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A Study of the Reliability of Surgical Apgar Score in Predicting Post Operative Morbidity and Mortality in Patients Undergoing Laparotomy

Dr Shipra Doda[1], Dr S. K. Sagar[2], Dr Anil Negi[3]

[1, 2, 3]Department of General Surgery, SRMS-Institute of Medical Sciences, Bareilly, U. P., India

Abstract: ***In my view, predicting surgical outcomes with precision remains a challenge, especially in resource-limited settings. This study evaluates the reliability of the Surgical APGAR Score (SAS) in predicting postoperative morbidity and mortality among patients undergoing laparotomy. Despite advancements in minimally invasive techniques, laparotomy remains a critical procedure, particularly in emergency settings where complications are more frequent. The SAS, derived from intraoperative variables such as heart rate, mean arterial pressure, and blood loss, offers a practical and straightforward method to assess surgical risk. It is evident that patients with a lower SAS face significantly higher rates of morbidity and mortality, with a clear predictive cutoff at ≤4 for mortality and ≤6 for morbidity. The findings suggest that integrating SAS into routine postoperative assessment could enhance risk stratification, optimize resource allocation, and improve patient monitoring, particularly in high-risk cases. That said, while the SAS is useful, its exclusion of factors like preexisting comorbidities and surgical duration raises concerns about its comprehensiveness. Nonetheless, given its simplicity and effectiveness, this scoring system holds promise for broader clinical application, particularly in healthcare environments with limited resources.***

Keywords: surgical APGAR score, laparotomy outcomes, postoperative risk, morbidity prediction, mortality assessment

1. Introduction

Laparotomies are the most commonly done abdominal / part of surgery, in the emergency and elective settings. Although minimally invasive surgeries had come up in a big way, and in many a cases replacing laprotomies, but still miles to go.

In such situations one the challenges that a surgeon faces intra and post operatively is that of reliability and accurately predicting patient groups that are at a risk of mortality and morbidity. Surgeons have lacked a routine objective evaluation of the condition of the patient after surgery. This lack of the condition of the tools that can be easily applied for routine measurement of surgical outcomes has hindered efforts to significantly reduce the overall complication rate after surgeries. The aim is to effectively manage patients during the perioperative period in order to limit postoperative morbidity and mortality. This requires an objective evaluation of the patient, which can be done using a risk rating system. Risk scoring aims to estimate a patient's likelihood of a poor outcome depending on the severity of their sickness as determined by information available at the beginning of their hospital stay. Risk scoring systems should, in theory, be objective and be able to predict death, which would facilitate communication and help people realize how serious a condition is. An ideal surgical risk score system should be straightforward, involve little in the way of calculations, data, and variables, be reasonably accurate, and be affordable. It should also be appropriate for all circumstances (elective and emergency procedures, as well as being applicable to all specialties).

Surgical APGAR score (SAS)[6] is such a score which is determined by three intra operative factors: lowest heart rate (HR), lowest mean arterial pressure (MAP) and estimated blood loss (EBL).

A patient has a higher likelihood of experiencing postoperative morbidity or mortality if their SAS is lower. By assigning a score to a patient's postoperative status ranging from 0 (showing heavy blood loss, hypotension, and an elevated HR or asystole) to 10 (representing minimal blood loss, normal blood pressure, and a physiologically low to normal HR), SAS can provide a "snapshot" of how a surgery went.[7] The lowest MAP, lowest HR, and EBL recorded during the procedure are used to generate this score at the conclusion of the procedure. The total of the points from each category is the score.

This study was carried out to access the reliability of SAS in predicting post operative morbidity and mortality in patients undergoing laparotomies.

2. Materials and Methods

This prospective and observational study was conducted in the department of General Surgery in a tertiary care hospital of North India from 1st Feb 2021 to 31st July 2022 after obtaining due permission from institutional ethical clearance committee to evaluate the patient records.

A total of 100 patients were included which underwent laparotomy for elective and emergency surgeries. After due consent from patients, clinical history, laboratory investigations, Final diagnosis, pre operative, intra operative and post operative parameters were collected and calculated. Complications during the hospital stay were noted. Details of patient follow-up after one month after surgery were also noted and surgical APGAR score was calculated and patients were grouped as per the risk group.

The data was recorded, tabulated, and statistics were applied using SPSS to see significant conclusion.

Definitions:
The SAS was calculated based on the three intra operative factors: lowest heart rate (HR), lowest mean arterial pressure (MAP) and estimated blood loss (EBL). The score was calculated from the total points of each category.

Variables	0	1	2	3	4
Estimated blood loss (EBL) ml	>1000	600-1000	101-600	<100	--
Lowest mean arterial pressure (MAP) mm Hg	<40	40-54	55-69	>70	--
Lowest heart rate/min (HR)	>85	76-85	66-75	56-65	<55

Risk Group	APGAR Score
High	0-4
Medium	5-7
Low	8-10

3. Observation and Results

A total of 100 patients of age group 18 – 60 years undergoing elective and emergency laparotomy were included in the study out of which 40 patients were females and 60 were males. In present study out of 100 patients, 27 patients (27%) belonged to age group 21 – 30 years and 51 – 60 years followed by 16 patients (16%) in 41 – 50 years respectively. Rest of the patients of age group 18 – 20 and 31 – 40 years were 15%. Mean value of age was 37.78 years with median (25^{th} – 75^{th} percentile) of 36.5

Risk distribution
In 100 laparotomies, 58 were elective and 42 were emergency laparotomies. It was observed that medium risk group were significantly higher in elective laparotomy compared to emergency laparotomy (medium: 62% vs 33% respectively) and high risk group were higher in emergency as compared to elective laparotomy (high:64 % vs 25% respectively). Table 1

Table 1: Comparison of risk group between elective and emergency laparotomy

Risk group	Elective (n=58)	Emergency (n=42)	Total	P value
Low	7 (12.07%)	1 (2.38%)	8 (8%)	0.134*
Medium	36 (62.07%)	14 (33.33%)	50 (50%)	0.005†
High	15 (25.86%)	27 (64.29%)	42 (42%)	0.0001†
Total	58 (100%)	42 (100%)	100 (100%)	-

Fisher's exact test, † Chi square test

Postoperative complications:
It was observed that overall in both the groups, pneumonia (30%) was the most common complication to occur followed by wound infection (28%) then sepsis (21%) and anastomotic leak (3%).

It was observed that death and sepsis were significantly higher in emergency laparotomies as compared to elective laparotomies in which wound infection was significantly higher (Death: 3.45% vs 16.67% respectively, Sepsis: 10.34% vs 35.71%, Wound infection: 39.66% vs 11.90% respectively). Table 2

Table 2: Comparison of complications between elective and emergency laparotomy

Complications	Elective (n=58)	Emergency (n=42)	Total	P value
Uneventful	6 (10.34%)	2 (4.76%)	8 (8%)	0.462*
Anastomotic leak	0 (0%)	3 (7.14%)	3 (3%)	0.071*
Death	2 (3.45%)	7 (16.67%)	9 (9%)	0.033*
Pneumonia	20 (34.48%)	10 (23.81%)	30 (30%)	0.25†
Sepsis	6 (10.34%)	15 (35.71%)	21 (21%)	0.002†
Ventilator	1 (1.72%)	0 (0%)	1 (1%)	1*
Wound infection	23 (39.66%)	5 (11.90%)	28 (28%)	0.002†
Total	58 (100%)	42 (100%)	100 (100%)	-

Fisher's exact test, † Chi square test

Determination of the cut- off values for predicting morbidity:
It was also observed that patients who had surgical APGAR score of > 6 had higher chances of no morbidity and patients with surgical APGAR score < 6 had higher chances of developing morbidity. Hence, surgical APGAR score is the significant predictor of morbidity at cut off <6 with AUC of 0.749 for correctly predicting morbidity. Figure: 1

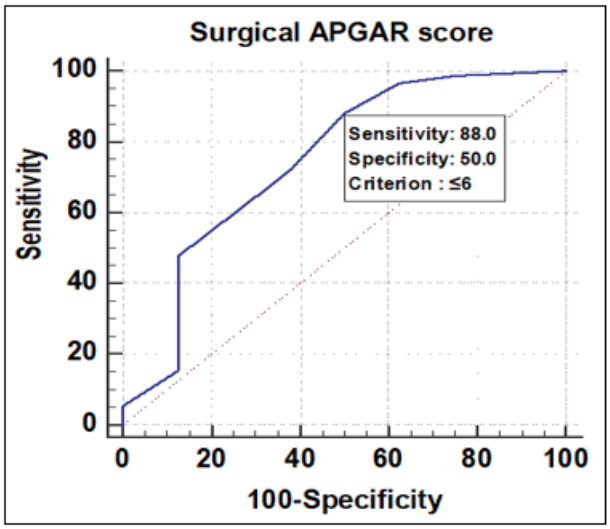

Figure 1

Determination of the cut- off values for predicting mortality:
In our study, it was observed that that in patients with surgical APGAR score of > 4 have more chances of survival compared to patients with surgical APGAR score of < 4. Hence, it is a significant predictor of mortality at cut off point of < 4 with AUC of 0.742 for correctly predicting mortality. Figure: 2

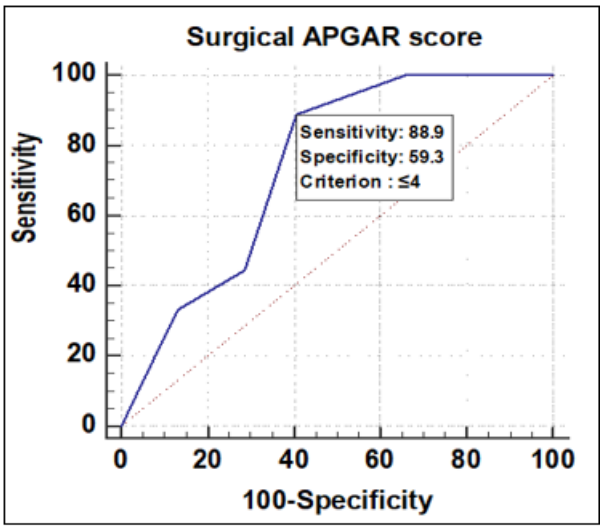

Figure 2

Risk group and morbidity:
It was observed that morbidity is more common in patients with high risk (100%) group followed by medium (92%) and low risk group (50%). Figure: 3

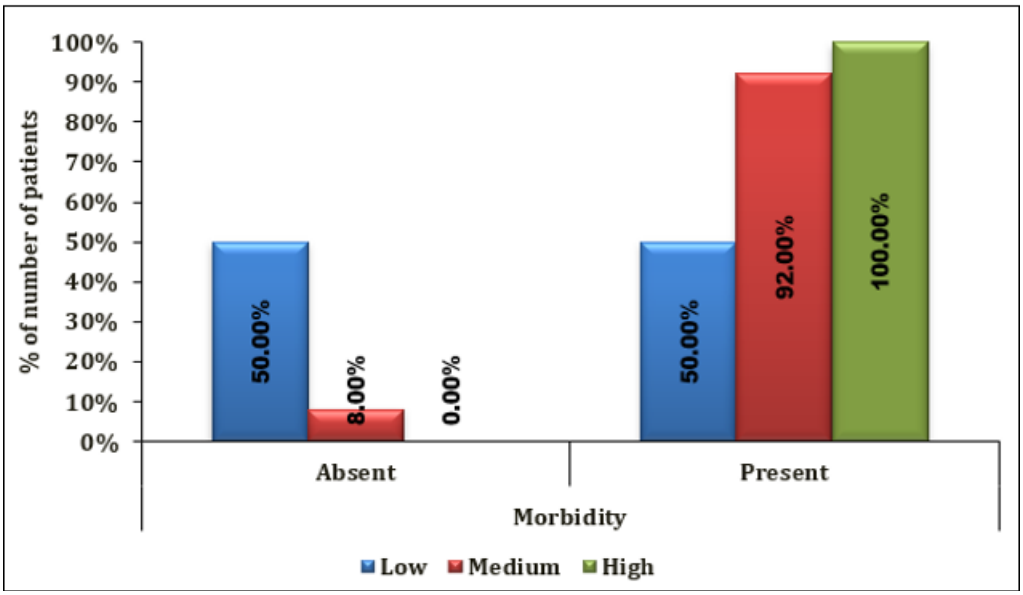

Figure :3 Risk and morbidity

Risk group and mortality:
In our study, mortality is more common in high risk group patients (19.05%) followed by medium risk group (2%). Figure 4

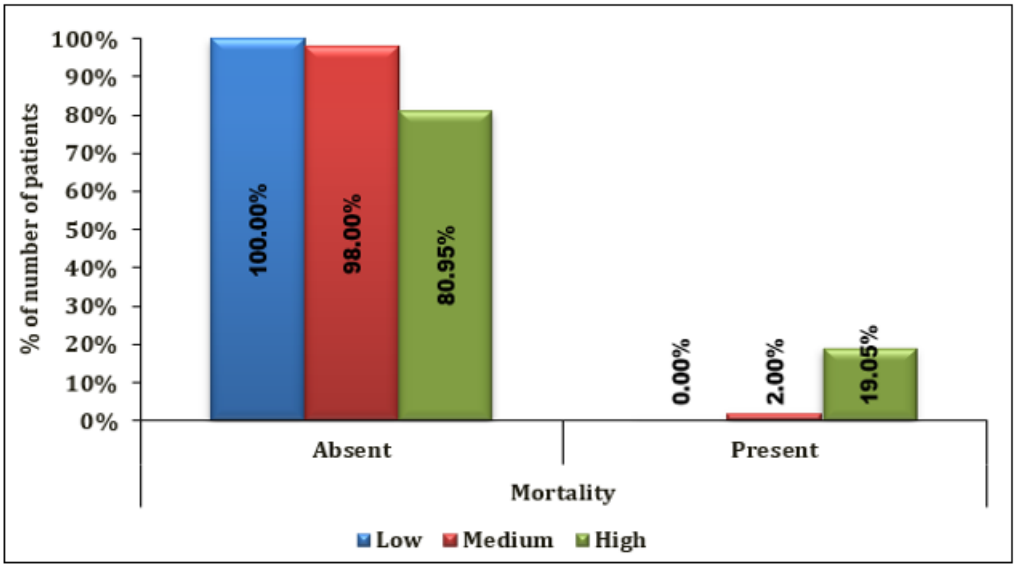

Figure 4: Risk and mortality

4. Discussion

Age and gender comparison

In the present study, the mean value of age (years) of study subjects was 37.78 ± 14.8 with median (25th-75th percentile) of 36.5 (24.75-51). Twenty-seven (27%) patients belonged to age group 21-30 years and 51-60 years, sixteen patients belonged to 41-50 years (16%). In our study, out of 100 patients, 60 patients were males and 40 patients were females .These findings were comparable to study conducted by **Shah NJ** mean age was 35.18 years with 15- 84 years range with skewed gender distribution of 78.7% of the patients in their study were male patients.[29]**Rajgopal V** also reported male predominance (66.0%) in their study and patients less than 40 years old were 21%, 27% were aged between 40 and 50 years, 24% were between 51 and 60 years old, and 28% were over 60 years old.[3]Another Indian study conducted by **Choudhari R** who reported 60.5% patients were males with mean age 47 years (± 14.6) of the study subjects. [30]

Complications

In our study, most common complication was pneumonia (30%) followed by wound infection (28%), sepsis (21%), death (9%) and anastomotic leak (3%). In contrast, **Choudhari R** in their study observed surgical site infection was the most common complication and seen in 19 out of 220 patients.[30] **Shah NJ** who observed most common complication was superficial surgical site infection (SSI) 26.8%, while least common was anastomotic leakage 3.75%.[29]

In our study, out 100 patients, 58 patients underwent elective laparotomy (58%) and 42 patients underwent emergency laparotomy (42%). Similarly, Choudhari R et al observed majority 72.7% were enrolled for elective surgery. In contrast, Shah NJ et al in their study reported mostly 85% surgery were in the emergency group.

In our study pneumonia was the most common complication in elective group because in this group majority of the surgeries were oncological surgeries, which required longer operative time and patient remained on ventilaors for relatively longer time. Similar observations were made by

Mortality and morbidity

In our study, post operatively within 30 days, 9 patients died. We found a mortality rate of 9% and a 92% rate of 30-day post laparotomy morbidity. More patients died in emergency surgery group. From ROC curve, surgical APGAR score was the significant predictor of mortality at cut off point of ≤4 with area under curve of 0.742 for correctly predicting mortality. About 88.89% of patients had surgical APGAR score ≤4.

From ROC curve, surgical APGAR score was the significant predictor of morbidity at cut off point of ≤6 with area under curve of 0.749 for correctly predicting morbidity. 88.04% of patients had surgical APGAR score ≤6. In the study done by Rajgopal V et al who reported a 19% rate of 30-day mortality, and a 30% rate of 30-day morbidity. Significant problems were identified in 23% of SAS < 4 patients, 41% of cases had 30-day mortality, and 26% of cases had significant complications. In contrast, only 11% of patients with a SAS of 9–10 experienced 30-day morbidities, and only 4% of patients died within 30 days. When compared to patients in the next (higher) category, the incidence of 30-day morbidity and mortality was considerably higher in each 2-point score range (p 0.001). Patients with an SAS of 2 had a relative risk of 13.6 for developing complications and a relative risk of 30-day death of 239 respectively. According to the study, patients who have lower surgical Apgar scores are at a higher risk of developing complications.

An excellent correlation between the score and the risk of complications was demonstrated by Choudhari R et al. with an area under the curve (AUC) of 0.8 (95% CI - 0.72-0.88). The curve demonstrated that a cutoff of 7 may predict the risk of a complication with 80% sensitivity.

These results are also comparable to earlier research by Haddow JB and Kinoshita M that demonstrated a similar AUC and predictive value of the score.

Mortality rate in our study was 3.2% (7 out of 220), which is much lower than that reported by Choudhari R et al in their study. The ROC curve likewise shows a strong connection with an AUC of_0.88 that was comparable to our current study. This is consistent with a prior study by Reynolds PQ et al, in which it was shown that SAS was inversely related to a linearly increasing risk of 30-day death.

More than 80% of deaths in high-risk groups (Apgar scores 0-4) have been recorded. In a similar manner, Choudhari R et al reported mortality rates of 50% and 8.3% in the high risk group, 23% and 3.7% in the intermediate risk group, and 4.2% and 0 in the low risk group, respectively. This information can be used as a simple guide to anticipate postoperative risk and plan care.

5. Conclusion

In emerging nations like India, a simple tool like the SAS would be quite helpful. It would be beneficial for the routine risk classification of postoperative patients, making it easier to identify patients at high risk. In a healthcare environment like India, where there are few resources available, the SAS score will help us plan and allocate the few resources toward the postsurgical management, monitoring, and follow-up of deserving high risk patients. This would thereby prevent the wastage of resources in monitoring of low risk patients where it is actually not needed.

- Surgical APGAR score is the significant predictor of mortality at cut off point of ≤4 with area under curve of 0.88 for correctly predicting mortality.
- Surgical APGAR score is the significant predictor of morbidity at cut off point of ≤6 with area under curve of 0.749 for correctly predicting morbidity.
- High risk group patients have significantly higher chances of mortality and morbidity.

6. Limitations

There are significant concerns about SAS which include its removal of variables including patient age, comorbidities, pre-existing comorbidities, operating time, blood

transfusions, use of intravenous fluids during surgery, and other variables that have a substantial impact on the patient's result. Despite the fact that the bulk of research come from a single facility and focus on homogenous types of procedures, our setup shows that the score is still accurate when applied to a population that is heterogeneous and includes all surgical procedures. The score has stood the test of time and showed to be useful despite being simplistic and that is its greatest strength.

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