ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

A STUDY OF EFFICACY OF SURGICAL APGAR SCORE IN PREDICTING MORBIDITY AND MORTALITY IN PATIENTS UNDERGOING MAJOR ELECTIVE SURGERIES

SHARANBASAPPA, ARUNKUMAR CHAWAN, Abhishek C V, Suhasini chippar ,

SENIOR RESIDENT Department of General Surgery ESICMC KALABURGI
SENIOR RESIDENT Department of General Surgery ESICMC KALABURGI
Assistant professor, department of general surgery, Adichunchangiri institute of medical sciences, ACU, BG Nagar
senior resident, department of general surgery, ESICMC KALABURGI
CORRESPONDING AUTHOR: SUHASINI CHIPPAR , SENIOR RESIDENT Department of General Surgery ESICMC KALABURGI

ABSTRACT

AIMS AND OBJECTIVE: - A STUDY OF EFFICACY OF SURGICAL APGAR SCORE IN PREDICTING MORBIDITY AND MORTALITY IN PATIENTS UNDERGOING MAJOR ELECTIVE SURGERIES

STUDY SETTING: All the patients undergoing major abdominal surgeries like open Cholecystectomy, CBD exploration, gastrectomy, colectomy , abdominal perineal resections and including thyroid surgeries and modified radical mastectomy will be included in study ESICMC KALABURGI.

TYPE OF STUDY: - A hospital based prospective study.

MATERIALS AND METHODS: - This study included 100 subjects whose age ranged from 18 years to 82 years with mean age 46.15 ± 15.65 years. The study's duration was between (2023-2024).The study will involve all individuals undergoing major surgery. All clinical data, including history, clinical symptoms, and diagnosis, as well as laboratory and radiological examinations, will be obtained and documented. Intraoperative results, including operative diagnosis and procedure nature, will be collected. SAS [Surgical Apgar Score] is determined using the three parameters which are estimated blood loss [EBL], lowest mean arterial pressure [MAP], and lowest heart rate [HR].

RESULTS: - Complications occurred in 14 (14%) of 100 subjects in our current study, including surgical site infection (7%), chest infection (1%), anastomotic leak (1%), hypotension (2%), myocardial infarction (1%), POD 5-Ischemic stroke with Aphasia

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

(1%), post-operative biliary leak (1%), and primary haemorrhage with hypotension with hypovolemic shock (1%). In our current investigation, there is a significant difference in the distribution of Total Protein with a mean value of 7.04±0.71 and a p-value of 0.043MW*, Estimated Blood Loss with a mean value of 227.88±103.94 and a p- value of 0.001MW*, according to the Mann Whitney U test. Similarly, with a mean value of 73.22± 8.73 and a p-value of 0.0234MW*, the lowest heart rate across morbidity was found. In our current study, a significant difference in mean Lowest Mean Arterial Pressure across morbidity was found, with a mean value of 64.54±8.47 and a p-value of 0.0298t* using a two sample t test. In our recent study, we identified a significant variation in the distribution of surgical APGAR[Appearance, Pulse, Grimace, Activity and Respiration] score over morbidity: APGAR SCORE ranged from 1 (1%), 3 (3%), 10 (10%), 20 (20%), 31 (31%), and 27 (27%), with a p-value of 0.005MC*.At cut-off 6, the surgical APGAR score has an area under the ROC curve (AU-ROC) of 0.715, predicting morbidity with 70.93% sensitivity and 64.29% specificity. The APGAR score after surgery is substantially linked with morbidity (p-value = 0.0024), according to logistic regression. Morbidity increases by 0.4753 for every unit increase in surgical APGAR score. As a result, the surgical APGAR score has a high discriminant power in predicting morbidity.

CONCLUSION: - The surgical Apgar score system aids in the prediction of morbidity and death following surgery. A lower surgical Apgar score is related with an increased risk of morbidity or fatality. This score allows surgeons to identify patients who are most likely to have serious problems or die. By allowing for earlier detection of possible problems, it allows for improved supervision of patients at higher risk.

Keywords: Surgical Apgar Score, Appearance, Pulse, Grimace, Activity and Respiration, Estimated blood loss, Mean arterial pressure, Heart rate.

MATERIALS AND METHODS

A. Study design: The proposed study is a hospital based prospective study centered ESICMC KALABURGI

B. Study participants: Humans

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

1. Inclusion criteria: All the patients undergoing the following elective surgeries done under general anesthesia were included in the study:

1. Thyroidectomy 2. Modified Radical Mastectomy 3. Cholecystectomy

4.CBD exploration 5. Colorectal surgeries 6. Gastric resection 7. Incisional Hernia

8. Heller's Cardiomyotomy

2. Exclusion criteria:

a) Patients under age of 14years

b) Patients undergoing re explorative laparotomy

c) Laparotomy converted from laparoscopic surgery.

Sample size -100

Ethical Clearance was sought from the Institutional Ethics Committee

Study procedure: All clinical data including history, clinical findings and diagnosis, laboratory and radio-logical investigations were collected and recorded. Intra operative findings included operative diagnosis and nature of procedure. The three parameters required for SAS that is estimated blood loss, lowest mean arterial pressure and lowest heart rate were collected, SAS was calculated. The patients were followed upto post operative day 14 for any complications.

Surgical Apgar score calculation

Patients were categorized into following risk groups based on SAS Risk group

- High risk- Apgar score 0-5
- Medium risk- Apgar score 6-7
- Low risk - Apgar score 8-10

The predicted mortality and morbidity risks were compared with the actual morbidity and mortality.

List of statistical tests used for data analysis:

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

1. All analysis were performed using SPSS version 20.0
2. Demographical data were explained by descriptive statistics
3. Quantitative data were evaluated with t-test
4. Qualitative data were evaluated with chi square test
5. $P<0.05$ was considered as statistically insignificant

RESULTS

In the present study, 100 subjects were included whose age ranged from 18 years to 83 years with mean age 47.85 ± 16.33 years. The following table gives the distribution of subjects according to mortality.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

Table 3: Distribution of subjects according to mortality.

Mortality	Number of subjects (%)
Absent	92 (92%)
Present	8 (8%)

As shown in Table 3 out of 100 subjects, 8% died while 92% survived.

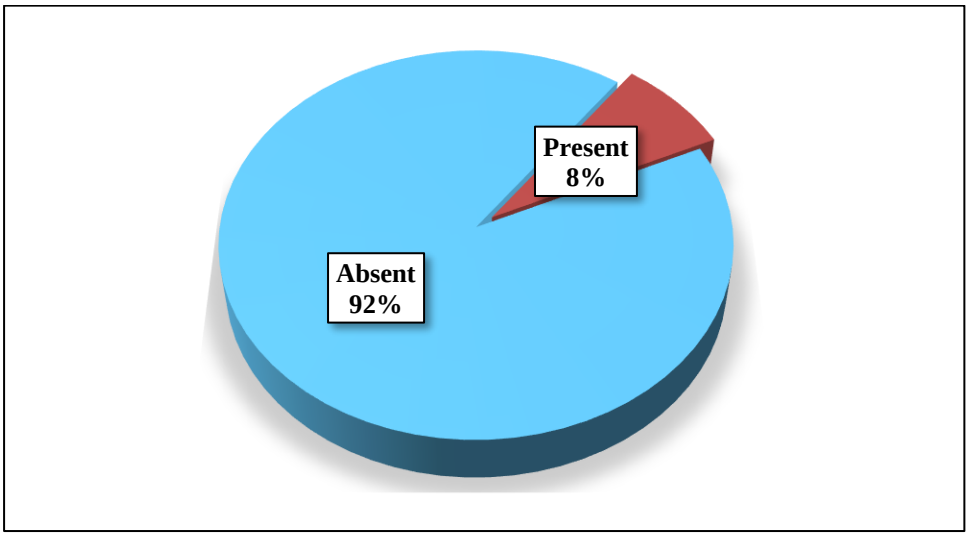


Figure 1: Distribution of subjects according to mortality.

The following table gives the distribution of subjects according to complications.

Table 4: Distribution of subjects according to complications.

Complications	Number of subjects (%)
Anastomotic Leak	1 (1%)
Pneumonia	1 (1%)
Hypotension	2 (2%)
Surgical site infection	6 (6%)
Myocardial infarction	1 (1%)
Ischemic stroke with Aphasia	1 (1%)

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

Post-Op Biliary leak	1 (1%)
Primary haemorrhage with hypotension with hypovolemic shock	1 (1%)

As shown in table-4 distribution of subjects according to complications in our present study showed out of 100 subjects, 14 (14%) had complications which includes- Surgical site infection-6 (6%), Pneumonia-1(1%), Anastomotic leak-1(1%), Hypotension-2(2%), Myocardial infarction-1 (1%),Ischemic stroke with Aphasia-1(1%), Post-Op Biliary leak-1(1%),and Primary haemorrhage with hypotension with hypovolemic shock-1(1%).

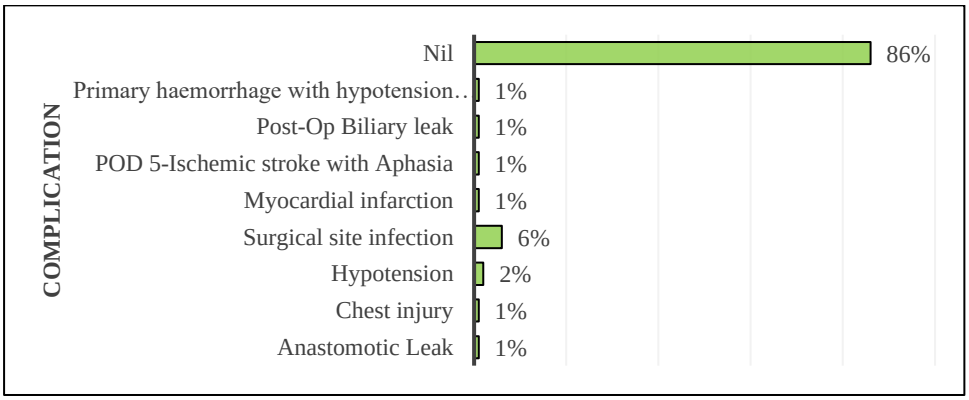


Figure 2: Distribution of subjects according to complication.

The following table gives the comparison of different variables over morbidity.

Table 5: Comparison of different variables over morbidity.

Variables	**Sub Category**	**Morbidity**		**Total**	**p-value**
		No	**Yes**		
Age (years)	18-20	1 (1.2%)	1 (7.1%)	2 (2%)	**<0.001**[MC*]
	20-39	34 (39.5%)	0	34 (34%)	
	40-59	29 (33.7%)	7 (50%)	36 (36%)	
	60-79	21 (24.4%)	4 (28.6%)	25 (25%)	
	≥80	1 (1.2%)	2 (14.3%)	3 (3%)	
	Mean ± SD Median (Min, Max)	46 ± 16 47 (19, 82)	58 ± 17 56 (18, 83)	47.85 ± 16.33 48 (18, 83)	**0.017**[MW*]
Hemoglobin	Mean ± SD Median (Min, Max)	12.85 ± 1.87 13 (7.5, 17.5)	11.63 ± 1.82 11.9 (7.4, 13.7)	12.67 ± 1.9 12.75 (7.4, 17.5)	**0.025**[t*]
TLC	Mean ± SD	11304.6 ± 14338.6	9975.6 ± 4581.5	11114.78 ± 13377.33	0.831[MW]

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

	Median (Min, Max)	9230 (1730,136160)	9975 (4390, 22820)	9265 (1730,136160)	
Platelet count	Mean ± SD Median (Min, Max)	2.78 ± 1.2 2.61 (0.56, 6.71)	2.83 ± 1.58 2.68 (0.33, 5.89)	2.78 ± 1.24 2.61 (0.33, 6.71)	0.996^{MW}
NA	Mean ± SD Median (Min, Max)	138 ± 4 138 (119, 150)	136 ± 6 138 (124, 143)	137.36 ± 4.64 138 (119, 150)	0.5748^{MW}
K	Mean ± SD Median (Min, Max)	4.15 ± 0.49 4.18 (3.03, 5.50)	4.08 ± 0.56 4.25 (3.10, 5.04)	4.13 ± 0.501 4.18 (3.03, 5.50)	0.659^{t}
CL	Mean ± SD Median (Min, Max)	100.2 ± 11.74 102 (1.60, 110)	98.89 ± 5.86 100.50 (90, 107)	100.01 ± 11.07 102 (1.60, 110)	0.197^{MW}
Urea	Mean ± SD Median (Min, Max)	21.6 ± 14.6 19 (3, 123)	23.5 ± 8.5 22.8 (13.7, 41)	21.87 ± 13.87 19.2 (3, 123)	0.187^{MW}
Creatinine	Mean ± SD Median (Min, Max)	0.83 ± 0.69 0.72 (0.36, 6.52)	0.69 ± 0.19 0.67 (0.41, 1.06)	0.81 ± 0.64 0.70 (0.36, 6.52)	0.383^{MW}
Total Bilirubin	Mean ± SD Median (Min, Max)	0.79 ± 1.16 0.51 (0.10, 8.77)	0.57 ± 0.38 0.39 (0.2, 1.42)	0.75 ± 1.08 0.50 (0.10, 8.77)	0.417^{MW}
Serum Aspartate Transaminase	Mean ± SD Median (Min, Max)	28.23 ± 28.43 21 (11, 178)	25.85 ± 12.39 22 (11, 54)	27.9 ± 26.75 21 (11, 178)	0.599^{MW}
Serum Alanine Transaminase	Mean ± SD Median (Min, Max)	87.3 ± 514.1 21 (6.7, 4647)	21.6 ± 10 19 (5.2, 46)	78.23 ± 477.35 21 (5.20, 4647)	0.493^{MW}
Serum Alkaline Phosphatase	Mean ± SD Median (Min, Max)	108 ± 88 82 (10, 734)	108 ± 32 101 (64, 171)	108.11 ± 82.77 87.5 (10, 734)	0.150^{MW}
Total Protein	Mean ± SD Median (Min, Max)	7.01 ± 0.8 7.2 (4.6, 8.5)	6.78 ± 0.53 6.87 (5.82, 7.8)	6.97 ± 0.77 7.02 (4.6, 8.50)	0.107^{MW}
Serum Albumin	Mean ± SD Median (Min, Max)	4.29 ± 4.53 3.9 (0.97, 44)	3.54 ± 0.75 3.4 (2.51, 4.7)	4.18 ± 4.21 3.90 (0.97, 44)	0.222^{MW}
Random Blood Sugar	Mean ± SD Median (Min, Max)	118 ± 52 101 (60, 392)	129 ± 54 115 (76, 246)	119.53 ± 51.83 103 (60, 392)	0.525^{MW}
Prothrombin Time	Mean ± SD Median (Min, Max)	14.73 ± 2.38 14.30 (5.7, 22)	15.72 ± 3.62 14.3 (12.4, 23.2)	14.86 ± 2.57 14.3 (5.7, 23.2)	0.803^{MW}
INR	Mean ± SD Median (Min, Max)	1.20 ± 0.212 1.15 (0.80, 1.80)	1.3 ± 0.332 1.20 (0.95, 1.99)	1.21 ± 0.231 1.15 (0.80, 1.99)	0.504^{MW}
Plasma Thromboplastin Time	Mean ± SD Median (Min, Max)	33.1 ± 6.4 31.40 (22.9, 57.3)	31.8 ± 4.9 31 (27, 44.8)	32.94 ± 6.21 31.30 (22.9, 57.3)	0.453^{MW}
Estimated Blood Loss	Mean ± SD Median (Min, Max)	227 ± 113 200 (100, 650)	342 ± 123 300 (200, 600)	243.28 ± 120.85 200 (100, 650)	$\mathbf{< 0.001^{MW*}}$
Lowest Heart Rate	Mean ± SD Median (Min, Max)	73 ± 8 73 (56, 90)	78 ± 12 80 (58, 100)	73.56 ± 8.85 74 (56, 100)	0.071^{MW}
Lowest Mean Arterial Pressure	Mean ± SD Median (Min, Max)	65 ± 8 66 (44, 82)	58 ± 11 56 (44, 80)	64.38 ± 9.14 65.5 (44, 82)	$\mathbf{< 0.001^{t*}}$
Surgical APGAR score	2	0	1 (7.1%)	1 (1%)	$\mathbf{<0.001^{MC*}}$
	3	3 (3.5%)	2 (14.3%)	5 (5%)	
	4	5 (5.8%)	5 (35.7%)	10 (10%)	
	5	22 (25.6%)	2 (14.3%)	24 (24%)	
	6	26 (30.2%)	1 (7.1%)	27 (27%)	
	7	24 (27.9%)	2 (14.3%)	26 (26%)	
	8	6 (7%)	1 (7.1%)	7 (7%)	
	Mean ± SD	6 ± 1	5 ± 2	5.77 ± 1.32	$\mathbf{0.006^{MW*}}$

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

	Median (Min, Max)	6 (3, 8)	4 (2, 8)	6 (2, 8)	
Mortality	Absent	80 (93%)	12 (85.7%)	92 (929%)	0.350^{MC}
	Present	6 (7%)	2 (14.3%)	8 (8%)	

*Abbreviation: MC – Chi square test with Monte Carlo simulation, t – Two sample t test, MW – Mann Whitney U test, * indicates statistical significance.*

As shown in the table-3Comparison of different variables over morbidity, from Chi square test and Mann Whitney U test, it is observed that, there is significant difference in the distribution of age and Surgical APGAR score over morbidity and their p- value was found to be< **0.001^{MC*}** .

Similarly from Mann Whitney U test, it is observed that, there is significant difference in the, Estimated Blood Loss over morbidity and its p- value was found to be< **0.001^{MW*}**. There is no significant difference in the distribution of TLC, Platelet count, NA, CL, Urea, Creatinine, Total Bilirubin, Serum Aspartate Transaminase, Serum Alanine Transaminase, Serum Alkaline Phosphatase, Serum Albumin, Random Blood Sugar, Prothrombin Time, INR and Plasma Thromboplastin Time over morbidity. From two sample t test, it is observed that, there is significant difference in mean of Heamoglobin, and its p- value was found to be **0.025^{t*}** and for Lowest Mean Arterial Pressure over morbidity p- value was found to be< **0.001^{t*}**.There is no significant difference in the mean of K over morbidity. From Chi square test, it is observed that, there is no significant association of mortality and morbidity.

Below graph depicts the same as shown in the table-5.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

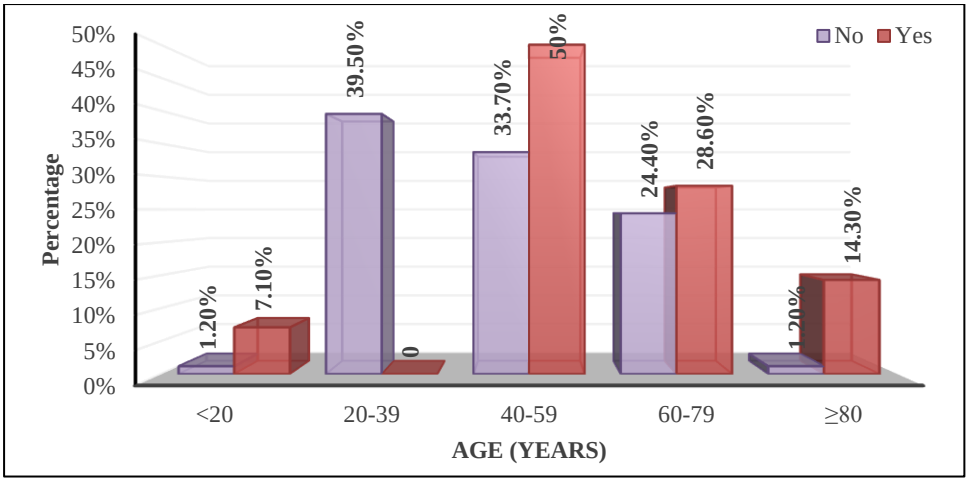


Figure 3: Distribution of age over morbidity.

Figure 4: Mean plot of age over morbidity.

As shown in the figure-4 from Chi square test and Mann Whitney U test, it can be seen that it the mean of age over morbidity has significant distribution.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

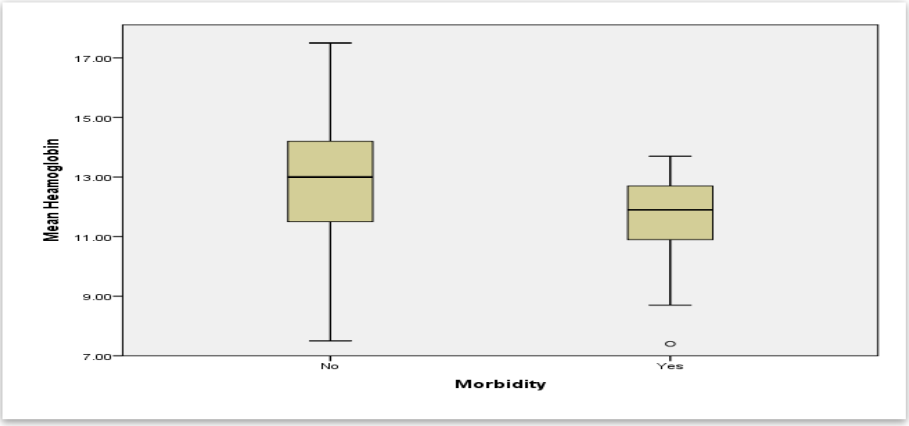


Figure 5: Mean plot of hemoglobin over morbidity.

As shown in the figure-5 from two sample t test, it can be seen that the mean ofhemoglobin over morbidity has a significant distribution.

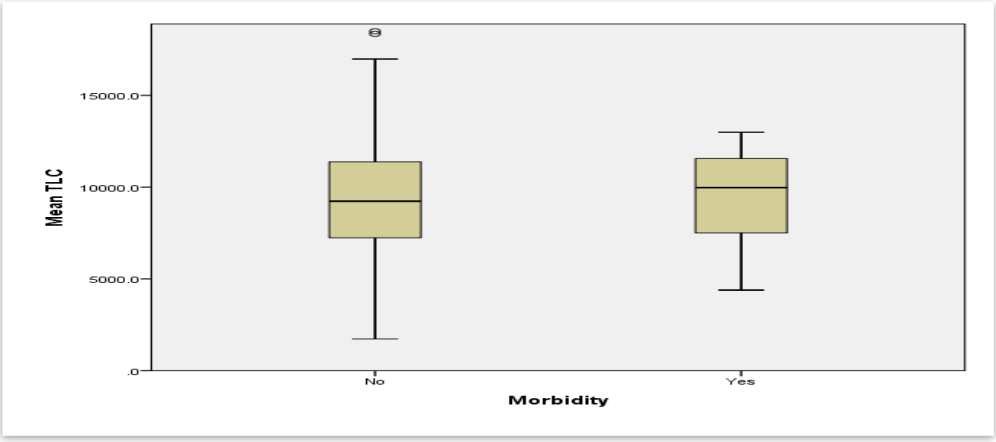


Figure 6: Mean plot of TLC over morbidity.

As shown in the figure-6 from Mann Whitney U test it can be seen that the mean of TLCover morbidity has no significant distribution.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

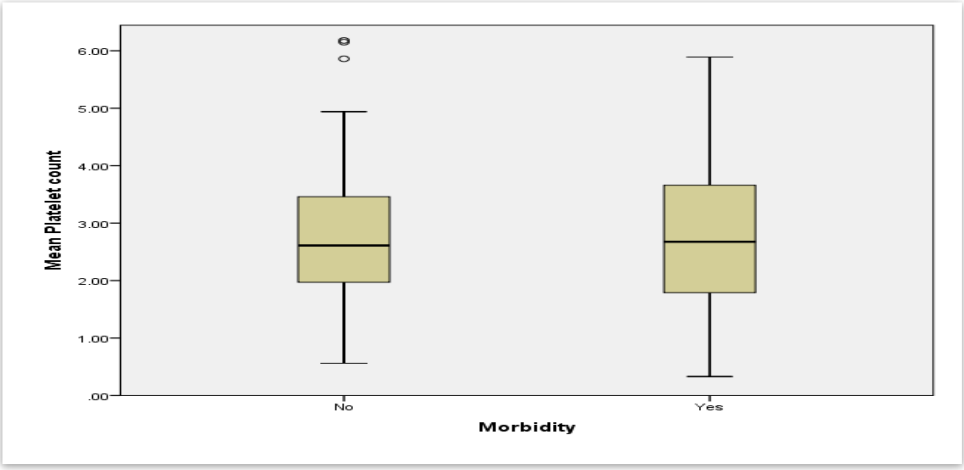


Figure 7: Mean plot of Platelet count over morbidity.

As shown in the figure-7 from Mann Whitney U test it can be seen that the mean of platelet count over morbidity has no significant distribution.

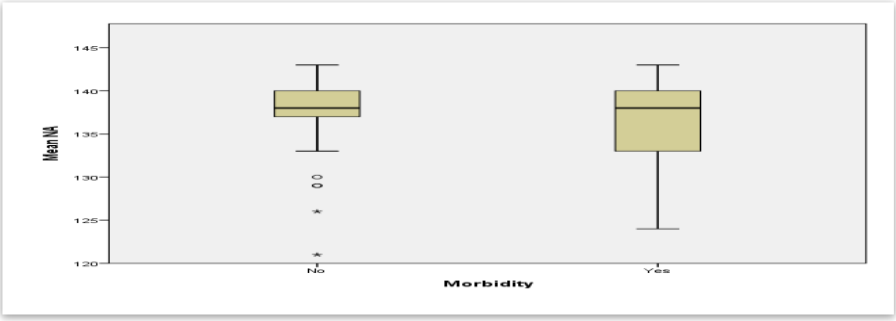


Figure 8: Mean plot of NA over morbidity.

As shown in the figure-8 from Mann Whitney U test it can be seen that the mean of NAover morbidity has no significant distribution.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

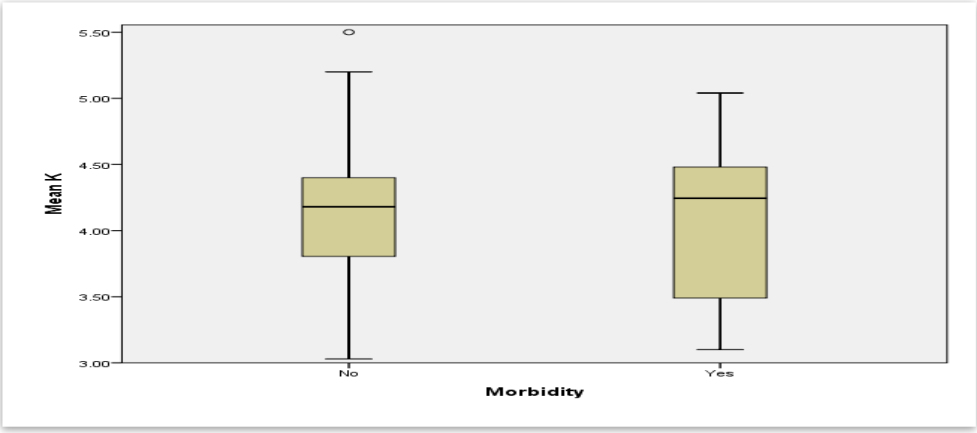


Figure 9: Mean plot of K over morbidity.

As shown in the figure-9 from Mann Whitney U test it can be seen that the mean of K over morbidity has no significant distribution.

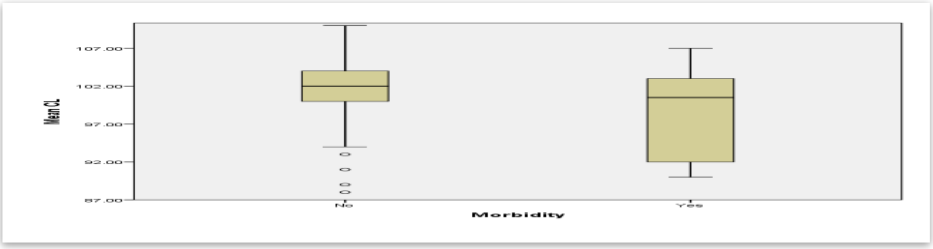


Figure 10: Mean plot of CL over morbidity.

As shown in the figure-10 from Mann Whitney U test it can be seen that the mean of CL over morbidity has no significant distribution.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

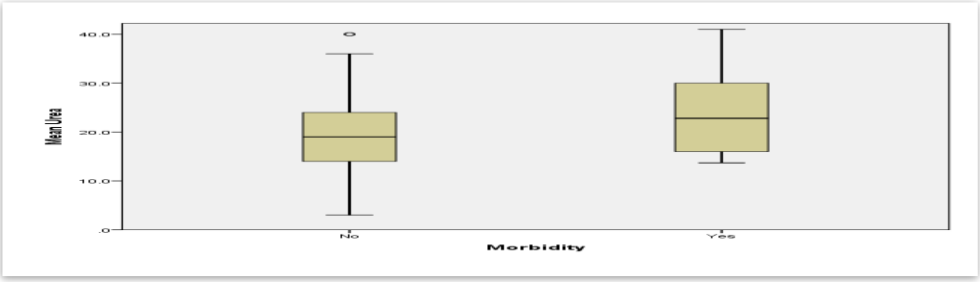


Figure 11: Mean plot of urea over morbidity.

As shown in the figure-11 from Mann Whitney U test it can be seen that the mean of Urea over morbidity has no significant distribution.

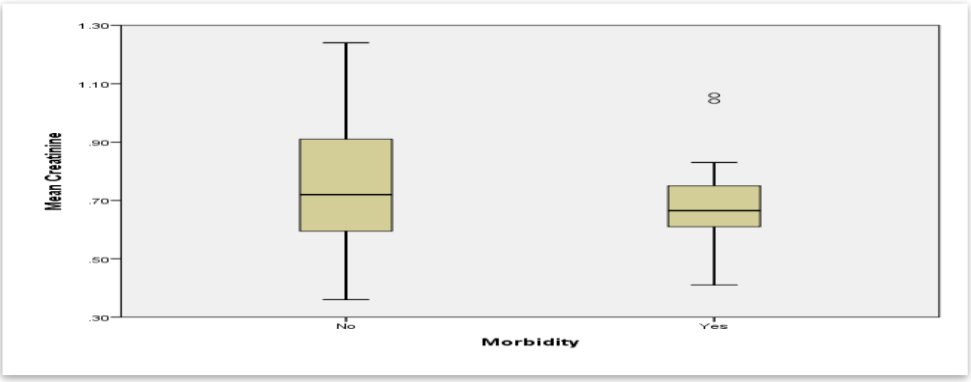


Figure 12: Mean plot of creatinine over morbidity.

As shown in the figure-12 from Mann Whitney U test it can be seen that the mean of Creatinine over morbidity has no significant distribution.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

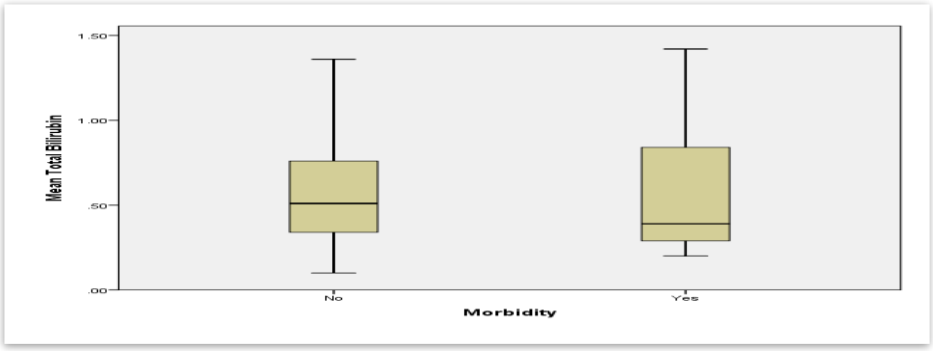


Figure 13: Mean plot of total bilirubin over morbidity.

As shown in the figure-13 from Mann Whitney U test it can be seen that the meanoftotal bilirubin over morbidity has no significant distribution.

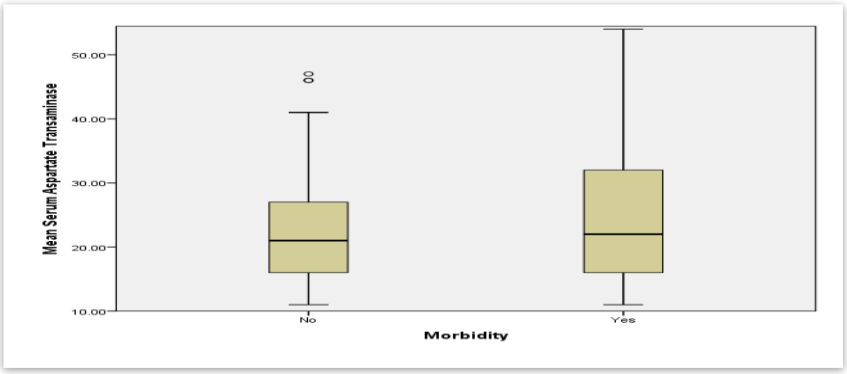


Figure 14: Mean plot of Serum Aspartate Transaminase over morbidity.

As shown in the figure-14 from Mann Whitney U test it can be seen that the mean ofSerum Aspartate Transaminaseover morbidity has no significant distribution.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

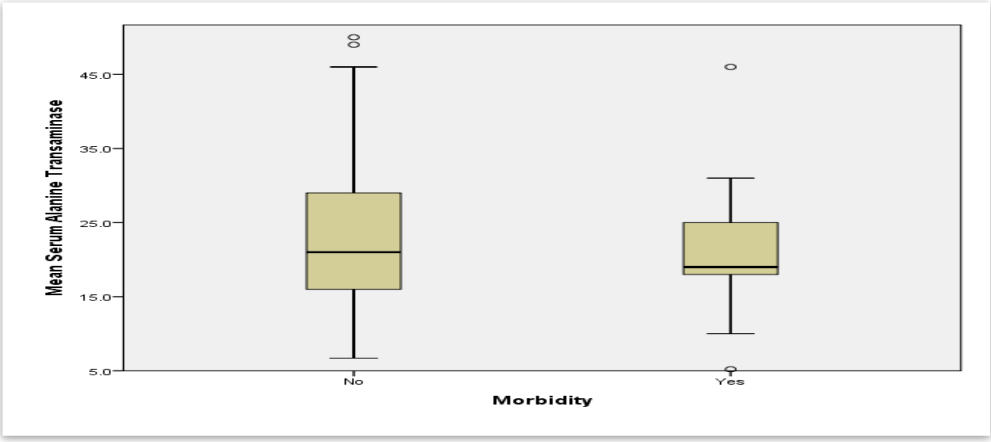


Figure 15: Mean plot of Serum Alanine Transaminase over morbidity.

As shown in the figure-15 from Mann Whitney U test it can be seen that the meanofSerum Alanine Transaminaseover morbidity has no significant distribution.

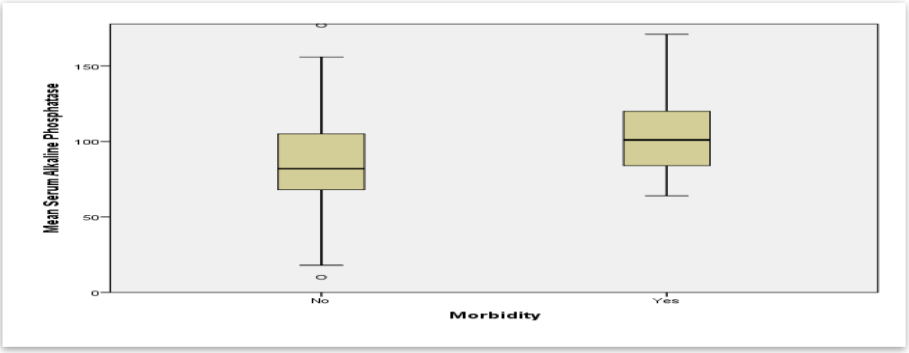


Figure 16: Mean plot of Serum Alkaline Phosphatase over morbidity.

As shown in the figure-16 from Mann Whitney U test it can be seen that the mean ofSerum Alanine Phosphataseover morbidity has no significant distribution.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

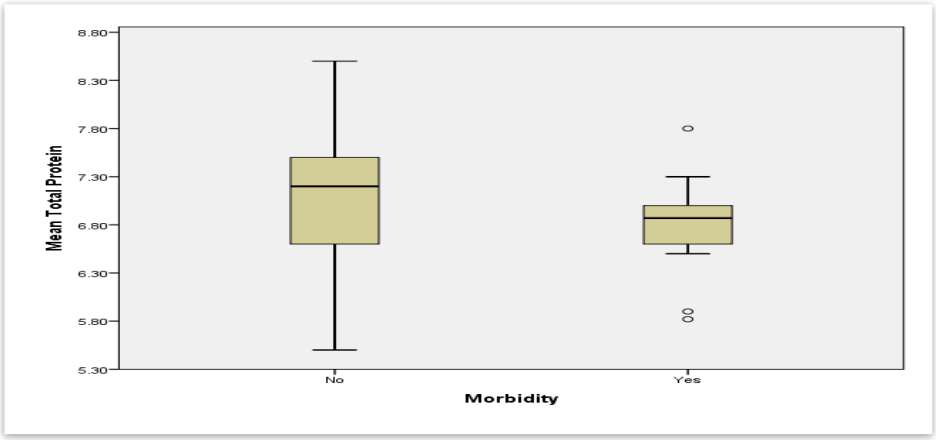


Figure 17: Mean plot of Total Protein over morbidity.

As shown in the figure-17 from Mann Whitney U test it can be seen that the meanofTotal Proteinover morbidity has no significant distribution.

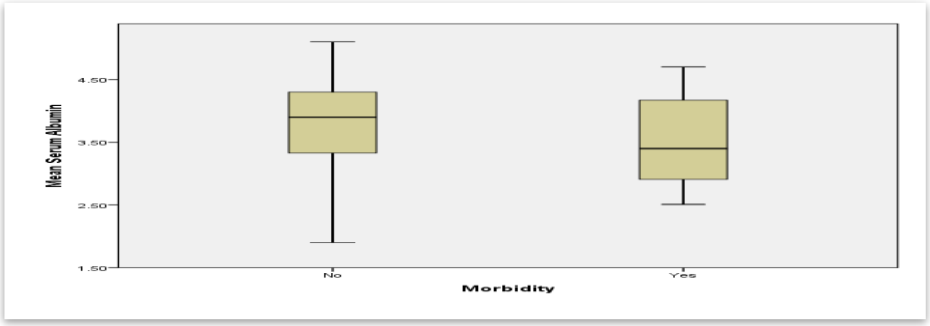


Figure 18: Mean plot of Serum Albumin over morbidity.

As shown in the figure-18 from Mann Whitney U test it can be seen that the meanofSerum Albuminover morbidity has no significant distribution.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

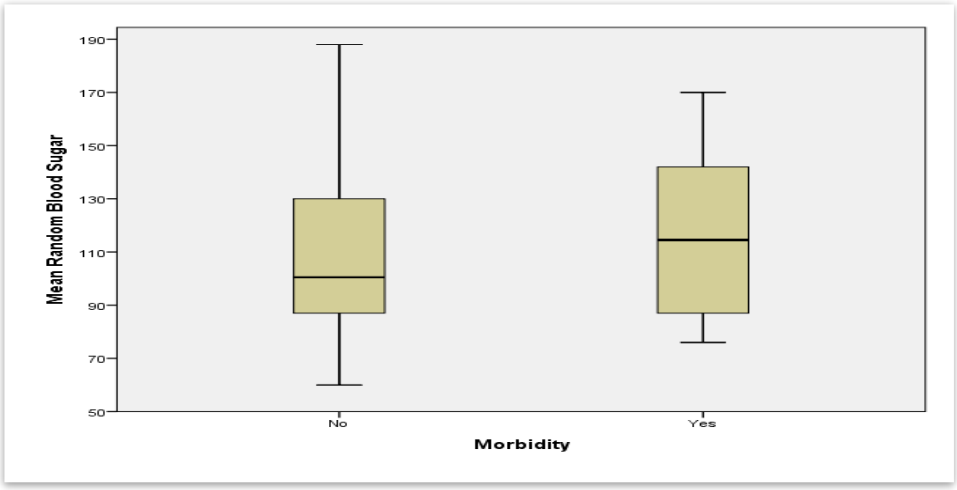


Figure 19: Mean plot of Random Blood Sugar over morbidity.

As shown in the figure-19 from Mann Whitney U test it can be seen that the mean of Random Blood Sugar over morbidity has no significant distribution.

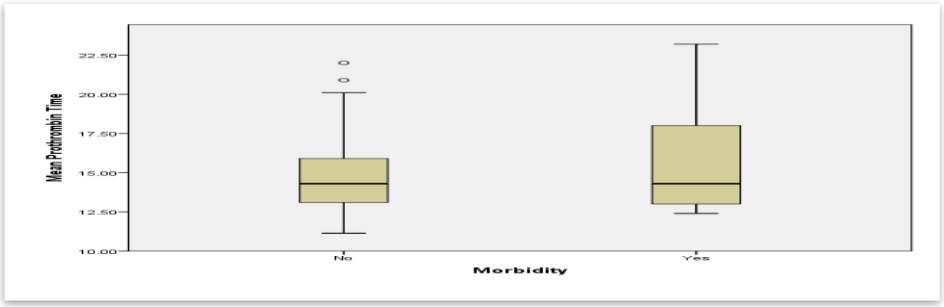


Figure 20: Mean plot of Prothrombin Time over morbidity.

As shown in the figure-20 from Mann Whitney U test it can be seen that the meanof Prothrombin Timeover morbidity has no significant distribution.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

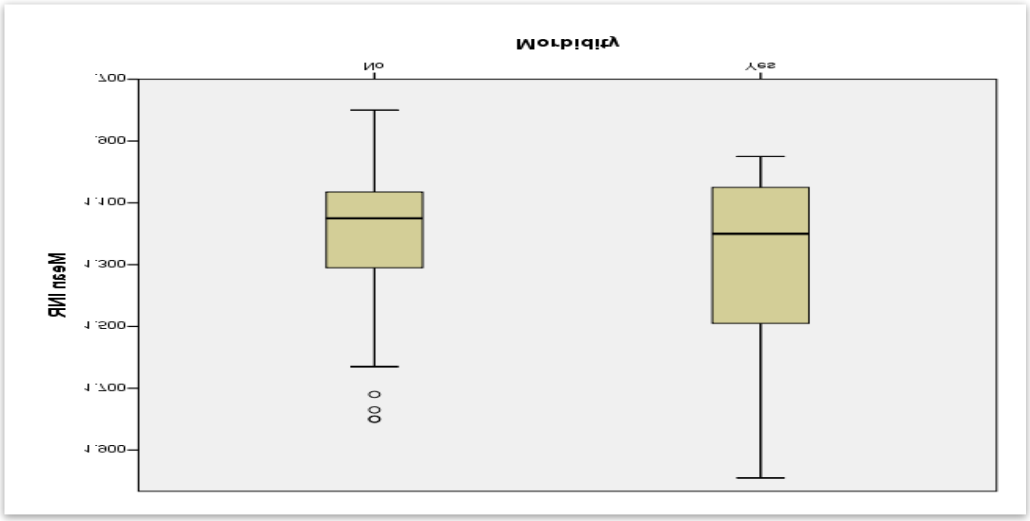


Figure 21: Mean plot of INR over morbidity.

As shown in the figure-21 from Mann Whitney U test it can be seen that the meanofProthrombin Timeover morbidity has no significant distribution.

Figure 22: Mean plot of Plasma Thromboplastin Time over morbidity.

As shown in the figure-22 from Mann Whitney U test it can be seen that the mean of Plasma Thromboplastin over morbidity has no significant distribution.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

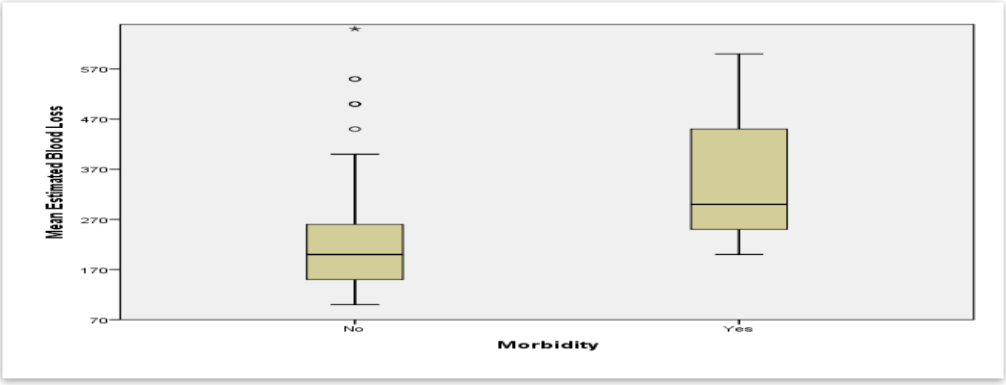


Figure 23: Mean plot of Estimated Blood Loss over morbidity.

As shown in the figure-23 from Mann Whitney U test it can be seen that the mean of Estimated Blood Lossover morbidity has significant distribution.

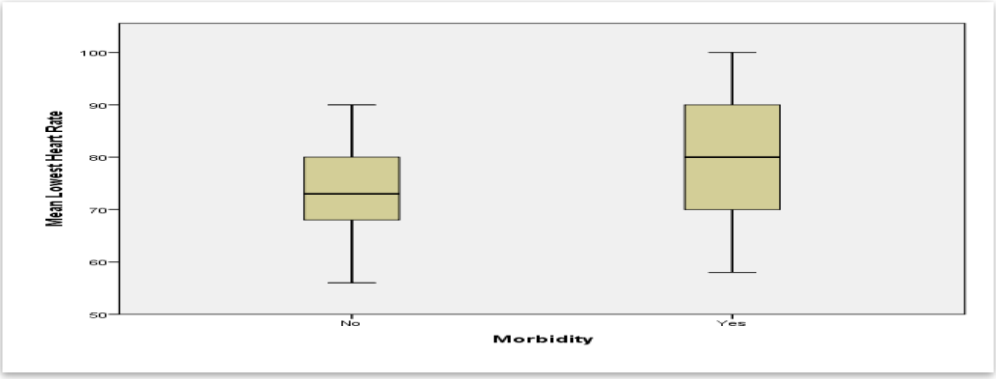


Figure 24: Mean plot of Lowest Heart Rate over morbidity.

As shown in the figure-24 from Mann Whitney U test it can be seen that the mean of Lowest Heart Rate over morbidity has no significant distribution.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

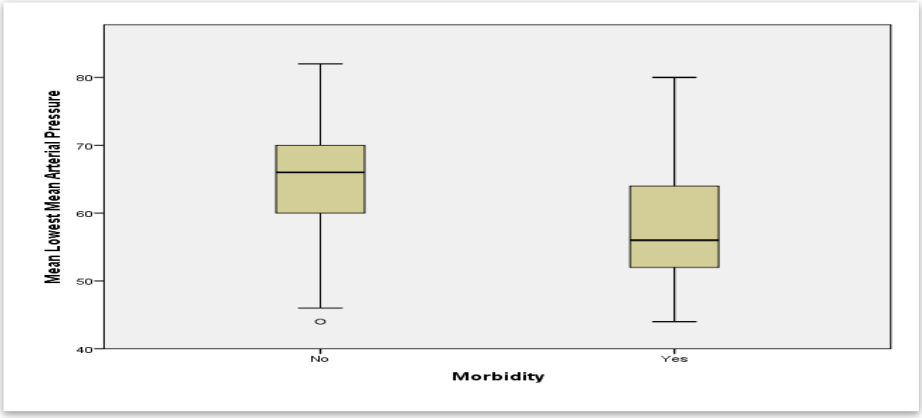


Figure 25: Mean plot of Lowest Mean Arterial Pressure over morbidity.

As shown in the figure-25 from two sample t test it can be seen that the mean of Lowest Mean Arterial Pressure over morbidity has significant distribution.

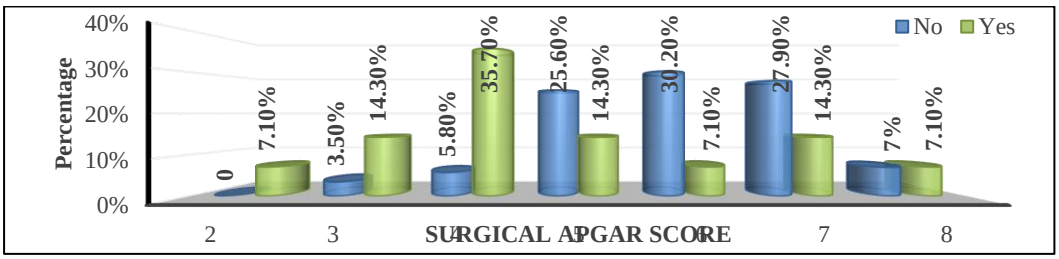


Figure 26: Distribution of surgical APGAR score over morbidity.

As shown in the figure-26distribution of surgical apgar score over morbidity which was found by the following ways, APGAR SCORE from 2-8 for the study participants with SAS[surgical APGAR score], 2 (7.10%), 3(14.30%), 4 (35.70%), 5 (14.30%), 6 (7.10%) ,7(14.30%) and SAS 8 (7.10%) respectively.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

Figure 27: Mean plot of surgical APGAR score over morbidity.

As shown in the figure-27 from Chi square test and Mann Whitney U test, it is observed that, there is significant difference in the distribution of surgical APGAR score over morbidity.

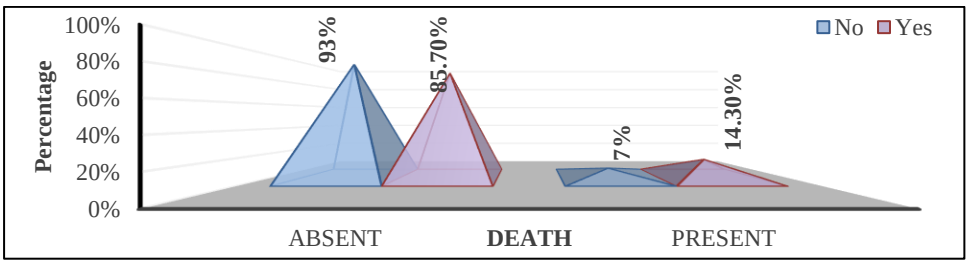


Figure 28: Distribution of mortality over morbidity.

As shown in the figure-28distribution of mortality over morbidity,out of 100 subjects, 85.70 % of the study population showed morbidity while 14.30% of the study participants died over morbidity during the study.

The following table gives Optimal cut-off and accuracy indices of surgical APGAR score in predicting morbidity.

Table 6: Optimal cut-off and accuracy indices of surgical APGAR score in predicting morbidity.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

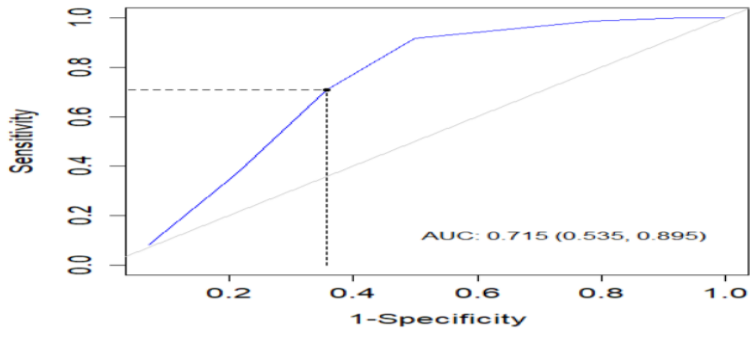
	Surgical APGAR score
Cut-off	(<) 6
Sensitivity (95% CI)	72.3% (61.6% - 84.2%)
Specificity (95% CI)	68.9% (33.4% - 86.24%)
PPV (95% CI)	93.4% (79.9% - 96.3%)
NPV (95% CI)	24.7% (17.21% - 55.8%)
AU-ROC (95% CI)	0.715 (0.535, 0.895)
Odds Ratio (95% CI)	0.48 (0.29, 0.75)
p-value	**0.002***

As shown in the table-6 optimal cut-off and accuracy indices of surgical apgar score in predicting morbidity the area under the ROC curve (AU-ROC) for surgical APGAR score is 0.715 at cut-off < 6 with 72.3% sensitivity and 68.9% specificity in predicting morbidity.

From logistic regression, it is observed that, surgical APGAR score is significantly associated with morbidity (p-value = 0.002). With unit increase in surgical APGAR score, the odds of having morbidity increases by 0.48. Hence, surgical APGAR score has good discriminant power in predicting morbidity.

Figure 29: ROC curves for surgical APGAR score in predicting morbidity.

As shown in the figure-29,the Receiver Operating Characteristic (ROC) curve for the SAS had an area under the curve (AUC) of 0.715 (0.535, 0.895) with 70.93% sensitivity and 64.29% specificity in predicting morbidity



The following table gives the comparison of surgical APGAR score over morbidity.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

Table 7: Comparison of surgical APGAR score over morbidity.

Surgical APGAR score	Morbidity		Total	p-value
	No	Yes		
Low risk	6 (7%)	1 (7.1%)	7 (7%)	**<0.001^{MC}***
Medium risk	72 (83.7%)	5 (35.7%)	77 (77%)	
High risk	8 (9.3%)	8 (57.1%)	16 (16%)	

*Abbreviation: MC – Chi square test with Monte Carlo simulation, * indicates statistical significance.*

As shown in the table-7 comparision of surgical APGAR score over morbidity, SAS in predicting low risk was found in 1 (7.14%), similarly for medium risk was found in 5 (35.7%) and for high risk was found in 8 (57.1%) and their p-value was found to be **<0.001^{MC}***.From Chi square test, it is observed that, there is significant difference in the distribution of surgical APGAR score over morbidity.

Below graph depicts the same as shown in the table-7.

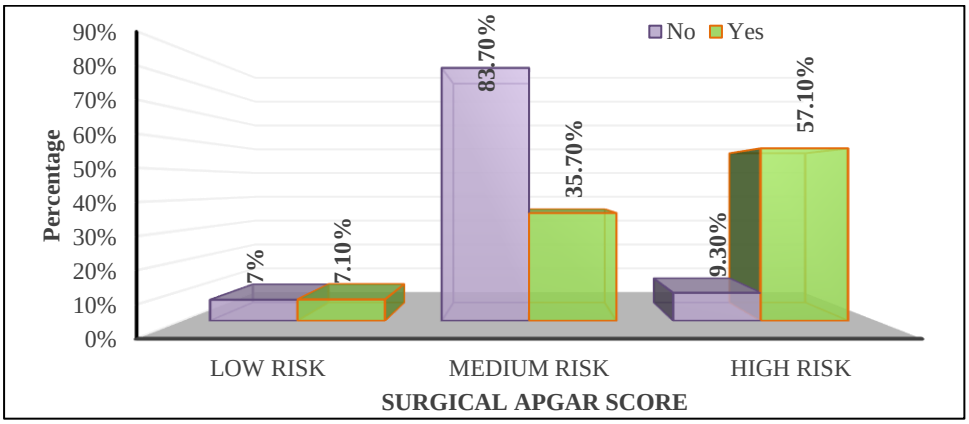


Figure 30: Distribution of surgical APGAR score over morbidity.

The following table gives the comparison of surgical APGAR score over mortality.

Table 8: Comparison of surgical APGAR score over mortality.

Surgical APGAR score	Mortality		Total	p-value
	No	Yes		

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

2	1 (1.1%)	0	1 (1%)	
3	3 (3.3%)	2 (25%)	5 (5%)	
4	9 (9.8%)	1 (12.5%)	10 (10%)	
5	19 (20.7%)	5 (62.5%)	24 (24%)	**<0.001^{MC}***
6	27 (29.3%)	0	27 (27%)	
7	26 (28.3%)	0	26 (26%)	
8	7 (7.6%)	0	7 (7%)	

*Abbreviation: MC – Chi square test with Monte Carlo simulation, * indicates statistical significance.*

As shown in the table-8Comparison of surgical APGAR score over mortality, SAS of 3 2(25%) showed mortality, and for SAS- 4, 1(12.5%) showed mortality and similarly SAS of 5 showed mortality 5 (62.5%). From Chi square test, it is observed that, there is significant difference in the distribution of surgical APGAR score over mortality.

Below graph depicts the same as shown in the table-8.

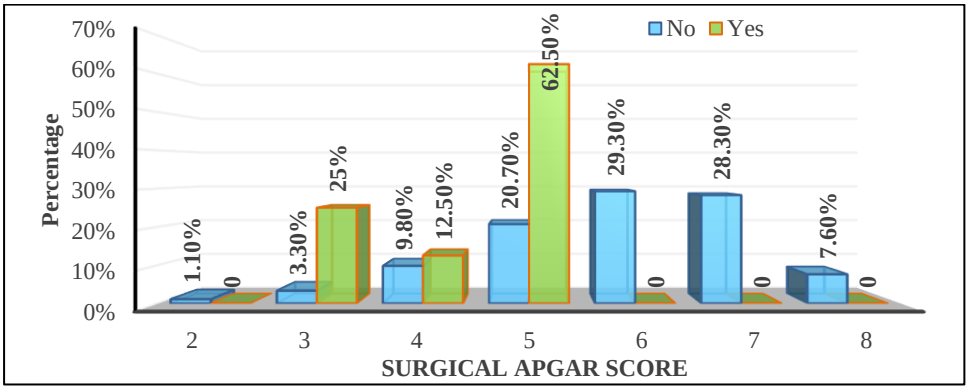


Figure 31: Distribution of surgical APGAR score over mortality.

The following table gives the comparison of risk groups over mortality.

Table 9: Comparison of risk groups over mortality.

		Surgical APGAR score	

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

Variable	Subcategory	Low risk	Medium risk	High risk	Total	p-value
Mortality	No	7 (100%)	72 (93.5%)	13 (81.3%)	92 (92%)	0.187[MC]
	Yes	0	0	8 (8%)	8 (8%)	

*Abbreviation: MC – Chi square test with Monte Carlo simulation, * indicates statistical significance.*

As shown in the table-9 Comparison of risk groups over mortality it was found that participants under high risk-showed mortality by 8 (8%). From Chi square test, it is observed that, there is no significant difference in the distribution of risk groups score over mortality.

Below graph depicts the same as shown in the table-9.

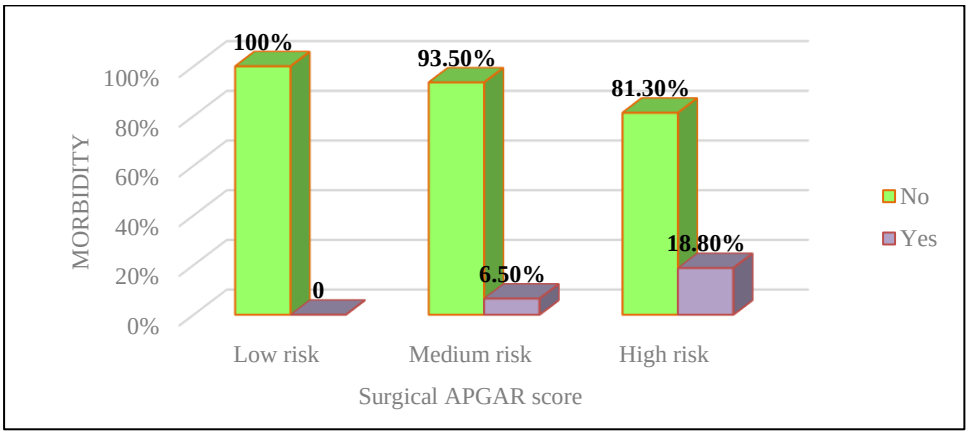


Figure 32: Distribution of risk groups over morbidity.

DISCUSSION

This is hospital based prospective study, titled "A STUDY OF EFFICACY OF SURGICAL APGAR SCORE IN PREDICTING MORBIDITY AND MORTALITY IN PATIENTS UNDERGOING MAJOR ELECTIVE SURGERIES", carried out at ESICMC KALABURGI. All the patients undergoing the following elective surgeries done under general anesthesia were included in the study:1. Thyroidectomy 2. Modified

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

Radical Mastectomy 3. Cholecystectomy 4.CBD exploration 5. Colorectal surgeries 6. Gastric resection 7. Incisional Hernia 8.hellers cardiomyotomy . All patients satisfying inclusion and exclusion criteria were included in study. After receiving approval from the institutional scientific and ethical committe, the study was carried out.Duration of the study was from DECEMBER 2023 to NOVEMBER 2024.The components studied includes, age, subjects according to complication and Comparison of different variables over morbidity.

We are discussing this study under the following headings

1. **Distribution of subjects according to their age**
2. **Distribution of subjects according to mortality**
3. **Distribution of subjects according to complications**
4. **Comparison of different variables over morbidity**
5. **Distribution of age over morbidity**
6. **Distribution of mortality over morbidity**
7. **Surgical APGAR score in predicting morbidity**
8. **Comparison of surgical APGAR score over morbidity**

1. **Distribution of subjects according to their age**

In our present study the data covers measurements from 100 people ranging in age from 18 to 83 years, with a mean age of 47.85 ± 16.33 years.

Similarly study done by **Thorn et al., 2012,**[74]a total of 223 consecutive general, vascular, and orthopaedic surgical cases were investigated in a prospective cohort done and Patients were over 16 to >90 years old.

In another study done by **Hyder et al., 2013**, [75]maintained a database of surgical patients as part of institutional participation in the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) of 3000 patients.

In study, done by**Varun Gandhi et al., 2015**[76]the age group chosen for the study was 16 and up. 37% of the patients were under the age of 40, 21% were between the ages of 40 and 50, 19% were between the ages of 50 and 60, and roughly 23% were over the age of 65. Mortality happened in a score range of 2 to 3.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

Rajgopal et al., 2019[77]concluded that in their study 66% of the 100 subjects were male, 34% were female. 21% were less than 40 years old, 27% were aged between 40 and 50 years, 24% were between 51 and 60 years old, and 28% were over 60 years old.

A total of 13,297 adult patients were enrolled in cohort study done by **Lin et al., 2021**[79]and after excluding patients with missing data (n = 142) and those who had multiple procedures (n = 16), a total of 13,139 patients were included in the final analysis. The cohort was largely made up of patients above the age of ≤ 50 (51.6%), with a mean age of 47.9 years (±20.6).

2. **Distribution of subjects according to mortality**

In our current study, out of 100 subjects, 8% died while 92% survived.

Similarly study done by **Thorn et al., 2012**, [74]in the general and vascular surgery cohorts, Eleven individuals in the group died within 30 days of each other, and their cases were investigated. Four people died as a result of general or vascular treatments. After undergoing emergency laparotomy and small bowel resection for ischemic problems, two of these patients were sent to the ICU from the operating room (SAS 5 and 2). A 94-year-old (SAS 5) patient who underwent elective axillofemoral bypass and developed a postoperative chest infection after being discharged to the ward, and a 35-year-old patient who had undergone a palliative bypass for colorectal cancer recurrence and was discharged to the ward before developing sepsis and renal failure (SAS 6).

In another study done by **Hyder et al., 2013**,[75]272 (9.1%) experienced major complications or mortality.

In study, done by**Varun Gandhi et al., 2015**[76]there were roughly 43 male patients, and 21 of them, or about 48.8%, had complications, including mortality, whereas the other 22 did not.Out of 58 cases, approximately 21 female patients had difficulties, including mortality, while the remaining 36 people did not.

3. **Distribution of subjects according to complications**

In our current study, 14 (14%) out of 100 subjects had complications, which included Surgical site infection (6%), Chest injury 1 (1%), Anastomotic leak 1 (1%), Hypotension 2 (2%), Myocardial infarction 1 (1%), POD 5-Ischemic stroke with

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

Aphasia 1 (1%), Post-Op Biliary leak 1 (1%), and Primary haemorrhage with hypotension with hypovolemic shock 1 (1%), while 86 (86%) participants didn't showed any complications.

Similarly study done by **Thorn et al., 2012**,[74]in the general and vascular surgery cohorts, 30/127 (24%),44 % of the surgeries were classified as emergency. 5/41 (12%) of patients with scores of 9-10 suffered significant problems within 30 days, with no mortality. 11/60 (18%) of patients with a score of 7-8 suffered significant problems with no fatalities. Patients with ratings of 5-6 experienced 11/20 (55%) complications (three fatalities), while those with grades of 4 or below had 3/5 (60%) issues (one mortality). In comparison to the SAS, major complications or mortality rose monotonically. Within 30 days of surgery, 17/87 (20%) patients in the orthopaedic cohort encountered at least one significant complication, with 7 (8%) dying. 46 percent of the procedures were classified as emergency. 4/25 (16%) of individuals with a score of 9-10 suffered serious problems (one mortality). Complications occurred in 6/40 (15%) of patients with a score of 7-8. (one mortality). Complications occurred in 5/19 (26%) of individuals with a score of 5-6, and in 2/3 (66%) of those with a score of 4 or less (one mortality). In comparison to the SAS, major complications increased.

Varun Gandhi et al., 2015[76]evaluated in total, 67 instances (67%) of elective surgery were performed, with 23 (34%) patients developing complications and 44 (65.7%) not developing difficulties. About 33 patients (33%) were operated on in emergency surgery, with 19 (57.5%) developing problems, including mortality, and 14 (42.4%) not developing issues. The p value was estimated based on the mode of operation and complications, and it was around 0.50. Breast surgery was performed on 9 of the 68 patients with minor and intermediate cases, with 4 (44.4%) developing problems. Thyroid surgery was performed on 9 patients, with 2 (22.2%) developing problems. 17 patients had hernia, umbilical, and paraumbilical hernia surgery, with 5 (29.4%) developing problems. So the majority of cases operated on are basic alimentary disorders (33) 48.5% of the time, and complications are more common in these patients, with an average of 16 problems and 3 mortality. About 32 cases were operated on during the major procedure. One (12.5%) patient suffered a problem after undergoing Hemicolectomy and complete colectomy surgery. Ventral and incisional hernia repair was performed on ten individuals, with three (30%) developing problems. One patient

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

died as a result of pancreatic necrosectomy (100%).A patient had a splenectomy, which resulted in complication (100%). Out of the ten patients who underwent cholelithiasis and CBD exploration, four (40%) experienced problems. In two occurrences of abdominoperineal surgery, two patients (100%) had problems.

In study, done by**Varun Gandhi et al., 2015**[76]of the 23% of patients with a low SAS (< 4), major complications were noted in 41%, and 30-day mortality was seen in 26%.

In another study done by **Venkatesh et al., 2019**, [78]female patients experienced 63.2% more complications than male patients, who experienced 33.3%. Only 20% of postoperative problems occurred in the elective environment, while 43.9% occurred in the emergency setting. When complications were compared to operation time, surgeries that lasted more than 120 minutes had a higher complication rate of 68.6%, but procedures that lasted less than 120 minutes only had a complication rate of 26.7%.

Choudhari et al., 2022[82] undertook a prospective observational study. 45 (20.5%) of the individuals had complications. The mortality rate was 3.2% (7 out of 220).

4. Comparison of different variables over morbidity

In our current investigation, we discovered that there is significant difference in the distribution of age and Surgical APGAR score over morbidity using the Chi square test and the Mann Whitney U test and their p- value was found to be< **0.001^{MC*}** .Estimated Blood Loss with a total mean value of 243.28 ± 120.85 and its p- value of **0.001^{MW*}** showed significant difference . There is no significant difference in the distribution of TLC, Platelet count, NA, CL, Urea, Creatinine, Total Bilirubin, Serum Aspartate Transaminase, Serum Alanine Transaminase, Serum Alkaline Phosphatase, Serum Albumin, Random Blood Sugar, Prothrombin Time, INR, and Plasma Thromboplastin Time do not differ significantly by morbidity.In our current study, a significant difference in mean of Lowest Mean Arterial Pressure over morbidity was found with a total mean value of 64.38 ± 9.14 and its p-value was reported to be < **0.001^{t*}**using a two sample t test. The Hemoglobin showed significantly difference by morbidity and its p- value was found to be **0.025^{t*}**.According to the Chi square test, there is no significant relationship between mortality and morbidity. There is no significant difference in the mean of K over morbidity. From Chi square test, it is observed that, there is no significant association of mortality and morbidity.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

In study, done by**Varun Gandhi et al., 2015**[76] in contrast, only 11% of patients with a high SAS of (9-10) developed 30-day morbidities, and 4% died within 30 days. Patients with an SAS of <2 had a relative risk of complications of 13.6 and a relative risk of 30-day mortality of 239.

Hulliyappa et al., 2022[81] conducted a study cohort of 400 people aged 15 to 75 years who were receiving emergency or elective general surgery. SAS were acquired from anesthesiologist records on anticipated blood loss, lowest heart rate, and lowest mean arterial pressure. As post-operative outcomes, major complications and mortality within 30 days of surgery were tracked. Significant complications occurred in 22 (7.41%) of the 297 elective procedures. 38 (36.86%) of the 103 patients who underwent emergency surgery suffered serious complications. Patients with high-risk SAS scores (31; 51.67%) had a 5.42 (CI: 3.03-9.70) greater chance of experiencing serious issues than those with low-risk SAS values (29; 48.33%).

Choudhari et al. 2022[82]did a prospective observational analysis in which all adult patients undergoing emergency and elective general surgical operations were included. Intraoperative information was collected, and post-operative outcomes were monitored for 30 days. The lowest intraoperative heart rate, MAP, and blood loss were used to calculate SAS. The study included a total of 220 patients. All following general surgical operations were taken into account. Sixty of the 220 cases were emergency, while the rest were elective.

5. Distribution of mortality over morbidity

In our current study, 85.70% of the study population showed morbidity, while 14.30% of the study participants died over morbidity during the study.

Observational research was done by **Onen et al., 2022** ,[80]Participants in the high SAS category were 18.4 times more likely (95% CI, 1.9-177, p = 0.012) to experience significant problems, whereas those in the medium SAS category were 3.9 times more likely (95% CI, 1.01-15.26, p = 0.048) to die. SAS demonstrated a good discriminatory ability for in-hospital major complications and mortality, with AUCs of 0.75 and 0.77, respectively. SAS ≤ 6 had a sensitivity and specificity of 60.5% and 81.14% for significant complications, respectively, and 54.8% and 81.3% for mortality. A SAS of ≤ 6 indicates a higher risk of serious complications and/or fatality. SAS has a good

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

specificity and a fair discriminating capacity in predicting the likelihood of developing significant complications and/or mortality after laparotomy.

Haynes et al., 2011[51] concluded that in 544 patients (9.2%) reported 1 problem during the first 30 days of postoperative hospitalisation. Those with a Surgical Apgar Score 5 (n = 302) had an adjusted complication rate of 32.9% (relative risk [RR],3.6; 95% CI,2.9-4.5), whereas those with a score of 10 (n = 238) had a 3.0% adjusted complication rate (RR, 0.3; 95% CI, 0.1-1.1). The c-statistic of the score for predicting any complication is 0.70; for mortality, it is 0.77.**Reynolds et al., 2011**[59] study says there were 1,558 burn patients that had surgery. 2.7% of these patients died by day 7 and 5.8% died by day 30. Approximately 2% of patients had a Surgical Apgar Score of 2, while almost 10% had a score of 9. Orthopedic sports/hand (11%), urology (10%), orthopaedic trauma (8%), general surgery (8%), and neurosurgery (7%) were the most prevalent subspecialties. Mortality rates ranged from 0% (renal, day 7) to 10.3% (burn, day 90), with burn, cardiac, emergency, trauma, and vascular patients having the highest rates. In a handful of the subspecialties, these rates were generally low within the first 7 days following surgery and remained low through day 90. (ophthalmology, oral, and renal). Nonetheless, despite being underpowered, analyses of these subspecialties were carried out in order to simplify understanding of the association between the Surgical Apgar Score and mortality.

6. Surgical APGAR score in predicting morbidity

The ideal cut-off and accuracy indices of surgical APGAR score in predicting morbidity were determined in our current study. The area under the ROC curve (AU-ROC) for surgical APGAR score is 0.715 at cut-off (<) 6 with 72.3% sensitivity and 68.9% specificity in predicting morbidity. According to logistic regression, surgery APGAR score is substantially linked with morbidity (p-value =**0.002***). Morbidity increases by 0.48 for every unit increase in surgical APGAR score. As a result, the surgical APGAR score has a high discriminant power in predicting morbidity.

In another study done by **Hyder et al., 2013**,[75] the sensitivity, positive predictive value, and negative predictive value did not change significantly as the sampling interval increased from instantaneous (shortest) to 10 minutes without overlap (largest), but there were significant improvements in specificity (79.5% to 82.9% across methods,

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

P for trend <0.001) and accuracy (76.0% to 79.3% across methods, P for trend< 0.01). In multivariate modelling, the predictive value of the SAS, as assessed by the c-statistic, virtually doubled between the shortest and greatest sampling intervals, rising from c = +0.012 (P = 0.038) to Δc = +0.021 (P = <0.002). Compared to a preoperative risk model, the net reclassification improvement and integrated discrimination improvement for the SAS's shortest versus largest sampling intervals were 0.01 (P = 0.8) vs 0.06 (P = 0.02), and for integrated discrimination improvement, they were 0.008 (P < 0.01) vs 0.015 (P < 0.001).

Lin et al., 2021[79]evaluated among 13,139 patients, 68.4% had SASs of 7-10 and 9% had SASs of 0-4. 7.8% of patients were taken to the ICU immediately following surgery. Age, gender, American Society of Anesthesiologists (ASA) class, emergency surgery, and the SAS were all associated with ICU admission. The odds ratios for ICU admission in patients with SASs of 0-2, 3-4, and 5-6 were 5.2, 2.26, and 1.73, respectively (P< 0.001). Higher ASA and lower SAS classifications were associated with higher rates of postoperative ICU hospitalisation following all surgeries. Despite the fact that the SAS is calculated intraoperatively, it is a useful clinical decision-making tool for urgent postoperative ICU transfer.

The study cohort done by **Hulliyappa et al., 2022**[81]when compared to low-risk individuals (3; 25%),the risks of dying after general surgery was 11.92 times higher in high-risk patients (9; 75%). SAS had a sensitivity and specificity of 51.67% and 83.53% in predicting significant problems, respectively. SAS has a sensitivity and specificity of 75% and 79.9% in predicting mortality, respectively. SAS is a straightforward and dependable method for predicting morbidity and 30-day mortality in patients having surgical procedures requiring intense perioperative monitoring under anaesthesia other than local.

A prospective observational research was conducted by **Choudhari et al., 2022**, [82]SAS categorized the patients as high risk (0-4), moderate risk (5-8), and low risk (9-10). Complication and fatality rates were 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.In general surgery patients, the surgical Apgar score is a simple and reliable predictor of postoperative morbidity and 30-day mortality. It is applicable to

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

all types of surgeries, including emergency and elective procedures, and regardless of the patient's general condition or the type of anaesthesia and surgery planned.

7. Comparison of surgical APGAR score over morbidity

In our current study comparing surgical APGAR score to morbidity, SAS was found to predict low risk in 1 (7.14%), medium risk in 5 (35.7%), and high risk in 8 (57.1%), with a p-value of **0.001^{MC}***. According to the Chi square test, there is a significant difference in the distribution of surgical APGAR score over morbidity.

Rajgopal et al., 2019[77]concluded that the surgical result difference between patients in each scoring group was statistically significant. Major complications were observed in 41% of the 23% of patients with aSAS<4, and 30-day mortality was observed in 26% of the cases. In patients with an SAS of 9-10, on the other hand, only 11% experienced 30-day morbidities, and only 4% died after 30 days. When compared to patients in the next (higher) category, the incidence of 30-day morbidity and mortality was substantially higher in each 2-point score category ($p<0.001$). Patients with an SAS of <2 had a relative risk of 13.6 for developing complications and a relative risk of 239 for 30-day mortality. As a result, a patient with a lower surgical Apgar score is more likely to develop complications and has a higher chance of mortality than a patient with a high score.

A four-month prospective observational research was done by **Onen et al., 2022**, [80]SAS was calculated using the obtained data, and patients were divided into three groups: low (8-10), medium (5-7), and high (0–4). The primary outcomes were serious complications and mortality in the hospital. As applicable, data were reported as proportions, means (standard deviation), or medians (interquartile range). The connection between the SAS and the key outcomes was assessed using inferential statistics, and the SAS discriminatory ability was determined using receiver-operating curve (ROC) analysis.

Yakar et al., 2022[83]for these retrospective observational analysis patients who underwent emergency surgery. The SAS was calculated using data from the patients' post-op examinations, and the mSAS was calculated by adding the duration of the operation to the data used in the SAS calculation (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). The

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

mSAS demonstrated a statistically significant relationship with the overall number of problems (r=0.360; p=0.001).

SAS and mSAS compliance rates were 98.4% and statistically significant (ICC: 0.984; p=0.001; p<0.01). The OT should be incorporated in large operations as a clear, objective, and realistic depiction of the SAS risk score. The mSAS was a good predictor of postoperative mortality and complications. With the widespread use of electronic medical record systems and the successful utilisation of pre-operative medical data, the mSAS can be used as a simple and new scoring system to predict prognosis.

Pittman et al., 2022 discriminating measures, incorporated all 36 included researches. When the SAS was employed to detect postoperative morbidity, the area under the receiver operating characteristic curve, or concordance-statistic, ranged from 0.59 in a general orthopaedic surgery population to 0.872 in an orthopaedic spine surgery population. When using the SAS to determine mortality, the area under the receiver operating characteristic curve, or concordance-statistic, ranged from 0.63 in a combined surgical group to 0.92 in a general and vascular surgery population. The SAS provides a reasonable and consistent degree of discrimination for postoperative morbidity and mortality across different surgical professions.

CONCLUSION

In this study, surgical APGAR score is proven to be efficient in predicting post operative morbidity and mortality in patients undergoing elective surgeries.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

A lower surgical Apgar score is related with an increased risk of morbidity or mortality. This score allow surgeons to identify patients at higher risk of post operative complications and early management of the same.

Since only 100 patients were included in the present study, we suggest to include a larger number of patients for better assessment of surgical APGAR score to predict post operative morbidity and mortality.

SUMMARY

This hospital-based prospective study was conducted at “ESICMC KALABURGI”, to investigate "A STUDY OF EFFICACY OF SURGICAL APGAR SCORE IN PREDICTING MORBIDITY AND MORTALITY IN PATIENTS UNDERGOING MAJOR ELECTIVE SURGERIES". The study will cover all patients the following elective surgeries done under general anesthesia were included in the study:

1. Thyroidectomy 2. Modified Radical Mastectomy 3. Cholecystectomy

4.CBD exploration 5. Colorectal surgeries 6. Gastric resection 7. Incisional Hernia

8.Hellers cardiomyotomy

The study covered all patients who met the inclusion and exclusion criteria. The study was carried out after gaining approval from the institutional scientific and ethical committee. The study's duration from December 2023 to november 2024. Age, participants according to complication, and comparison of different variables over morbidity are among the components addressed.

Following are the salient observations of the study:

1. The measurements were taken from 100 participants ranging in age from 18 to 83 years old, with a mean age of 47.85±16.33 years.
2. In our study, out of 100 subjects, 8% died while 92% survived
3. In our current study, 14 (14%) of 100 subjects experienced complications, which included surgical site infection 6 (6%), pneumonia 1 (1%), anastomotic

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

leak 1 (1%), hypotension 2 (2%), myocardial infarction 1 (1%), Ischemic stroke with Aphasia 1 (1%), post-operative biliary leak 1 (1%), and primary haemorrhage with hypotension with hypovolemic shock 1 (1%).

4. Using the Chi square test and the Mann Whitney U test, we discovered that there is significant variation in the distribution of age over morbidity and Surgical APGAR scoreand their p- value was found to be < **0.001**.
5. There is no significant difference between morbidity and the distribution of TLC, Platelet count, Na^+, Cl^-, Urea, Creatinine, Total Bilirubin, Serum Aspartate Transaminase, Serum Alanine Transaminase, Serum Alkaline Phosphatase, Serum Albumin, Random Blood Sugar, Prothrombin Time, INR, and Plasma Thromboplastin Time in our current study.
6. In our current study, the two sample t test revealed a significant difference in the mean of haemoglobin, with a p-value of **0.025**.
7. In the current study, the Mann Whitney U test shows that there is a significant difference in Estimated Blood Loss over morbidity, with a p-value of **0.001**.
8. A significant difference was found in mean Lowest Mean Arterial Pressure across morbidity was identified in our current investigation, with a mean value of 64.38 ± 9.14 and a p-value of < **0.001** utilising a two sample t test.
9. There is no statistically significant difference in mean K^+ over morbidity. According to the Chi square test, there is no significant relationship between mortality and morbidity.
10. Using the following methodologies, we discovered a significant difference in the distribution of surgical APGAR score over morbidity in our current study: The study participants' APGAR SCORE ranged from 2-8 for the study participants with SAS[surgical APGAR score], 2 (7.10%), 3(14.30%), 4 (35.70%), 5 (14.30%), 6 (7.10%) ,7(14.30%) and SAS 8 (7.10%) respectively.
11. In our current study, the optimal cut-off and accuracy indices of surgical apgar score in predicting morbidity are 0.715 at cut-off < 6 with 72.3% sensitivity and 68.9% specificity in predicting morbidity. According to logistic regression, surgical APGAR score is significantly associated with morbidity (p-value = 0.002). Morbidity increases by 0.48 units for every unit increase in surgical

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

APGAR score. As a result, the surgical APGAR score has a high discriminant power in predicting morbidity.

12. In our current study comparing surgical APGAR score to morbidity, SAS was found to predict low risk in 1 (7.14%), medium risk in 5 (35.7%), and high risk in 8 (57.1%), with a p-value of 0.001. According to the Chi square test, there is a significant difference in the distribution of surgical APGAR score over morbidity.
13. In our current study, an SAS of 3, 2 (25%) showed mortality, an SAS of 4 ,1 (12.5%) showed mortality, and an SAS of 5, 5 (62.5%) showed mortality. According to the Chi square test, there is a significant difference in the distribution of surgical APGAR score over mortality.
14. In our current study, we discovered that participants in the high risk group showed mortality by 8 (8%). According to the Chi square test, there is no significant difference in the distribution of risk groups score over mortality.

REFERENCES

1. Vincent C, Moorthy K, Sarker SK, Chang A, Darzi AW. Systems approaches to surgical quality and safety: from concept to measurement. Annals of surgery. 2004 Apr;239(4):475.

2. Gawande AA, Thomas EJ, Zinner MJ, Brennan TA. The incidence and nature of surgical adverse events in Colorado and Utah in 1992. Surgery. 1999 Jul 1;126(1):66-75.

3. Jonsson MH, Bentzer P, Turkiewicz A, Hommel A. Accuracy of the Physiological and Operative Severity Score for the enUmeration of Mortality and morbidity score and the Nottingham risk score in hip fracture patients in Sweden—A prospective observational study. Acta Anaesthesiologica Scandinavica. 2018 Sep; 62(8):1057-63.

4. Aronson WL, McAuliffe MS, Miller K. Variability in the American Society of Anesthesiologists physical status classification scale. AANA journal. 2003 Aug 1;71(4):265-76.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

5. Apgar V. A proposal for a new method of evaluation of the newborn. Classic Papers in Critical Care. 1952;32(449):97.

6. Gawande AA, Kwaan MR, Regenbogen SE, Lipsitz SA, Zinner MJ. An Apgar score for surgery. Journal of the American College of Surgeons. 2007 Feb 1;204(2):201-8.

7. Nair A, Bharuka A, Rayani BK. The reliability of surgical Apgar score in predicting immediate and late postoperative morbidity and mortality: a narrative review. Rambam Maimonides Medical Journal. 2018 Jan;9(1).

8. DeathCollaborators GCo. Global, regional, and national age-sex specific mortality for 264 causes of death, 1980–2016: a systematic analysis for the Global Burden of Disease Study 2016. The Lancet. 2017;390(10100):1151–210.

9. Nepogodiev D, Martin J, Biccard B, Makupe A, Bhangu A, Ademuyiwa A, Adisa AO, Aguilera ML, Chakrabortee S, Fitzgerald JE, Ghosh D. Global burden of postoperative death. The Lancet. 2019 Feb 2;393(10170):401.

10. Haynes AB, Regenbogen SE, Weiser TG, Lipsitz SR, Berry WR, Gawande AA. Surgical outcome measurement for a global patient population: validation of the Surgical Apgar score in eight countries. Journal of the American College of Surgeons. 2009 Sep 1;209(3):S93-4.

11. Biccard BM, Madiba TE, Kluyts HL, Munlemvo DM, Madzimbamuto FD, Basenero A, Gordon CS, Youssouf C, Rakotoarison SR, Gobin V, Samateh AL. Perioperative patient outcomes in the African Surgical Outcomes Study: a 7-day prospective observational cohort study. The Lancet. 2018 Apr 21;391(10130):1589-98.

12. "Mortality of emergency abdominal surgery in high-, middle-and low-income countries." *Journal of British Surgery* 103, no. 8 (2016): 971-988.

13. Kitara DL, Kakande I, Mugisa BD, Obol JH. The postoperative complications prediction in Mulago Hospital using POSSUM scoring system. East and Central African Journal of Surgery. 2010;15(2):90-6.

14. Sehgal S, Ravishankar N, Raghupathi DS, Kotekar N. Can the surgical Apgar score predict morbidity and mortality in general surgery?. International Surgery Journal. 2019 Apr 29;6(5):1481-6.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

15. Dilaver NM, Gwilym BL, Preece R, Twine CP, Bosanquet DC. Systematic review and narrative synthesis of surgeons' perception of postoperative outcomes and risk. BJS open. 2020 Feb;4(1):16-26.

16. Hussain A, Mahmood F, Teng C, Jafferbhoy S, Luke D, Tsiamis A. Patient outcome of emergency laparotomy improved with increasing “number of surgeons on-call” in a university hospital: Audit loop. Annals of medicine and surgery. 2017 Nov 1;23:21-4.

17. Huddart S, Peden CJ, Swart M, McCormick B, Dickinson M, Mohammed MA, Quiney N, Hemmings V, Riga A, Belguamkar A, Zuleika M. Use of a pathway quality improvement care bundle to reduce mortality after emergency laparotomy. Journal of British Surgery. 2015 Jan;102(1):57-66.

18. Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: a severity of disease classification system. Critical care medicine. 1985 Oct 1;13(10):818-29.

19. Copeland GP. The POSSUM system of surgical audit. Archives of surgery. 2002 Jan 1;137(1):15-9.

20. Wolters U, Wolf T, Stützer H, Schröder T. ASA classification and perioperative variables as predictors of postoperative outcome. British journal of anaesthesia. 1996 Aug 1;77(2):217-22.

21. Gawande AA, Kwaan MR, Regenbogen SE, Lipsitz SA, Zinner MJ. An Apgar score for surgery. Journal of the American College of Surgeons. 2007 Feb 1;204(2):201-8.

22. Regenbogen SE, Ehrenfeld JM, Lipsitz SR, Greenberg CC, Hutter MM, Gawande AA. Utility of the surgical apgar score: validation in 4119 patients. Archives of Surgery. 2009 Jan 19;144(1):30-6.

23. Regenbogen SE, Lancaster RT, Lipsitz SR, Greenberg CC, Hutter MM, Gawande AA. Does the Surgical Apgar Score measure intraoperative performance?. Annals of surgery. 2008 Aug;248(2):320.

24. Ngarambe C, Smart BJ, Nagarajan N, Rickard J. Validation of the Surgical Apgar Score after laparotomy at a tertiary referral hospital in Rwanda. World Journal of Surgery. 2017 Jul;41(7):1734-42.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

25. Varun Gandhi R. *Utility of Surgical Apgar Score in predicting Morbidity and Mortality in General Surgical Procedures* (Doctoral dissertation, Stanley Medical College, Chennai).

26. Pearse RM, Holt PJ, Grocott MP. Managing perioperative risk in patients undergoing elective non-cardiac surgery. Bmj. 2011 Oct 5;343.

27. Weiser TG, Regenbogen SE, Thompson KD, Haynes AB, Lipsitz SR, Berry WR, et al. An estimation of the global volume of surgery: a modelling strategy based on available data. Lancet. 2008;372(9633):139-44.

28. Ridley S. Cardiac scoring systems–what is their value?. Anaesthesia. 2003 Oct;58(10):985-91.

29. Markus PM, Martell J, Leister I, Horstmann O, Brinker J, Becker H. Predicting postoperative morbidity by clinical assessment. Journal of British Surgery. 2005 Jan;92(1):101-6.

30. Hartley MN, Sagar PM. The surgeon's' gut feeling'as a predictor of post-operative outcome. Annals of the Royal College of Surgeons of England. 1994 Nov 1;76(6 Suppl):277-8.

31. Arvidsson S, Ouchterlony J, SjÖoUstedt L, SvÄaUrdsudd K. Predicting postoperative adverse events. Clinical efficiency of four general classification systems The Project Perioperative Risk. Acta Anaesthesiologica Scandinavica. 1996 Aug;40(7):783-91.

32. Gawande AA, Kwaan MR, Regenbogen SE, Lipsitz SA, Zinner MJ. An Apgar score for surgery. Journal of the American College of Surgeons. 2007 Feb 1;204(2):201-8.

33. Regenbogen SE, Ehrenfeld JM, Lipsitz SR, Greenberg CC, Hutter MM, Gawande AA. Utility of the surgical apgar score: validation in 4119 patients. Archives of Surgery. 2009 Jan 19;144(1):30-6.

34. Jones HJ, Cossart LD. Risk scoring in surgical patients. British Journal of Surgery. 1999 Feb;86(2):149-57.

35. Copeland GP, Jones D, Walters MP. POSSUM: a scoring system for surgical audit. British Journal of Surgery. 1991 Mar;78(3):355-60.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

36. Wolters U, Wolf T, Stützer H, Schröder T. ASA classification and perioperative variables as predictors of postoperative outcome. British journal of anaesthesia. 1996 Aug 1;77(2):217-22.

37. Hartmann B, Junger A, Röhrig R, Klasen J, Jost A, Benson M, Braun H, Fuchs C, Hempelmann G. Intra-operative tachycardia and peri-operative outcome. Langenbeck's archives of surgery. 2003 Sep;388(4):255-60.

38. Reich DL, Bodian CA, Krol M, Kuroda M, Osinski T, Thys DM. Intraoperative hemodynamic predictors of mortality, stroke, and myocardial infarction after coronary artery bypass surgery. Anesthesia & Analgesia. 1999 Oct 1;89(4):814.

39. Röhrig R, Junger A, Hartmann B, Klasen J, Quinzio L, Jost A, Benson M, Hempelmann G. The incidence and prediction of automatically detected intraoperative cardiovascular events in noncardiac surgery. Anesthesia & Analgesia. 2004 Mar 1;98(3):569-77.

40. Charlson ME, MacKenzie CR, Gold JP, Ales KL, Topkins MA, Fairclough Jr GP, Shires GT. The preoperative and intraoperative hemodynamic predictors of postoperative myocardial infarction or ischemia in patients undergoing noncardiac surgery. Annals of surgery. 1989 Nov;210(5):637.

41. Monk TG, Saini V, Weldon BC, Sigl JC. Anesthetic management and one-year mortality after noncardiac surgery. Anesthesia & Analgesia. 2005 Jan 1;100(1):4-10.

42. Chang HS, Hongo K, Nakagawa H. Adverse effects of limited hypotensive anesthesia on the outcome of patients with subarachnoid hemorrhage. Journal of neurosurgery. 2000 Jun 1;92(6):971-5.

43. Regenbogen SE, Lancaster RT, Lipsitz SR, Greenberg CC, Hutter MM, Gawande AA. Does the Surgical Apgar Score measure intraoperative performance?. Annals of surgery. 2008 Aug;248(2):320.

44. Prasad SM, Ferreria M, Berry AM, Lipsitz SR, Richie JP, Gawande AA, Hu JC. Surgical apgar outcome score: perioperative risk assessment for radical cystectomy. The Journal of urology. 2009 Mar;181(3):1046-53.

45. Regenbogen SE, Bordeianou L, Hutter MM, Gawande AA. The intraoperative Surgical Apgar Score predicts postdischarge complications after colon and rectal resection. Surgery. 2010 Sep 1;148(3):559-66.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

46. Zighelboim I, Kizer N, Taylor NP, Case AS, Gao F, Thaker PH, Rader JS, Massad LS, Mutch DG, Powell MA. “Surgical Apgar Score” predicts postoperative complications after cytoreduction for advanced ovarian cancer. Gynecologic oncology. 2010 Mar 1;116(3):370-3.

47. Ohlsson H, Winsö O. Assessment of the Surgical Apgar Score in a Swedish setting. Acta Anaesthesiologica Scandinavica. 2011 May;55(5):524-9.

48. Sobol JB, Gershengorn HB, Wunsch H, Li G. The Surgical Apgar Score Is Strongly Associated With Intensive Care Unit Admission After High-Risk Intra-Abdominal Surgery. Survey of Anesthesiology. 2014 Jun 1;58(3):109-10.

49. Glass NE, Pinna A, Masi A, Rosman AS, Neihaus D, Okochi S, Saunders JK, Hatzaras I, Cohen S, Berman R, Newman E. The surgical apgar score predicts postoperative ICU admission. Journal of Gastrointestinal Surgery. 2015 Mar;19(3):445-50.

50. Assifi MM, Lindenmeyer J, Leiby BE, Grunwald Z, Rosato EL, Kennedy EP, Yeo CJ, Berger AC. Surgical Apgar score predicts perioperative morbidity in patients undergoing pancreaticoduodenectomy at a high-volume center. Journal of Gastrointestinal Surgery. 2012 Feb;16(2):275-81.

51. Haynes AB, Regenbogen SE, Weiser TG, Lipsitz SR, Dziekan G, Berry WR, Gawande AA. Surgical outcome measurement for a global patient population: validation of the Surgical Apgar Score in 8 countries. Surgery. 2011 Apr 1;149(4):519-24.

52. Wuerz TH, Regenbogen SE, Ehrenfeld JM, Malchau H, Rubash HE, Gawande AA, Kent DM. The Surgical Apgar Score in hip and knee arthroplasty. Clinical Orthopaedics and Related Research®. 2011 Apr;469(4):1119-26.

53. Urrutia J, Valdes M, Zamora T, Canessa V, Briceno J. An assessment of the Surgical Apgar Score in spine surgery. The spine journal. 2015 Jan 1;15(1):105-9.

54. La Torre M, Ramacciato G, Nigri G, Balducci G, Cavallini M, Rossi M, Ziparo V. Post-operative morbidity and mortality in pancreatic surgery. The role of surgical Apgar score. Pancreatology. 2013 Mar 1;13(2):175-9.

55. Ito T, Abbosh PH, Mehrazin R, Tomaszewski JJ, Li T, Ginzburg S, Canter DJ, Greenberg RE, Viterbo R, Chen DY, Kutikov A. Surgical Apgar Score predicts an

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

increased risk of major complications and death after renal mass excision. The Journal of urology. 2015 Jun;193(6):1918-22.

56. Ziewacz JE, Davis MC, Lau D, El-Sayed AM, Regenbogen SE, Sullivan SE, Mashour GA. Validation of the surgical Apgar score in a neurosurgical patient population. Journal of neurosurgery. 2013 Feb 1;118(2):270-9.

57. Melis M, Pinna A, Okochi S, Masi A, Rosman AS, Neihaus D, Saunders JK, Newman E, Gouge TH. Validation of the Surgical Apgar Score in a veteran population undergoing general surgery. Journal of the American College of Surgeons. 2014 Feb 1;218(2):218-25.

58. Miki Y, Tokunaga M, Tanizawa Y, Bando E, Kawamura T, Terashima M. Perioperative risk assessment for gastrectomy by surgical Apgar score. Annals of surgical oncology. 2014 Aug;21(8):2601-7.

59. Reynolds PQ, Sanders NW, Schildcrout JS, Mercaldo ND, St. Jacques PJ. Expansion of the surgical Apgar score across all surgical subspecialties as a means to predict postoperative mortality. The Journal of the American Society of Anesthesiologists. 2011 Jun 1;114(6):1305-12.

60. Charlson ME, MacKenzie CR, Gold JP, Ales KL, Topkins M, Shires GT. Preoperative characteristics predicting intraoperative hypotension and hypertension among hypertensives and diabetics undergoing noncardiac surgery. Annals of surgery. 1990 Jul;212(1):66.

61. Mangano DT. Perioperative cardiac morbidity. Canadian journal of anaesthesia. 1994 May;41(1):R13-9.

62. Delilkan AE. Comparison of subjective estimates by surgeons and anaesthetists of operative blood loss. Br Med J. 1972 Jun 10;2(5814):619-21.

63. Gardiner AJ, Dudley HA. The measurement of blood loss at operation. BJA: British Journal of Anaesthesia. 1962 Sep 1;34(9):653-6.

64. Lau D, Yee TJ, La Marca F, Patel R, Park P. Utility of the Surgical Apgar Score for patients who undergo surgery for spinal metastasis. Clinical Spine Surgery. 2017 Oct 1;30(8):374-81.

65. Thorn CC, Chan M, Sinha N, Harrison RA. Utility of the Surgical Apgar Score in a district general hospital. World journal of surgery. 2012 May;36(5):1066-73.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

66. Urrutia J, Valdes M, Zamora T, Canessa V, Briceno J. Can the Surgical Apgar Score predict morbidity and mortality in general orthopaedic surgery?. International orthopaedics. 2012 Dec;36(12):2571-6.

67. Costa VV, Caldas AC, Nunes LG, Beraldo PS, Saraiva RÂ. Influence of angiotensin-converting enzyme inhibitors on hypotension after anesthetic induction: is the preoperative discontinuation of this drug necessary?. Revista brasileira de anestesiologia. 2009;59:704-15.

68. Ebert TJ, Muzi M, Berens R, Goff D, Kampine JP. Sympathetic responses to induction of anesthesia in humans with propofol or etomidate. Anesthesiology. 1992 May 1;76(5):725-33.

69. Hartmann B, Junger A, Röhrig R, Klasen J, Jost A, Benson M, Braun H, Fuchs C, Hempelmann G. Intra-operative tachycardia and peri-operative outcome. Langenbeck's archives of surgery. 2003 Sep;388(4):255-60.

70. Charlson ME, MacKenzie CR, Gold JP, Ales KL, Topkins M, Shires GT. Intraoperative blood pressure. What patterns identify patients at risk for postoperative complications?. Annals of surgery. 1990 Nov;212(5):567.

71. Mauney Jr FM, Ebert PA, Sabiston Jr DC. Postoperative myocardial infarction: a study of predisposing factors, diagnosis and mortality in a high risk group of surgical patients. Annals of surgery. 1970 Sep;172(3):497.

72. Reich DL, Bennett-Guerrero E, Bodian CA, Hossain S, Winfree W, Krol M. Intraoperative tachycardia and hypertension are independently associated with adverse outcome in noncardiac surgery of long duration. Anesthesia & Analgesia. 2002 Aug 1;95(2):273-7.

73. Lawrence JP. Advances and new insights in monitoring. Thoracic surgery clinics. 2005 Feb 1;15(1):55-70.

74. Thorn CC, Chan M, Sinha N, Harrison RA. Utility of the Surgical Apgar Score in a district general hospital. World journal of surgery. 2012 May;36(5):1066-73.

75. Hyder JA, Kor DJ, Cima RR, Subramanian A. How to improve the performance of intraoperative risk models: an example with vital signs using the surgical Apgar score. Anesthesia and analgesia. 2013 Dec;117(6):1338.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

76. Varun Gandhi R. *Utility of Surgical Apgar Score in predicting Morbidity and Mortality in General Surgical Procedures* (Doctoral dissertation, Stanley Medical College, Chennai).2015

77. Rajgopal V, Kulkarni SV. Efficacy of the surgical Apgar score in predicting post-operative morbidity and mortality in patients undergoing laparotomy. International Surgery Journal. 2019 Jul 25;6(8):2791-6.

78. Venkatesh G, Vijayaraghavan P. Utility of surgical APGAR score in predicting post-operative morbidity and mortality in patients undergoing laparotomy â€“A prospective study.2019

79. Lin YC, Chen YC, Yang CH, Su NY. Surgical Apgar score is strongly associated with postoperative ICU admission. Scientific Reports. 2021 Jan 8;11(1):1-7.

80. Onen BC, Semulimi AW, Bongomin F, Olum R, Kurigamba G, Mbiine R, Kituuka O. Surgical Apgar score as a predictor of outcomes in patients following laparotomy at Mulago National Referral Hospital, Uganda: a prospective cohort study. BMC surgery. 2022 Dec;22(1):1-2.

81. Huliyappa H, Ramachar SM. Utility of the surgical Apgar score in predicting morbidity and mortality: A prospective study. Polish Annals of Medicine.;29(2):89-93.2022

82. Choudhari R, Bhat R, Prasad K, Vyas B, Rao H, Bhat S. The utility of surgical Apgar score in predicting postoperative morbidity and mortality in general surgery. Turkish Journal of Surgery. 2022;38(3):266-74.

83. Yakar MN, Polat C, Akkılıç M, Yeşildal K, Yakar ND, Turgut N. Use of a modified surgical APGAR score for prediction of postoperative complications in emergency surgery: An observational retrospective study. Turkish Journal of Trauma and Emergency Surgery. 2022 May 1;28(5):615.

84. Pittman E, Dixon E, Duttchen K. The Surgical Apgar Score: A Systematic Review of Its Discriminatory Performance. Annals of Surgery Open. 2022 Dec 1;3(4):e227.

85. Haynes AB, Regenbogen SE, Weiser TG, Lipsitz SR, Dziekan G, Berry WR, Gawande AA. Surgical outcome measurement for a global patient population:

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 1, 2025

validation of the Surgical Apgar Score in 8 countries. Surgery. 2011 Apr 1;149(4):519-24.

86. Reynolds PQ, Sanders NW, Schildcrout JS, Mercaldo ND, St. Jacques PJ. Expansion of the surgical Apgar score across all surgical subspecialties as a means to predict postoperative mortality. The Journal of the American Society of Anesthesiologists. 2011 Jun 1;114(6):1305-12.