Outcome of Noncardiac Surgical Patients Admitted to a Multidisciplinary Intensive Care Unit

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Abstract

Context: Surgical procedures carry significant morbidity and mortality depending on the type of surgery and patients. There is a dearth of evidence from India on the outcome of surgical patients admitted to an Intensive Care Unit (ICU). **Aims:** We aimed to describe the incidence and risk factors of postoperative complications and mortality in noncardiac surgical patients admitted to the ICU. **Settings and Design:** This was a prospective observational study on all perioperative patients admitted to a multidisciplinary ICU for 18 months. **Subjects and Methods:** Data on demography, admission Acute Physiology and Chronic Health Evaluation II (APACHE-II), Sequential Organ Failure Assessment (SOFA) scores, perioperative course, type and duration of surgery, reason for ICU admission, ICU interventions, and perioperative complications were recorded. The primary outcomes analyzed were perioperative complications and mortality. **Results:** The study included 762 patients with a mean age of (mean ± standard deviation [SD]) 50.5 ± 18 years and a male (58.4%) preponderance. The mean (±SD) admission APACHE-II and SOFA scores were 15 (±5.0) and 4.26 (±2.6), respectively. The most common reason for ICU admission was elective mechanical ventilation 50%, followed by prolonged surgery 26.2% and hemodynamic instability 21.2%. Most (51.1%) patients belonged to American Society of Anaesthesiologists physical Status III or IV and Lee's surgical risk Category I and II (66.8%). The most common surgical procedures performed were gastro-intestinal (28.5%) followed by interventional Neuro-radiology (14.0%) and orthopedic (13.9%). Overall perioperative complications were observed in 51.4% (n = 392). Common complications observed were hemodynamic instability 24%, hypothermia 17.2%, sepsis 17.3%, poor glycemic control 11.2%, perioperative myocardial infarction 7.1%, cardiac arrest 0.13%, and acute kidney injury (AKI) 10.1%. The overall hospital mortality was 7.9%. Multivariate logistic regression analysis showed that admission APACHE-II score, sepsis, AKI, and ICU length of stay were independent predictors for mortality. **Conclusions:** High risk perioperative patients after noncardiac surgery have significant mortality and morbidity.

Key words: Critically ill, noncardiac surgical patients, perioperative patients

Introduction

Advances in medical care have resulted in increased use of safe surgery in many disease conditions including high risk patient populations like elderly, those with multiple comorbid conditions and those undergoing major surgeries.[1-3]

Approximately 234 million major surgeries are performed annually with a mortality of 0.4–4% which may be even higher in high risk patients (12.3%–25%).[4] Studies have shown that reduced functional and organ reserve along with comorbid conditions impact perioperative mortality and morbidity.[3,5,6]

There is a dearth of evidence on the outcome of noncardiac surgical patients admitted to Intensive Care Unit (ICU) in India. Hence, in the present study, we primarily aimed to describe the incidence of postoperative complications and mortality in noncardiac surgical patients and secondarily to identify risk factors for incidence of complications.

Subjects and Methods

This was a prospective, observational study on consecutive perioperative patients admitted to ICU during a period of 18 months (April 2014–October 2015). Institutional Ethical Committee approval with a consent waiver was obtained

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due to the observational nature of the study. Patients <18 years, surgical duration <30 min and surgeries done under monitored anesthesia care/local anesthesia were excluded from the study. Data on demographics, severity of illness scores such as Acute Physiology and Chronic Health Evaluation II (APACHE-II) and Sequential Organ Failure Assessment (SOFA), type of surgery/anesthesia, duration of surgery, reason for ICU admission, interventions during ICU stay and perioperative complications as defined [Figure 1] were recorded. The primary outcomes analyzed were perioperative complications and hospital mortality. The secondary outcomes analyzed were duration of ICU stay, ventilator free days and ICU free days.

Results were expressed as mean ± standard deviation (SD) for quantitative data and frequencies for qualitative variables. Statistical analysis included Fisher's exact test, *t*-test and the Mann–Whitney U-test with $P < 0.05$ considered statistically significant. Multiple logistic regression was used to identify the independent risk factors for mortality SPSS Statistics for Windows, Version 17.0. Chicago: SPSS Inc. was used.

Results

We recorded the data on 762 patients [Figure 2] were included and found their mean age to be 50.5 ± 18 years and were of male predominance 58.4% (*n* = 445). The mean APACHE-II score was 15 ± 5.0, SOFA score (admission) was 4.26 ± 2.6 and SOFA (discharge) was 2.93 ± 3 [Table 1].

The reasons for admission to ICU were for elective mechanical ventilation and observation in view of co-existing medical conditions 50% (*n* = 383), followed by prolonged duration of surgery 26.2% (*n* = 200) and hemodynamic instability 21.2% (*n* = 163).

Most (51.1%) of the patients belonged to American Society of Anesthesiologists (ASA) physical Status III or IV (ASA III – 35% and IV – 16.1%). Increasing ASA physical status has been associated with higher mortality (observed mortality 0%, 0.6%, 11.5%, and 21.16% in ASA I, II, III, and IV, respectively) [Table 1].

In the present study, most patients belonged to the Lee's surgical risk category of I and II (66.8%) (Lee's I – 19.7%, Lee's II – 47.1%), whereas 10.8% belonged to the highest surgical risk Category IV. The observed mortality increased with higher surgical risk (Lees I – 0.67%, II – 1.4%, III – 18% and IV – 29%) [Table 1].

The most common surgical procedures performed were gastro-intestinal (28.5%, *n* = 217), interventional neuro-radiological (14.0%, *n* = 107) and orthopedic (13.9%, *n* = 106) [Figure 3].

In our study, 379 patients (49.7%) received blood-product transfusion and most of it was used in the operating room (298 [39.1%]). The median perioperative blood loss in our study was 200 ml (interquartile range [IQR] 100–900). In patients who required blood-product transfusion this was 700 ml (IQR 280–1200). Out of the 379 patients who received blood-product transfusion only 20 patients (2.62%) received massive transfusion. The median massive transfusion volume was 5550 ml (5100–6000 ml). Eight of these twenty patients died accounting for an observed mortality of 40%, but the overall mortality in patients who received transfusion was 15.8% [Table 2].

Fifty percent (*n* = 383) of patients in our study received mechanical ventilation in ICU. Other ICU interventions observed in our study included invasive monitoring (76.1%, *n* = 580), fluid resuscitation (43.7%, *n* = 333), inotropic/vasopressor requirement (24%, *n* = 183), and renal replacement therapy (5%, *n* = 38), all these were more frequently used in nonsurvivors [Table 1].

The overall perioperative complications observed in the present study was 51.4% (*n* = 392) [Table 3]. The surgical complications included 5.5% (*n* = 42) and the nonsurgical complications was 45.9% (*n* = 350). Nonsurgical complications observed were hemodynamic instability 24% (*n* = 183), hypothermia 17.2% (*n* = 131), sepsis 17.3% (*n* = 132), poor glycemic control 11.2% (*n* = 90), perioperative myocardial infarction (MI) 7.1% (*n* = 54), cardiac arrest 0.13% (*n* = 14), and acute kidney injury (AKI) 10.1% (*n* = 77) [Table 3].

The overall hospital mortality in our study was 7.9% (*n* = 60).

Secondary outcome measures were ICU length of stay (LOS) (mean ± SD) 3.15 ± 2.3 days, ICU free days 8.21 ± 5.9 and

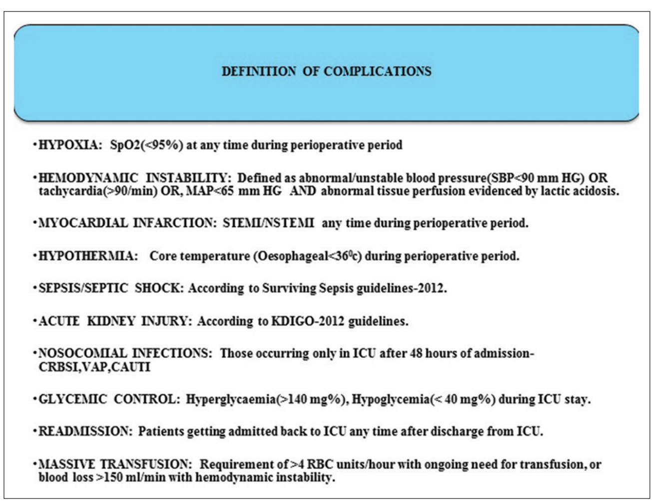

Figure 1: Definition of complications.

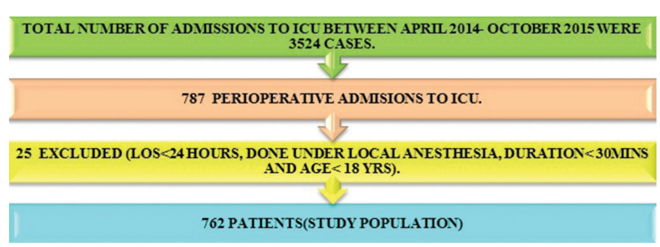

Figure 2: Admission data.

Table 1: Profile and characteristics of survivors and nonsurvivors

Demographics	Total (*n*=762)	Survivors (*n*=702)	Nonsurvivors (*n*=60)	*P*
Age (years)	50.5±18	49.27±17.7	63.6±15	0.000
Male, *n* (%)	445 (58.4)	411 (58.5)	34 (56)	0.777
Female, *n* (%)	317 (41.6)	291 (41.5)	26 (44)	0.777
Severity of illness scores (mean±SD)				
APACHE-II	15±5.0	14.46±4	26.9±3	0.001
Admission SOFA	4.26±2.6	3.72±1.8	10.5±2.3	0.001
Discharge SOFA	2.93±3	2.12±1.14	12.42±1.51	0.000
ASA physical status, *n* (%)				
I	69 (9.1)	69 (9.8)	0	0.000
II	300 (39.4)	298 (42.5)	2 (3.3)	0.000
III	270 (35.4)	238 (33.9)	32 (53.3)	0.000
IV	123 (16.1)	97 (13.8)	26 (43.3)	0.000
Surgical risk (Lee's), *n* (%)				
I	150 (19.7)	149 (21.2)	1 (1.7)	0.000
II	359 (47.1)	354 (50.4)	5 (8.3)	0.000
III	171 (22.4)	140 (20)	31 (51.7)	0.000
IV	82 (10.8)	59 (8.4)	23 (38.3)	0.000
Type of surgery				
Elective, *n* (%)	480 (63)	439 (62.5)	41 (68.3)	0.61
Emergency, *n* (%)	282 (37)	263 (37.5)	19 (31.7)	0.61
Duration, mean±SD (min)	196.33±125.47	178±102.5	198±127	0.232
ICU-interventions, *n* (%)				
Mechanical ventilation	383 (50.2)	323 (46)	60 (100)	0.0001
Fluid resuscitation	333 (43.7)	273 (39)	60 (100)	0.000
Invasive monitoring	580 (76.1)	521 (74.2)	59 (98.3)	0.000
Inotropic requirement	26 (3.4)	21 (3)	5 (8.3)	0.029
Vasopressor requirement	157 (20.6)	98 (14)	59 (98.3)	0.000
Insulin requirement	69 (9)	49 (7)	20 (33.3)	0.000
Blood transfusion (ICU)	167 (22)	136 (20)	31 (51.6)	0.000
Renal replacement therapy	38 (5)	11 (1.6)	27 (45)	0.000

APACHE: Acute Physiology and Chronic Health Evaluation; SOFA: Sequential Organ Failure Assessment; SD: Standard deviation; ASA: American Society of Anaesthesiologists; ICU: Intensive Care Unit

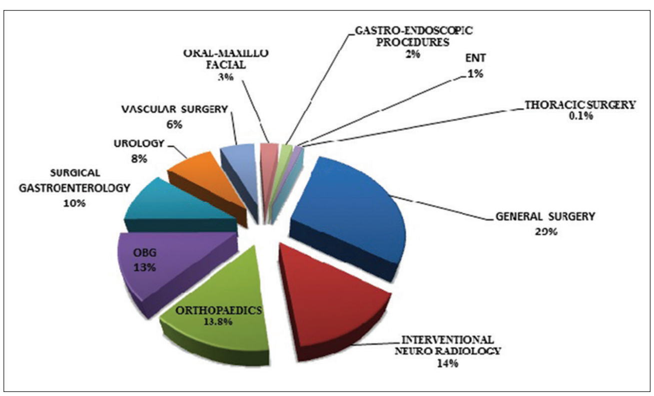

Figure 3: Case-mix of postoperative patients.

ventilator free days 8.47 ± 6.5. Multivariate logistic regression analysis showed that admission APACHE-II score (odds ratio [OR] - 2.07, 95% confidence interval [CI] - 1.6–2.7; $P = 0.000$), ICU LOS (OR - 1.36, 95% CI - 1.43–1.78; $P = 0.023$), sepsis (OR - 0.088, 95% CI - 0.18–0.439; $P = 0.003$) and AKI (OR - 0.086, 95% CI - 0.016–0.46; $P = 0.004$) were independent risk factors for mortality.

Discussion

Identification of high risk surgical patients and development of strategies aimed at reducing perioperative morbidity and mortality is a major challenge for anesthesiologists and surgeons.[5,6] The objective of this study was to examine the characteristics and outcome of noncardiac surgical patients admitted to an ICU, which represents a heterogenous high risk patient population.

Our study group was predominantly male (58.4%) with a mean age of 50.5 ± 18 years. Studies described by Lobo *et al*. and Abelha *et al*.[7,8] had an elderlypopulation (62.4 ± 17 years and 64.11 ± 14 years respectively). We found that an increasing age correlated with a higher mortality (survivors [49.3 ± 17.8] vs. nonsurvivors [64 ± 15]; $P = 0.000$).

Our overall hospital mortality when compared to a study by Abelha *et al*.,[8] was lower (11.2%). This may be explained by the fact that their study group was older (64 vs. 50.5) and were of higher risk as categorized by the ASA physical status (ASA III/IV - 57% vs. 51%) than ours. In a study by Sakr *et al*.[9] the mortality rate was 9%. These patients had higher APACHE II

Table 2: Perioperative blood usage

	Patients not requiring blood-product transfusion (*n*=383)		Patients requiring blood-product transfusion (*n*=379)	
	Mean±SD	Median (IQR)	Mean±SD	Median (IQR)
Total blood loss (ml)	183±200	100 (50-200)	1067±1633	700 (280-1200)
Total blood-product transfusion (ml)	NA	NA	1220±1360	600 (300-1600)

NA: Not available; SD: Standard deviation; IQR: Interquartile range

Table 3: Complications and patients outcomes

Perioperative complications	Total (*n*=762)	Survivors (*n*=702)	Nonsurvivors (*n*=60)	*P*
Primary outcomes, *n* (%)				
Hypoxia	73 (9.6)	60 (8.5)	13 21.7)	0.001
Hemodynamic instability	183 (24)	147 (21)	36 (60)	0.0001
Myocardial infarction	54 (7)	32 (4.5)	22 (36.6)	0.001
Hypothermia	131 (17.2)	112 (16)	19 (31.6)	0.002
Sepsis/septic shock	132 (17.32)	87 (12.4)	45 (75)	0.001
Acute kidney injury	77 (10)	36 (5.1)	41 (68.3)	0.000
Nosocomial infections	34 (4.5)	23 (3.3)	11 (18.3)	0.000
Hypo/hyperglycaemia	90 (11.8)	51 (7.2)	39 (65)	0.000
Pulmonary embolism	2 (0.26)	0	2 (3.3)	0.000
Cerebrovascular accident	6 (0.79)	1 (0.14)	5 (8.3)	0.000
Surgical complications	42 (5.5)	31 (4.4)	11 (18.3)	0.000
Other complications	26 (3.4)	17 (2.4)	9 (15)	0.000
Readmission	21 (2.75)	17 (2.4)	4 (6.6)	0.054
Seizures	6 (0.79)	4 (0.57)	2 (3.3)	0.000
Coagulopathy	4 (0.52)	1 (0.14)	3 (5)	0.000
Postcardiac arrest	14 (1.83)	4 (0.57)	10 (16.6)	0.000
Secondary outcomes (mean±SD)				
ICU LOS (days)	3.15±2.3	3.1±2.3	3.73±2.2	0.037
ICU free days	8.21±6	8.54±6	4.35±4.1	0.000
Ventilator free days	8.5±6.5	8.81±6.6	4.5±4.2	0.005

LOS: Length of stay; ICU: Intensive Care Unit; SD: Standard deviation

score (22 ± 8.3 vs. 15.4 ± 5.1 current study) and were mainly cardiac surgical patients (26.4%) when compared to our study. Another study by Hashmi *et al.*[10] observed an overall mortality of 33% which was very high when compared to our study. This may be attributed to a higher incidence of emergency surgeries (62% vs. 37%) compared to ours. The INDICAPS[11] study described a mortality of (18.8%) in surgical ICU patients.

Several retrospective studies have demonstrated a correlation between ASA classification and perioperative mortality and have suggested its usefulness as a predictor of patient outcome.[8,12,13] Similar to our study [Table 1], Wolter *et al.*[14] in their study also demonstrated an increasing mortality with worse ASA physical status (ASA I – 0.1%, II – 0.7%, III – 3% and 5%, IV – 18.3%). Lee *et al.*[15] also found increasing mortality with patients who had higher surgical risk (Lee Class I – 0.4% vs. Lee Class IV – 11%). We found that patients in ASA III/IV had an APACHE in the range of 17–18 (predicted mortality – 26.2%) while those belonging to Lee's Class III/IV had an APACHE in the range of 18–19 (predicted mortality – 29.1%) [Table 1]. This may be the reason for the high observed mortality in our study compared to that observed by Wolter *et al.*,[14] and Lee *et al.*[15]

The importance of the type of surgery has been emphasized in several studies[8,16] and poor outcome has been attributed to emergency surgery. However, our study did not find any association between emergency surgery and mortality (OR - 1.293, 95% CI - 0.735–2.275; $P = 0.372$) [Table 1].

Major hemorrhage that is life threatening and likely to result in the need for massive transfusion is not uncommon in the perioperative period.[16,17] This is associated with a high risk for respiratory and infectious complications and for mortality. In a study described by Turan *et al.*[16] the mortality rate was 21.5%. This was low compared to our study (40%) although their incidence of massive transfusions itself was lower (0.77% vs. 2.62%).

Studies that have examined perioperative sepsis are limited. They are mostly retrospective in nature or have looked at elective surgeries only.[18–20] The overall incidence of severe sepsis/septic shock among a mixed general ICU population in INDICAPS[11] study was higher than our study (28.3%, 17.3%). The predominant sources of perioperative sepsis in our study were abdominal ($n = 52$), soft tissue ($n = 47$), urological ($n = 23$), respiratory ($n = 10$). The National Surgical

Quality Improvement Program (USA) data[20] evaluating sepsis in general surgical patients reported 34% mortality in patients with severe sepsis/septic shock which was similar to our study (34.01%) (OR - 21.2, 95% CI - 11.4–39.5; $P < 0.0001$). In addition 34 (4.5%) patients developed nosocomial infections. In a study by Custovic *et al*.[21] incidence of nosocomial infections in ICU was 11.25%. Pneumonia was the predominant infection in this study. Similiarly we too found pneumonia to be the most common nosocomial infection. Ventilator-associated pneumonia ($n = 20$, 60% of all nosocomial infections). The other nosocomial infections included catheter-associated urinary tract infection ($n = 9$, 25%), and catheter-related blood stream infection ($n = 5$, 15%). The incidence of nosocomial infections in INDICAPS[11] study was 12.2% and the mortality rate in such patients was 28.4%. The mortality rate in patients who developed nosocomial infections in our study was 32.3%. When compared to survivors nosocomial infections were more common in nonsurvivors (3.3% vs. 18.3%) (OR - 6.6, 95% CI - 3–14.3; $P = 0.0001$) [Table 3].

In various studies described earlier mortality after perioperative MI varied widely between 0.3%–3.5% in low risk patients and 25%–33% in high risk patients.[22,23] 7.1% ($n = 54$) of patients in our study had perioperative MI out of which almost one-third (29.6%) were new-onset and developed postoperatively. The mortality due to perioperative MI was high (41%) and this may be explained by the fact that 6 of 16 patients presented to our ICU in postcardiac arrest status. Nonsurvivors (36.6%) had a significantly higher incidence of MI than survivors (4.5%) (OR - 12, 95% CI - 6.43–22.8; $P < 0.0001$) [Table 3].

Many modern ICU treatment goals are aimed to prevent AKI. In an ICU setting, beginning and ending supportive therapy kidney investigators[24] showed major surgery as the second leading cause of AKI (34%) with overall mortality of 60%. AKI is a serious complication with even small rises in serum creatinine associated with both increased morbidity and mortality. In our study, although the incidence of AKI was lower, (10.1% [$n = 77$]). Thirty-eight patients (49.4%) required renal replacement. The observed mortality in patients with AKI was 53.2% and was consistent with earlier studies. AKI was more common in nonsurvivors than survivors in our study (68% vs. 5.1%) (OR - 19, 95% CI - 11.7–31.3; $P = 0.000$) [Table 3].

Limitations

The main limitation of the study was relatively small study population ($n = 762$). This number may be inadequate to identify independent risk factors for common perioperative complications. We also did not have posthospitalisation follow-up data and hence more relevant end points based on long-term outcomes could not be assessed.

Conclusions

High risk noncardiac surgical patients encounter significant morbidity and mortality. Higher admission APACHE-II scores, longer ICU LOS, sepsis and AKI were independent predictors for perioperative mortality in this study. The present study represents only a small sample size of 762 patients which in our opinion may not be adequate to draw major conclusions. A larger study is required to identify the risk factors for perioperative complications in this important high risk group of noncardiac surgical patients.

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Conflicts of interest

There are no conflicts of interest.

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