0.001**
Bacteriemia	15 (22.1)	19 (6.8)	3 (1.3)	[a]0.001**
Acute renal failure	13 (19.1)	5 (1.8)	2 (0.9)	[a]0.001**
Deep vein thrombosis	0 (0)	1 (0.4)	0 (0)	[b]1.000
Pulmoner tromboemboli	0 (0)	1 (0.4)	0 (0)	[b]1.000
Cardiac arrest	18 (26.5)	11 (3.9)	4 (1.7)	[a]0.001**
Cardiopulmonary resuscitation	18 (26.5)	10 (3.6)	4 (1.7)	[a]0.001**
Albumin replacement	36 (52.9)	58 (20.6)	19 (8.3)	[a]0.001**
Inotropic support	29 (42.6)	19 (6.8)	4 (1.7)	[a]0.001**
Exitus	20 (29.4)	14 (5.0)	5 (2.2)	[a]0.001**

[a]Pearson's Chi-square Test. [b]Fisher-Freeman-Halton Test. **P<0.01. mSAS: Modified Surgical Apgar Score.

the observation rates of unplanned intubation in patients according to OT (p=0.004; p<0.01). The observation rate of unplanned intubation was significantly higher in patients with an OT of 5.01–7 h than patients with an OT of 3.01–5 h and equal and shorter than 3 h.

The observation rates of unplanned intubation, surgical site infection, newly-emerging cardiac arrhythmia, MI, DVT, and PTE did not show significant difference according to OT (p>0.05).

A statistically significant difference was determined between the observation rates of pneumonia in patients according to OT (p=0.003; p<0.01). The observation rate of pneumonia was significantly higher in patients with an OT of 5.01–7 h and 3.01–5 h than patients with an OT equal and shorter than 3 h.

A statistically significant difference was determined between the observation rates of sepsis or septic shock, bacteriemia in patients according to OT (p=0.001; p<0.01, p=0.001; p<0.01; respectively). The observation rate of sepsis or septic shock, bacteriemia was significantly higher in patients with an OT of 5.01–7 h than patients with an OT of 3.01–5 h and equal and shorter than 3 h.

A statistically significant difference was determined between the observation rates of mortality in patients according to OT (p=0.001; p<0.01). The observation rate of mortality was significantly higher in patients with an OT of 5.01–7 h and 3.01–5 h than patients with an OT equal and shorter than 3 h (Table 8).

A statistically significant difference was determined between the mSAS points of patients according to the presence of mortality (p=0.001; p<0.01); the mSAS points of patients with mortality were lower. A statistically significant difference was determined between the OT s of patients according to the presence of mortality (p=0.001; p<0.01); the OTs of patients with mortality were lower (Fig. 1).

Table 8. Association of duration of surgery with complication and mortality

Complications	Duration of surgery			p
	5.01–7 hours (n=5)	3.01–5 hours (n=57)	≤3 hours (n=517)	
	n (%)	n (%)	n (%)	
mpaired consciousness	2 (40.0)	11 (19.3)	30 (5.8)	[b]0.001**
The need for intensive care unit	3 (60.0)	34 (59.6)	122 (23.6)	[b]0.001**
The need for mechanical ventilation during the first 48 h postoperatively	3 (60.0)	15 (26.3)	30 (5.8)	[b]0.001**
Unplanned intubation	2 (40.0)	4 (7.0)	17 (3.3)	[b]0.004**
Unplanned reoperation	1 (20.0)	3 (5.3)	18 (3.5)	[b]0.106
Bleeding requiring transfusion	3 (60.0)	23 (40.4)	71 (13.7)	[b]0.001**
Postoperative blood and blood product transfusion	3 (60.0)	23 (40.4)	72 (13.9)	[b]0.001**
Surgical site infection	0 (0)	0 (0)	10 (1.9)	[b]0.644
Newly-emerging cardiac arrhythmia	1 (20.0)	2 (3.5)	16 (3.1)	[b]0.142
Myocardial infarction	0 (0)	1 (1.8)	8 (1.5)	[b]1.000
Pneumonia	2 (40.0)	6 (10.5)	19 (3.7)	[b]0.003**
Sepsis or septic shock	3 (60.0)	6 (10.5)	26 (5.0)	[b]0.001**
Bacteriemia	3 (60.0)	7 (12.3)	27 (5.2)	[b]0.001**
Acute renal failure	2 (40.0)	7 (12.3)	11 (2.1)	[b]0.001**
Deep vein thrombosis	0 (0)	0 (0)	1 (0.2)	[b]1.000
Pulmoner tromboemboli	0 (0)	0 (0)	1 (0.2)	[b]1.000
Cardiac arrest	2 (40.0)	10 (17.5)	21 (4.1)	[b]0.001**
Cardiopulmonary resuscitation	2 (40.0)	10 (17.5)	20 (3.9)	[b]0.001**
Albumin replacement	4 (80.0)	22 (38.6)	87 (16.8)	[b]0.001**
Inotropic support	3 (60.0)	16 (28.1)	33 (6.4)	[b]0.001**
Exitus	2 (40.0)	10 (17.5)	27 (5.2)	[b]0.001**

[b]Fisher-Freeman-Halton Test. **P<0.01.

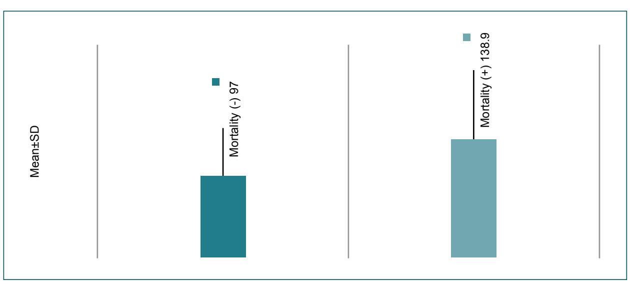

Figure 1. Distribution of operative times according to the presence of mortality.

DISCUSSION

In this study, we aimed to define a new mSAS for predicting the incidence of postoperative complications and mortality in emergency surgery. We also wanted to identify the effectiveness of this modified scoring system, comprising of the duration of the operation in addition to the three intraoperative parameters of the SAS. In our study, there was a statistically significant negative relationship between the mSAS and the total number of complications (as the mSAS decreased and the number of complications increased) (r=–0.451; p=0.001; p<0.01). There was a statistically significant positive relationship between the OT and the total number of complications (as OT increased and the number of complications increased) (r=0.360; p=0.001; p<0.01).

Intraoperative management provides a significant contribution to the determination of general outcomes and prognosis. Some risk estimates were integrated into the intraoperative variables and the methods were found.[17–20] The most commonly studied general tools are APACHE II, ASA-PS, and P-POSSUM. APACHE systems were designed for use in critical care.[21] Careful preoperative evaluation, appropriate intraoperative management, and intraoperative crisis checklists should be used for safer perioperative care in the future. The main concern is whether intraoperative events can change the surgical outcome or not.[22]

The POSSUM scoring systems are the most widely validated perioperative risk predictors used at the moment. Nevertheless, the inclusion of pre-operative and post-operative variables by these scoring systems precludes validation for preoperative risk prediction.[1] Clinical scoring systems responding to dynamic changes in population characteristics are more precise, but noteworthy sources are required to apply. The combination of objective clinical variables with the data obtained from new techniques such as cardiopulmonary exercise testing and biomarker assays may enhance the prediction accuracy of clinical risk scores used to guide perioperative management.[3]

Current international interventions for reducing the considerable associated morbidity and mortality are initiated on delivering individualized perioperative care. Although the identification of high-risk patients requires the routine evaluation of individual risk, no method of doing this has been shown to be practical and reliable among the commonly encountered spectrum of presentations, comorbidities, and surgical procedures. In a meta-analysis performed by Oliver et al.,[21] the authors identified 20 validation studies assessing 25 risk assessment tools in patients undergoing emergency laparotomy. The most commonly studied general tools were APACHE II, ASA-PS, and P-POSSUM. Calibration reports were markedly absent in many prognostic tool validation studies. When APACHE II was used either preoperatively or postoperatively, it has been demonstrated that individual outcomes across a variety of patient groups undergoing emergency laparotomy were discriminated most consistently (area under the curve 0.76–0.98). APACHE systems were designed for use in critical care. The ability of APACHE II for generating individual risk estimates from objective, solely preoperative data items may lead to better-informed shared decisions, triage, and perioperative management of patients undergoing emergency laparotomy. The main concern is whether intraoperative events can change the surgical outcome or not. However, there is no consensus about how does intraoperative patient safety directly impacts these risk variables.[22]

Intraoperative management provides a significant contribution to the determination of general outcomes and prognosis. Quantitative measurements of intraoperative care were not available. Changes in the medical condition of a patient including hypotension, hypertension, hypothermia, bradycardia, tachycardia, and blood loss among intraoperative effective factors were independently associated with adverse outcomes. Some risk estimates were integrated into the intraoperative variables and the methods were found.[17–20]

In 2007, Gawande et al.[13,14] have defined a 10-point SAS inspiring from obstetric Apgar score to present a simple, objective, and direct evaluation for the surgeons. The SAS is a score predicting postoperative complications and mortality with intraoperatively defined three independent variables -lowest heart rate, lowest mean arterial pressure, and estimated amount of blood loss. In general, it has been validated that the SAS effectively predicts major postoperative complications within 30 days of general surgery. Virtually, do these predicted risks result from preoperative predicted risks of a patient or reflect the measurements in the operating room?[2]

Relatively little is known about the influence of intraoperative hemodynamic variables on surgical outcomes. In the study performed by Reich et al.,[18] the POSSUM score was recorded in the patients undergoing major non-cardiac surgery (n=797). No statistically significant relationship was found between intraoperative variables (heart rate, mean arterial pressure, and systolic arterial blood pressure), and mortality and morbidity in shorter operations. The POSSUM score and OT beyond 220 min, high HR (odds ratio, 2.704; p=0.01) and high SAP (odds ratio, 2.095; p=0.009) were associated with negative surgical outcome in longer operations. Therefore, intraoperative tachycardia and hypertension were evaluated to be independent variables associated with negative postoperative outcomes after major non-cardiac surgery of long duration over and above the risk imparted by underlying medical conditions.

Similar results associated with operation duration were determined also in cardiac surgery. Aortic cross-clamp duration higher than 150 min is directly associated with postoperative morbidity and mortality.[23]

In our study including patients undergoing emergency surgery, the SAS was calculated from the data obtained from the examination of the patients at the end of the operation. Furthermore, the duration of the operation was added to data used in the calculation of the SAS (Operation duration >8 h, –4 points; 7.01–8 h, –3 points; 5.01–7 h, –2 points; 3.01–5 h, –1 point; and 0–3 h 0 points added). Durations of surgeries ranged between 10 and 390 min, the mean duration of surgery was 99.82±58.38 min; the duration of surgeries of 0.9% (n=5), 9.8% (n=57) and 89.3% (n=517) of patients were 5.01–7.00, 3.01–5.00, and ≤3 h; respectively. Twenty-eight point 3% of patients (n=164) were admitted to the ICU and the mean hospitalization duration of these patients was 7.48±15.08 days. The number of MV days of 48 patients with the need for mechanical ventilation during the first 48 h postoperatively ranged between 1 and 103 days and the mean number of MV days was 14.73±22.44 days. An intraoperative blood and blood product transfusion were observed in 6.2% (n=36) of patients.

In the meta-analysis performed by Lee et al.[24] investigating operative outcomes and perioperative complications of patients undergoing cervical cancer, radical hysterectomy, and/or laparoscopic radical hysterectomy surgeries, 4367 patients were investigated. The number of lymph nodes, age, OT, and amount of blood loss was determined as prognostic factors. Furthermore, in our study, a statistically significant relationship was determined between the mSAS risk scores and the total number of complications of patients (p<0.01). The rate of not observation of complications is significantly higher in patients with low-risk levels. The rate of observation of four or more complications using the mSAS is higher in patients with very-high risk levels and medium risk levels.

A positive statistically significant correlation was determined between the mSAS points and the total number of complications (as the number of complications increased as OT increased) (r=–0.451; p=0.001; p<0.01). In the study performed by Sudarshan et al.[25] investigating the prognostic factors from patient-level characteristics and clinical presentation to predict outcomes including mortality, post-operative complications, ICU admission and prolonged duration of hospital stay during 1 year; surgery was required in 258 of 527 patients presenting to the emergency room and postoperative complications developed in 22% of them. The use of anti-coagulants, systolic blood pressure <90, hypothermia, and leukopenia were found to be independent predictors increasing in-hospital mortality and leukopenia, smoking, and tachycardia at presentation were determined to be prognostic factors for the development of postoperative complications. The use of anti-coagulants, leukopenia, leukocytosis, and tachypnea at presentation was found to be independent predictive factors for ICU admission. A prolonged hospitalization was associated with increasing age, higher ASA score, tachycardia, and presence of comorbidities at presentation.

The SAS can predict postoperative major complications and mortality within 30 days of surgery. It has been validated that it should be used to objectively guide the post-operative care in different patient populations. When the operation duration was considered to be an independent risk predictor in our study, the mSAS points of patients ranged between 0 and 10 points and the mean mSAS point was 6.74±1.930 points. Eleven point seven percent (n=68), 48.6% (n=281), and 39.7% (n=230) of patients were observed to be in very-high risk, medium risk and low-risk groups, respectively. The total number of complications of patients ranged between 0 and 16. The mean and median number of complications of patients was 1.52±3.16 and 0, respectively. Post-operative impaired consciousness, unplanned intubation, the need for ICU, pneumonia, sepsis or septic shock, bacteriemia, the need for MV during the first 48 h postoperatively, bleeding requiring transfusion, post-operative blood and blood product transfusion, ARF, albumin replacement, inotropic support of patients, cardiac arrest, and CPR were found to be significantly higher in patients with the duration of emergency surgery of ≥3 h (p=0.001; p<0.01). Unplanned reoperation, surgical site infection, newly-emerging cardiac arrhythmia, MI, DVT, and PTE were not affected by the duration of surgery (p>0.05).

The compliance level of the SAS and mSAS points was 98.4% and this condition was determined to be statistically significant (intra class correlation coefficient: 0.984; p=0.001; p<0.01). A statistically significant difference was determined between the durations of surgeries of patients according to the presence of mortality (p=0.001; p<0.01); the duration of surgeries of patients with mortality were longer.

Determination of pre-operative comorbid medical conditions, ensuring pre-operative optimization of them and the appropriate selection of surgical approaches are important; however, this may not always be possible in emergency surgeries. In the 5-year retrospective study of Shim et al.,[26] the 30-day morbidity rate was determined to be 4.5% (n=72) in patients (n=1609) undergoing hysterectomy for benign indications. Urinary complications wound infection, blood transfusion more than 4 units, and Charlson comorbidity index of 2 or more, OT were determined to be independent risk factors for morbidity. The SAS has been previously validated as predictive of early post-operative outcomes in general, vascular, urological, gynecological, orthopedic, neurosurgical, and pancreas surgeries with many studies.[15,16,27–33]

Since the SAS is affected by the three variables, it cannot evaluate the care quality alone and it is associated with not only performances of the medical teams and also prior conditions of patients and the severity of the surgery.[17] The limitations of the SAS include the following: Lack of validity in other cohorts of patients, lack of comparison between different institutions, and the potential for imprecision resulting from "estimating" blood loss. Consequently, it can be accepted as one of the less applicable scoring systems in current clinical practice.[3]

The first study on this subject was performed by Pearson et al.[34] in 2017. Blood loss was estimated using a mSAS for liver transplant (SAS-LT) in 628 liver transplant patients and death or serious perioperative morbidity occurred in 105 patients (16.7%). Twelve point six percent of patients (n=79) were discharged from the ICU in 24 h or less. The SAS-LT points of these patients were significantly higher than those with a longer stay in the ICU. The SAS-LT utilizing simple intraoperative metrics to predict early morbidity and mortality after liver transplantation was found to have similar accuracy with the other scoring systems.

The Royal College of Surgeons of England recommended randomized controlled trials with a large number of patients and implementing a wide range of post-operative interventions and improvements in care as well as featuring a quality improvement approach based on the SAS. These were followings: The surgical care package, arterial blood gas monitoring, a goal-directed fluid therapy plan, monitoring the effect of muscle relaxants and when necessary reversion of this effect, correction of hypothermia, glycemic monitoring, and control, early nutrition, early mobilization, and physiotherapy, enhanced ward monitoring, and experienced personnel. Thereafter, the collection of outcome data and a detailed evaluation are required.[26]

Conclusion

Since OT is considered as it may be an independent predictor of post-operative mortality and complications, we suggest that the OT should be included as a simple, objective, and practical indication of the SAS risk score in emergency surgeries. Since the mSAS is simple at a level of no need for biochemical tests or prolonged clinical assessments for the identification of high-risk patients, it can easily be calculated with completion of the surgical process. With the widespread use of electronic medical record systems and the effective use of pre-operative medical data, the mSAS can be used as an easy and new scoring system to predict prognosis. It will ensure a comprehensive evaluation of the perioperative condition of the patient and consequently quality improvement of postoperative care.

Ethics Committee Approval: This study was approved by the University of Health Sciences, Okmeydani Training and Research Hospital Ethics Committee (Date: 19.03.2019, Decision No: 1192).

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ORİJİNAL ÇALIŞMA - *ÖZ*

Acil cerrahide ameliyat sonrası komplikasyonların öngörülmesinde modifiye cerrahi APGAR skorunun kullanımı: Gözlemsel geriye dönük çalışma

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AMAÇ: Gawande ve ark.nın 2007 yılında tanımladığı Cerrahi Apgar (SAS), skorlama sisteminin ameliyat sonrası komplikasyon insidansını ve mortaliteyi tahmin etmede oldukça etkili olduğu gösterilmiştir. Bu çalışmada, acil cerrahide ameliyat sonrası komplikasyon insidansını ve mortaliteyi tahmin etmek için yeni, modifiye edilmiş bir SAS tanımlamayı amaçladık. Ayrıca, SAS skorunun üç intraoperatif parametresine ek olarak operasyonun süresinden oluşan bu modifiye edilmiş skorlama sisteminin etkinliğini de ölçmek istedik.
GEREÇ VE YÖNTEM: Bu geriye dönük gözlemsel çalışmaya acil cerrahi uygulanan 579 hasta dahil edildi. Operasyon sonunda hastaların muayenesinden elde edilen verilerden SAS hesaplandı ve SAS hesaplamasında kullanılan verilere operasyon süresi eklenerek modifiye SAS (mSAS) hesaplandı (Cerrahi süre >8 sa; -4 puan; 7.01–8 sa; -3 puan; 5.01–7 sa; -2 puan; 3.01–5 sa; -1 puan; 0–3 sa; 0 puan eklendi).
BULGULAR: mSAS ile toplam komplikasyon sayısı arasında istatistiksel olarak anlamlı bir ilişki vardı (ameliyat süresi arttıkça komplikasyon sayısı arttı) (r=0.360; p=0.001). SAS ve mSAS'ın uyum düzeyleri %98.4 idi ve istatistiksel olarak anlamlı bulundu (ICC: 0.984; p=0.001; p<0.01).
TARTIŞMA: Operasyon süresinin, büyük operasyonlarda SAS risk skorunun basit, objektif ve pratik bir göstergesi olarak dahil edilmesi gerektiğini öneriyoruz. mSAS, ameliyat sonrası mortalite ve komplikasyonların bağımsız bir prediktörüdür. Elektronik tıbbi kayıt sistemlerinin ve ameliyat öncesi tıbbi verilerin etkin kullanımı ile mSAS, prognozu tahmin etmek için kolay ve yeni bir puanlama sistemi olarak kullanılabilir.
Anahtar sözcükler: Ameliyat sonrası komplikasyonlar; Apgar skor; morbidite; ölüm, perioperatif bakım.

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