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Original Research Article

A 10 Point Surgical APGAR Score to Predict Post Operative Morbidity and Mortality in Patients undergoing General Surgical Procedures in a Tertiary Care Hospital of Southern Odisha

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ABSTRACT

Background
This intraoperative score can serve as a simple aid in communication among surgeons during intraoperative decision making, post anaesthesia care providers, surgical residents and ICU or surgical ward staff regarding patient's immediate postoperative status. It varies from 0 to 10 points divided into three risk categories (0 to 4 high, 5 to 7 moderate, 8 to 10 low). It also helps in conveying the condition of a patient and prognosis after surgery to the attenders. It can be integrated into surgical quality improvement programs to enhance patient safety and outcomes.

Methods
It is a prospective observational study taking 210 patients were randomly selected to exclude any bias satisfying inclusion and exclusion criteria for the study, were admitted to the Dept. of General Surgery, MKCG Medical College and Hospital, Berhampur, Ganjam, Odisha, During the period from July 2022 to June 2024. All the patients underwent elective or emergency general surgical procedures were assessed under Surgical Apgar Score's (SAS) for postoperative morbidity and mortality. The results were recorded on various intraoperative parameters like estimated blood loss, lowest mean arterial pressure, and lowest heart rate, the Surgical Apgar Score was calculated

Results
Of the 210 patients, there was a 7 % 30 day mortality rate, with the rate of complications being

9 %. No complication was noted in 84 % of the patients studied. Mean surgical Apgar score was 6.75. The difference in surgical outcome between patients in different score groups was also statistically significant. Among the 32 (15.2%) patients with an Apgar score of <4, major complications occurred in 25 % and a 30 day mortality of 34.4 % was seen. In contrast, among 36 patients with a score of 9 – 10, only 2.7 % suffered a major complication, while no deaths were noted in this group. The incidence of complications in elective surgeries was 9.3 % and the mortality was noted to be 1.4 %, while in emergency surgeries, the complication rate was 8.4 % with the mortality being 16.9 %.

Conclusion

The surgical Apgar score has proved to be an clinical decision making tool in predicting post-operative morbidity and mortality. Higher percentage of patients over 40 years of age have low surgical Apgar scores after general surgical procedures and hence are at risk for major complications, including a high mortality. Patients with low surgical Apgar score would require more intensive monitoring in the postoperative period even if they are undergoing a minor procedure. Mortality rates are twelve times higher in emergency surgeries in comparison to elective cases. In case of laparotomy, the rate is two times higher for emergency laparotomy. The 10 point Apgar scoring system is an easy and fairly accurate method of identifying the patients at risk of complications and mortality in the postoperative period.

Keywords: APGAR Score, Morbidity and Mortality, Laparotomy

INTRODUCTION

Healthcare providers, including hospital teams and surgeons, endeavour to consistently lower the incidence of complications for a patient undergoing any surgical procedure. A vital aspect of managing risk in the practice of surgery is the prediction of complications following surgery.

Recognizing patients at high risk or having a high probability of developing peri-operative complications will significantly contribute to the improvement of the quality of a particular operation and reducing the healthcare cost. Differences in post-operative outcomes are usually due to variability in patient's perioperative risk factors.[1]

Any model, to be an ideal predictor of complications in a patient undergoing surgery should be, in addition to being simple, should readily be applicable to any patient being operated. The development of a model for predicting complications in surgical patients requires a precise estimation of the occurrence of the complications. Hence, an appropriate definition of various complications of surgery, which can be easily detected, is necessary.

However, the response of the body to surgical stress is variable intra-operatively, in terms of vital parameters such as the patient's heart rate, arterial blood pressure, percentage saturation and tissue or organ perfusion. This further contributes to the variability in patients' risk of 1 developing complications.

The evolution of better monitoring techniques and well equipped laboratories have led to the development of newer general and specialized surgical scoring systems, such as:-

General: APACHE II, MODS (Multiple Organ Dysfunction Score), SAPS II, TRIOS (Three days Recalibrated ICU Outcome Score), etc.

Specialized/Surgical: POSSUM (Physiologic and Operative Severity Score for the Enumeration of Mortality and Morbidity), Glasgow Coma Score for neurosurgical patients, MPM for cancer patients, NSQIP (National Surgical Quality Improvement Program), etc.

However Risk stratification is essential in the selection of patients at high risk of postoperative complications for aggressive treatment or the instigation of specific interventions in the immediate postoperative period to mitigate the development of complications and prevent death.

The methods of surgical quality assessment available at present, such as the National Surgical Quality Improvement Program (NSQIP),[2-4] developed by the American College of Surgeons, indirectly evaluate the surgical performance, i.e., by assessing the various risk factors in the pre-operative period and by comparing the discrepancies between the observed complication rates and the expected rates to a particular treatment being provided.

For example, the pre-operative factors which predict postoperative morbidity, in small bowel obstruction surgeries, include a history of congestive cardiac failure, any chronic obstructive pulmonary disease, cerebrovascular accident with neurological deficit, total leucocyte count < 4500/cu.mm,[3] creatinine value > 1.2 mg/dl in the pre-operative period, and advancing age. The factors which predict morbidity intraoperatively comprise a higher wound class and the ASA class. Operative factors such as simple small bowel resection in comparison to adhesiolysis alone has higher incidence of complications and morbidity.[5]

The pre-operative risk factors which have a definite impact on the mortality are a positive history of metastatic malignancy, pre-operative haematocrit value< 38%, pre-operative creatinine value>1.2mg/dl, preoperative sodium value > 145mg% and age.

Factors which predict mortality intraoperatively are higher wound class and advanced ASA class. But, various studies have found that elevated leucocyte count occurs more often in patients requiring adhesiolysis when compared to patients going for small bowel resection, indicating the unreliable nature of leucocytosis in differentiating infection and inflammation.[5]

In the operation theatre, most surgeons' rely on "gut feeling" instead of objective assessment, regarding the course of the operation and the post-operative prognosis.[6] These models rate the patient in broad categories and provide a clinical guide regarding patient's postoperative care.

The operative management of a patient contributes to the overall outcome of a surgery, but measures to quantify the operative care are not readily available.[1] The factors causing alteration in patient's condition intra-operatively, which include hypertension, hypotension,[7] hypothermia, tachycardia, bradycardia,[8.9] and blood loss,[10] have been identified as independent links for unfavourable perioperative outcomes. Several models available for risk prediction have incorporated these variables for early prediction of postoperative mortality and morbidity. Nevertheless, a clear consensus on the ideal or the most applicable postoperative risk assessment model has not been reached.[11] Hence, the question of evaluating performance and operating room safety remains unanswered in surgeon's mind.[12]

In order to make a simple, impersonal and direct method of risk grading available to surgeons, a Surgical Apgar Score was determined by Atul Gawande et al.[13] Several parameters recorded in the operation theatre were assessed, and three variables were found to be independent predictors of most complications in the postoperative period and death. These variables were – patient's lowest heart rate during surgery, estimated loss of blood during the procedure and the lowest mean arterial pressure. These three predictors have helped build a score which has proved beyond doubt as a very strong predictive model for categorizing patients who are at increased risk of developing complications in the postoperative period and death following general surgical procedures and vascular surgical procedures.[13]

This scoring system requires data which can be collected immediately upon completion of a procedure, regardless of the technological capacity and the resources available, and in any setup, making it the simplest available scoring system for assessing the risk.

Similar to the obstetrical Apgar score,[14] this score cannot assess the quality and

standard of care by itself, as the three variables being taken into consideration are influenced by the surgical teams' performance, and also the pre-operative physiological status of the patient and the nature and complexity of the procedure they undergo.[15] In order to be a useful predictor clinically of post-surgical morbidity and mortality, each component of the score or the score as a whole should contribute to predict the surgical outcome.

This score's simplicity, availability in real time, immediate applicability in decision making and inexpensive nature make it a powerful tool for early recognition of complications. Such an early predictability helps improve safety in surgery. As the feedback is almost immediate, this helps the surgical team in categorizing patients who need more intense postoperative monitoring and care and those who are expected to pass through an uncomplicated course.

This scoring system can act as a mode of communication between the nursing staff, residents and surgeons regarding the immediate postoperative status of a patient and thereby assist in decision making, such as need for admission after an OP procedure/day-care procedure, admission to ICU or the need for frequent visits to the surgeon postoperatively. Even in a patient with low surgical Apgar score but an uncomplicated outcome, it would enable early identification of problems, as these patients are subjected to repeated reviews and routine clinical surveillance.

The ability of the surgical Apgar score to predict the risk of post-surgical complications in patients undergoing general surgical procedures will be evaluated in this study.

AIM AND OBJECTIVE

Aim

To predict the risk of postoperative complications in patients undergoing general surgical procedures

Objectives

- To identify patients at risk of developing postoperative complications based on intraoperative data.
- To estimate the incidence of postoperative complications in patients undergoing elective and emergency general surgical procedures.
- To describe the morbidity and mortality which are associated with various surgical procedures.

MATERIALS & MATERIALS

Among all the patients who underwent elective or emergency general surgical procedures in MKCG medical college and hospital, 210 patients were randomly selected to exclude any bias satisfying inclusion and exclusion criteria for the study.

Inclusion Criteria

- Age 18 years or older.
- Undergoing general surgical procedures under general, epidural, or spinal anaesthesia.
- Patient willing to take part in the study.

Exclusion Criteria

- Surgeries under local anaesthesia, not requiring intensive monitoring and regular follow-up.
- Patients unwilling to take part in the study.

METHODS

Study Parameters -Estimated Blood Loss (EBL): The amount of blood lost during surgery was estimated using a combination of suction canisters, surgical sponges, and the surgeon's visual assessment. **Lowest Mean Arterial Pressure (MAP)**: The lowest recorded mean arterial pressure during surgery was documented. Significant drops in MAP can indicate potential complications such as shock or organ perfusion deficits. **Lowest Heart Rate (HR)**: The lowest heart rate observed during the surgical procedure was recorded. Bradycardia or significant fluctuations in heart rate can signal underlying issues with cardiac function or anaesthesia management. Patient demographics and clinical characteristics were summarized using means, medians, frequencies, and percentages. The SAS was categorized into five groups (0-2, 3-4, 5-6, 7-8, 9-10) and correlated with postoperative morbidity and mortality .Logistic regression analysis was performed to evaluate the predictive value of the SAS for postoperative complications and mortality. Sensitivity, specificity, positive predictive value, and negative predictive value of the SAS were calculated to determine its accuracy in predicting postoperative outcomes. The study adhered to ethical guidelines and was approved by the Institutional Ethics Committee of MKCG Medical College and Hospital.

OBSERVATION AND RESULTS

Age Group Wise Distribution of Patients

Age Group(Years)	No. of Patients	percentage
<40	79	37.6
40-50	54	25.8
50-60	42	20
>60	35	16.6
Total	210	

Table 1: Age group wise distribution of patients

More than 62.4% of the patients accounting to 131 cases were in the age group of >40 year

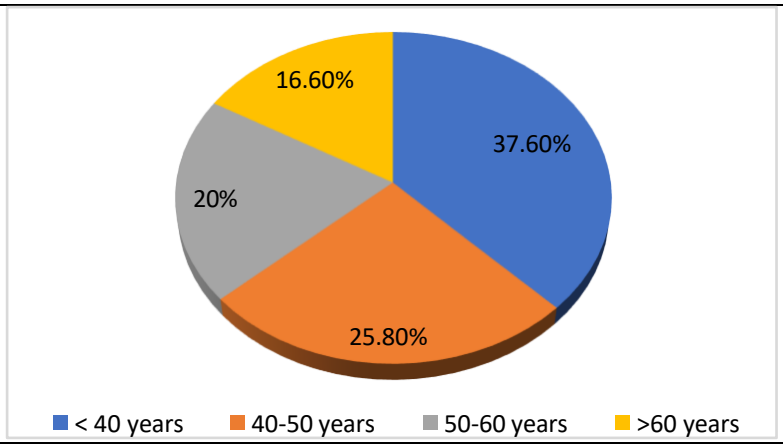

Chart 1: Age group wise distribution of patients

Total Number of Elective and Emergency Surgeries

Type of Surgery	No. of Patients	Percentage
Elective	139	66.2
Emergency	71	33.8
Total	210	

Table 2: Distribution of surgeries into elective and emergency surgeries

66.2% of surgeries were elective in nature, 33.8 % of the surgeries were emergencies amounting to 1/3rd of the total cases.

Apgar score and Number of Patients

Score	No. of Patients	Percentage
0-2	10	4.8%
3-4	22	10.4%
5-6	51	24.3%
7-8	91	43.3%
9-10	36	17.2%
Total	210	

Table 3: APGAR score and number of patients

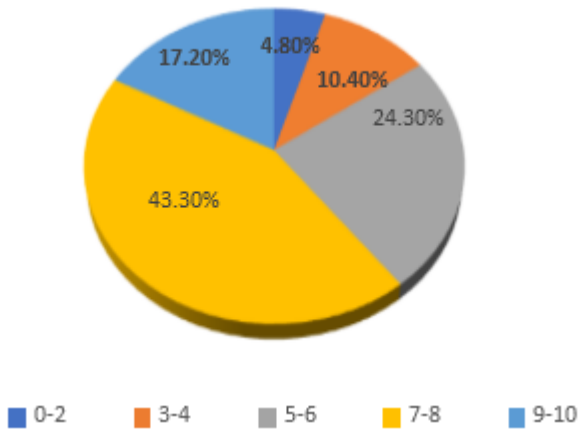

Chart 2: Apgar score

32 patients had an Apgar score of 4 and less than 4, constituting 15.2 %. The score of 7 to 8 was noted among the maximum number of patients constituting 43.3 %..

Number of Laparotomy

Type of Surgery	No. of Patients	Percentage
Laparotomy	60	28.6
Others	150	71.4
Total	210	

Table 4: Distribution of Surgeries into Laparotomy and Others

Laparotomy: Elective and Emergency

Type of Surgery	No. of Patients	Percentage
Elective	10	16.6
Emergency	50	83.4
Total	60	

Table 5: Distribution of Laparotomy into Elective and Emergency Surgeries

Percentage Distribution of Surgical Apgar score vs Age Year Group

Score	Age Group			
	<40 Years	40-50 Years	50-60 Years	>60 Years
0-2	1	4	2	3
3-4	4	5	3	10
5-6	19	11	12	9
7-8	30	26	24	11
9-10	25	8	1	2
Total	79	54	42	35

Table 6: Surgical Apgar score vs Age Year Group

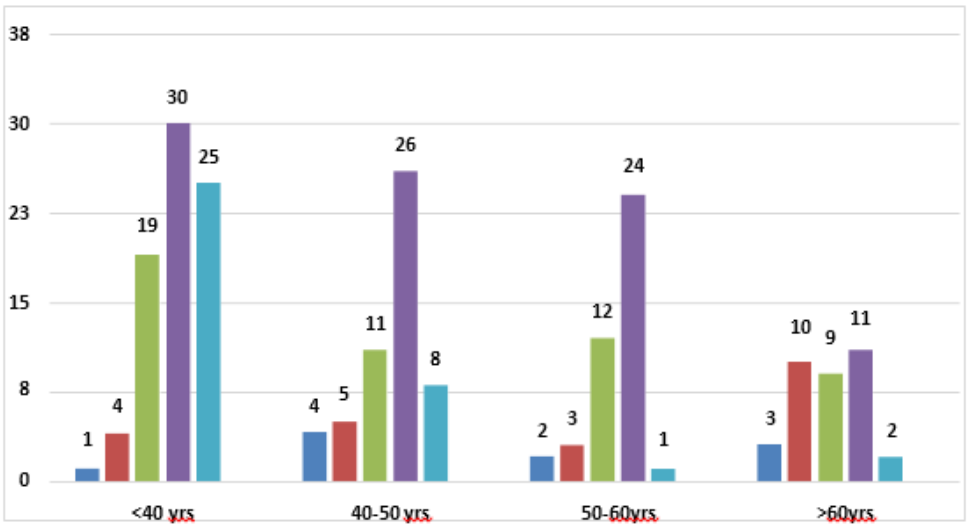

Chart 3: Surgical Apgar Score vs Age Year Group

37.1 % of patients (13 patients of 35) in the age group of > 60 years had low Apgar score of < 4. Only 6.3 % (5 patients of 79) in the younger age group of < 40 years had low Apgarscore of < 4. 60.5 % (127 patients of 210) had a high Apgar score of > 7.

Classification of Surgeries with Complication Rates and Mortality

Type of Surgery(Minor & Intermediate)	Number of cases	Major Complications	Mortality
Minor &Intermediate Surgeries	**168(80%)**	**11 (6.5%)**	**8 (4.8%)**
Simple Alimentary Tract Surgery	62	4 (6.4%)	7 (11.8%)
Breast Surgery	11	1 (9%)	0
Thyroid ,Parathyroid,Parotid Surgery	24	2 (8.3%)	0
Inguinal and Umbilical Hernia Surgery	66	2 (3.2%)	0
Skin and Soft Tissue	5	2 (40%)	1 (20%)

Major and Extensive Surgeries	**42 (20%)**	**8 (19%)**	**6 (15.3%)**
Alimentary and Retroperitoneal Surgeries	8	2 (25%)	4 (50%)
Ventral/ Incisional Hernia	24	4(16.6%)	0
Hepatobiliary Surgery	9	2(22.2%)	1(11.1%)
Pancreatic Surgery	1	0	0
Total	**210**	**19 (9%)**	**14 (6.7%)**

Table 7: Types of surgery and the complications and mortality

80 % cases were minor and intermediate and 20 % cases were major and extensive surgeries. Major complications noted at 30 days of postoperative period constituted 19 cases i.e. 9 % and 30 day mortality was 6.7 %.Major and extensive surgeries had a complication rate of 19 % and 30day mortality of 15.3%. Minor procedures had a complication rate of 6.5 % and mortality rate of 4.8 %.

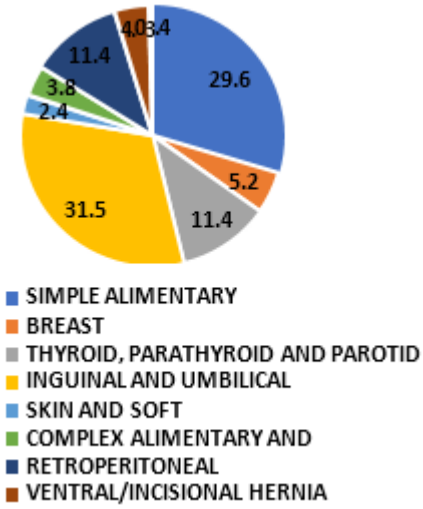

Chart 4: Number of surgeries

Surgical Apgar Score with Major Complications And Mortality

	Surgical apgar Score Category				
	0-2	**3-4**	**5-6**	**7-8**	**9-10**
No. Of Patients	10	22	51	91	36
Major Complications	3(30%)	5(22.7%)	7(13.7%)	3(3.29%)	1(2.7%)
Relative Risk for Major Complications	13.71	3.36	4.39	1.05	1(reference category)
Mortality	4(40%)	7(31.8%)	3(5.8%)	0	0

Table 8: Surgical Apgar Score with Major Complications And Mortality

60.4 % of cases belonged to high Apgar score of 7 – 10 (i.e., less complication rates) and 15.2 % of cases had a low Apgar score of < 4. There was a progressive increase in the number of complications from 2.7%% in score category 9 – 10 to 30 % in category 0 – 2. With the 9 – 10 category taken as a reference for assessing the relative risk, there was a 13.71 (0 -2), 3.36 (3 – 4), 4.39 (5 – 6) and 1.05 (7 – 8) times the risk of developing complications when compared to the reference category. In this study, there was no 30 day mortality for patients with an Apgar score >7. But, the mortality rate was found to be 40 % with score of 0 – 2, 31.8 % with score between 3 and 4, and 5.8 % with a score of 5 – 6. This

indicates that patients with a low Apgar score of 4 or less had a very high mortality rate.

Major Complications and Mortality in Elective and Emergency Surgeries Vs
Elective Surgery No. of Cases -139

Surgical Apgar Score	No. of Cases	Major Comlications (Percentage)	Mortality(Percentage)
0-2	5	2(40%)	0
3-4	9	2(22.2%)	2(33.3%)
5-6	30	5(16.6%)	0
7-8	68	3(4.3%)	0
9-10	27	1(3.7%)	0
Total	**139**	**13(9.3%)**	**2(16.9%)**

Table 9: Outcomes for elective surgery, in relation to the surgical Apgar Score

Complications were noted in both the patients in the 0 – 2 group, 22.2% and 16.6% each in the 3 -4 and 5 - 6 score groups. 30 day mortality of 33.3 % was noted in the 3 – 4 group.

Emergency Surgery – No. of Cases 71

Surgical Apgar Score	No. of Cases	Major Complications (Percentage)	Mortality(Percentage)
0-2	5	1(20%)	3(60%)
3-4	13	3(23%)	6(46.1%)
5-6	21	2(9.5%)	3(14.2%)
7-8	23	0	0
9-10	9	0	0
Total	**71**	**6(8.4%)**	**12(16.9%)**

Table 10 - Outcomes for emergency surgery, in relation to the surgical Apgar score

Major complications were noted in 20 % of 0 – 2 group with 60% 30 day mortality, 23 % of 3 – 4 group with 46.1 % mortality, 9.5 % of 5 – 6 group with 14.2 % mortality. No significant mortality and morbidity were noted in patients with Apgar score > 7.

Major Complications and Mortality in Elective and Emergency Laparotomy VS Surgical Apgar Score
Elective Surgery- No. of Cases 10

Surgica L Apgar Score	No. of Cases	No Complications	Major Complications (Percentage)	Mortality (Percentage)
0-2	2	0	2	0
3-4	2	0	1	1
5-6	4	4	0	0
7-8	2	2	0	0
9-10	0	0	0	0
Total	10	6	3	1

Table 11: Outcomes for Elective Laparotomy in Relation to the Surgical Apgar Score

Major complications were noted in both the patients in the 0 – 2 group. 50 % 30 day mortality was noted in the 3 – 4 group.

Emergency Laparotomy – No. of Cases 50

Surgical Apgar Score	No. of Cases	No Complications	Major Complications (P Ercentage)	Mortality(Percentage)
0-2	5	0	2	3
3-4	13	5	2	6
5-6	19	14	2	3
7-8	11	11	0	0
9-10	2	2	0	0
Total	50	32	6	12

Table 12: Outcomes for Emergency Laparotomy, in Relation to the Surgical Apgar Score

40 % of the patients in the 0 – 2 group were noted to have major complications with a mortality rate of 60 %. 15.3 % in the 3 – 4 group developed major complications with a mortality rate of 46.1 %, whereas the morbidity and mortality rates were 10.5 % and 15.7 % respectively in the 5 – 6 group.

Test of Significance: Complications

Score Category	No. of Cases	Major Complications	Chi Square Value	P value	Significant if p < 0.05
Less Than 4	32	8	4.011	0.04	Yes
9-10	36	1	Reference value		

Table 13: Chi Square test for complications

A score of less than 4 shows statistically significant association with the incidence of postoperative complications, when compared to the score of 9 – 10.

Test of Significance: 30 Day Mortality

Score Category	No. of Cases	Mortality	Chi square value	P value	Significant if<0.05
Less than 4	32	11	16.7	0.04	Yes
9-10	36	0	Reference value		

Table 14: Chi Square test for 30 day mortality

There were no deaths noted among patients with a score of 9– 10. The mortality rate was 34.3 % among those with a score of less than 4, which is statistically significant.

DISCUSSION

Randomly selected 210 cases who underwent elective and emergency general surgical procedures in MKCG medical college and hospital, Berhampur were evaluated as described earlier in the methods and methodology. All the patients were appropriately assessed and managed according to standard guidelines for the respective disease.

More than 62.4 % of the patients were in the age group of over 40 years. About 37.6 % patients belonged to the below 40 years age group. Earlier studies have shown an average age distribution of 55.3 years to 63.6 years.[16]

About 37.1 % of patients (13 patients of 35) in the age group > 60 years had a low Apgar score of < 4. Whereas, in the younger age group of< 40 years, only 6.3 % (5 patients of 79) had a low score of < 4. 60. 4 % of the patients had a high Apgar score of > 7. 66.7 % of the surgeries in this study were elective in nature and 33.3 % were emergency procedures amounting to one third of the total cases. A study by Capewell et al on emergency admissions in surgery

showed that between 46 % to 57 % of all surgical admissions are emergency in nature.[17]

Majority of the surgeries were minor or intermediate (80 %), with major and extensive surgeries amounting to 20 %. Even after stratifying the patients by the magnitude of the operation, the score remained a highly significant predictor of outcome.

The incidence of complications in elective surgeries was 9.3 % and the mortality was noted to be 1.4 %, while in emergency surgeries, the complication rate was 8.4 % with the mortality being 16.9 %.

About 6.5 % of minor surgeries had major complications with a 30 day mortality rate of 4.8%. Among major and extensive surgeries, the major complication rate was noted to be 19% and the 30 day mortality rate was 15.3%.

A study by Scott et al showed an incidence of major complications in minor and major surgeries to be 4.8 % and 21.3 % respectively.[18] A mortality rate of 0.4 % vs 3.7 % between minor and major surgeries was seen in a cohort of general surgery.

Of the 210 patients, there was a 7 % 30 day mortality rate, with the rate of complications being 9 %. No complication was noted in 84 % of the patients studied. Mean surgical Apgar score was 6.75. The difference in surgical outcome between patients in different score groups was also statistically significant. Among the 32 (15.2%) patients with an Apgar score of <4, major complications occurred in 25 % and a 30 day mortality of 34.4 % was seen. In contrast, among 36 patients with a score of 9 – 10, only 2.7 % suffered a major complication, while no deaths were noted in this group.

With the 9 – 10 category taken as a reference for assessing the relative risk, there was a 13.71 (0 – 2), 3.36 (3 – 4), 4.39 (5 – 6) and 1.05 (7 – 8) times the risk of developing complications. Though no death were noted in the patients with a score over 7, 40 % death rate was noted in the score group of 0 – 2 and 41.8 % in the group 3 – 4.

It was also noted that in every 2 point score category, the incidence of both major complications and death was significantly greater than that of patients in the next higher category. A similar result with a relative risk of major complications amongst low scored operations of 16.1 % was noted in a study by Gawande et al when compared with those in the higher scored operation.

The relative risk of predicting a major complication was significantly higher in all the subgroups of the Apgar score for emergency surgeries as compared to elective surgeries. A statistically significant result with an odds ratio of 4.8 % was obtained in a study by Gawande et al for emergency procedures.[13] Other studies have shown complication rates of 43 % and a mortality rate of 4 % in emergency GI procedures.[19]

When compared with other scoring systems, even the P-POSSUM score has no morbidity prediction equation, as a result of the original authors' lack of confidence in the reporting of perioperative complications.[20] Subsequent studies have shown P-POSSUM to both over-predict and under-predict mortality[21] in different settings.

A study on APACHE III risk prediction model by Knaus WA et al, have shown that the overall predictive accuracy of the APACHE III equation within 24 hours of ICU admission following a major surgery was within 3 %.

CONCLUSION

The surgical Apgar score represent a significant advancement in the field of perioperative care, offering a practical and effective means of predicting and improving surgical outcomes. Higher percentage of patients over 40 years of age have low surgical Apgar scores after general surgical procedures and hence are at risk for major complications, including a high mortality. Patients with low surgical Apgar score would require more intensive monitoring in

the postoperative period even if they are undergoing a minor procedure. Mortality rates are twelve times higher in emergency surgeries in comparison to elective cases. In case of laparotomy, the rate is two times higher for emergency laparotomy. The 10 point Apgar scoring system is an easy and fairly accurate method of identifying the patients at risk of complications and mortality in the postoperative period. This score can also serve as a simple aid in communication among surgeons, post anesthesia care providers, surgical residents and ICU or surgical ward staff regarding patients' immediate postoperative status. It also helps in conveying the condition of a patient and prognosis after surgery to the attenders.

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