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Outcomes of near-miss/adverse perioperative events during elective and emergency non-cardiac surgeries that required unplanned admissions to the intensive care unit of a tertiary care center: a retrospective cohort study

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Abstract

Background The near-miss/adverse events during elective and emergency non-cardiac surgeries requiring unplanned admissions to the intensive care unit (ICU) during the perioperative period are not known. Patients undergoing elective and emergency (E) noncardiac surgeries classified according to the American Society of Anesthesiologists physical status (ASA PS) (I–IV) were studied.

Results From 01 January 2019 to 31 December 2020, 6584 patients above 18 years underwent non-cardiac surgeries at a tertiary care center in eastern India, of which 87.3% ($n = 5754$) were elective surgical cases, and 12.5% ($n = 826$) were emergency surgeries. 0.98% of the patients ($n = 65$) (26 men and 39 females) had serious adverse/near-miss events requiring unplanned admission to the ICU, of these, 50.7% ($n = 33$) were elective cases, in ASA PS I 12.3% ($n = 8$), ASA II 27.6% ($n = 18$) ASA III 9.2% ($n = 6$) and ASA IV 1.53% ($n = 1$) respectively and 49.3% ($n = 32$) were emergency cases in ASA PS I (E) 13.8% ($n = 9$) (13.8%), ASA II (E) 26.1% ($n = 17$), ASA III(E) 4.6% ($n = 3$) and ASA IV(E) 4.6% ($n = 3$) respectively. Near miss events were mainly due to (a) cardiac-related events seen in 37.5% ($n = 25$) patients, (b) hemorrhage seen in 25% ($n = 16$), and (c) airway-related issues seen in 16.1% ($n = 11$) patients respectively. The adverse events were mainly due to drug-related errors in 21.4% ($n = 13$) patients. 13.84% ($n = 9$) patients had died and 86.16% ($n = 56$) had survived due to the availability of critical care services.

Emergency surgeries 25% (8 out of 32 patients) had a higher mortality rate due to adverse/near-miss events compared to elective surgeries which were 3.03% (1 out of 33 cases) respectively.

Conclusions Emergency non-cardiac surgeries were associated with higher rates of adverse/near-miss events. Early recognition and prompt management of critical adverse events during intraoperative and postoperative periods with the help of critical care facilities may improve clinical outcomes.

Keywords Near-miss/adverse events, Perioperative, Critical care

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Background

Near-miss and adverse events are commonly seen during the perioperative period due to patient, surgical, and/or anesthesia-related factors. According to the definition of “The Agency for Health Care Research and Quality (AHRQ), a *near-miss* is an ‘event or situation that did not produce patient injury, but only due to chance (through luck or timely intervention)’ whereas an *adverse event* is defined as an ‘unintended or unexpected event which could have caused or may cause harm to patients, including death during the course of the hospital treatment (Heideveld-Chevalking et al. 2014).

Methods

We have studied the perioperative near miss and adverse events from a tertiary care center in eastern India over 2 years period from 01 January 2019 to 31 December 2020. Data was taken retrospectively in patients who had undergone noncardiac surgeries from the patient’s electronic health record after approval from the hospital’s ethics committee, and written informed consent was taken from all the participants.

Statistical methods

Data were analyzed with continuous variables presented as median, while categorical variables were expressed as percentages (%). For significance estimation, the Student *t* test was used for continuous variables, and the chi-square test/Fisher’s exact test for categorical data and the Kruskal-Wallis test were used for the analysis of nonparametric data using the ‘R’ 3.6.2 software.

Results

A total of 6584 patients underwent noncardiac surgeries older than 18 years of age in the age group of these 5754 (87.3%) were elective surgical cases and 826 (12.5%) patients underwent emergency surgeries. 0.988% of patients (*n*=65) (26 men and 39 females) had serious adverse/near-miss events, requiring unplanned admissions to the ICU. Of these 50.7% (*n*=33) were in ASA PS grade I 12.3% (*n*=8), ASA II 27.6% (*n*=18), ASA III 9.2% (*n*=6), and ASA IV 1.53% (*n*=1), respectively, and 49.3% (*n*=32) patients underwent emergency surgical procedures (E) in ASA PS grade I(E) 13.8% (*n*=9) (13.8%), ASA II (E) 26.1% (*n*=17), ASA III(E) 4.6% (*n*=3), and ASA IV(E) 4.6% (*n*=3), respectively (see Fig. 1). The mean age of our patients was 43 years with males being 40% (*n*=26) and females being 60% (*n*=39). The median age of the patients in survivors vs non-survivors was 49.5 and 47 years respectively (see Fig. 2).

The following characteristics were also taken into consideration whether the event was related to the number of comorbidities, type of anesthesia (GA, regional, epidural, or/subarachnoid block), type of surgery (emergency/elective), the experience of the surgeon and the anesthetist, time of the surgery (working/off working hours), and the intensive care unit (ICU) management (organ support such as mechanical ventilatory support and dialysis, etc.). Emergency surgeries (28%) had a higher risk of intraoperative adverse events and mortality compared to elective surgeries (3%) (*p*=0.008) (see Table 1 and Fig. 3).

Of the total 65 unplanned admissions (*n*=9 patients) had died during their stay in the ICU and 86.16% (*n*=56) had survived due to the availability of

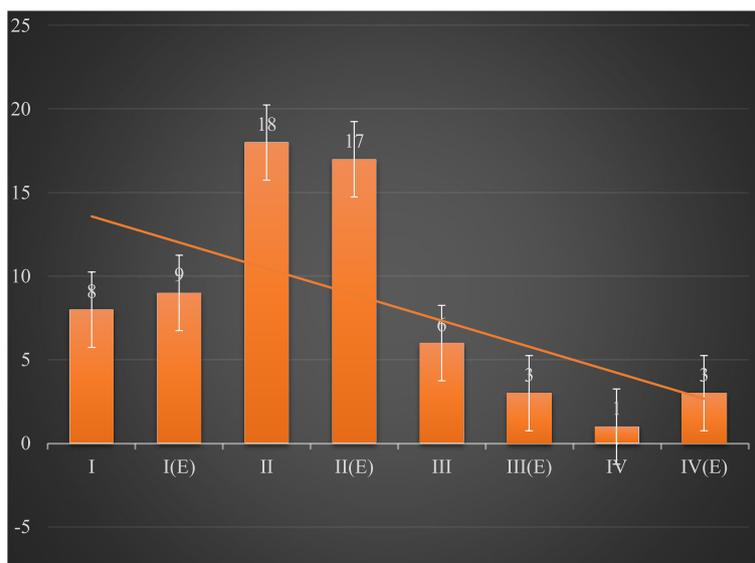


Fig. 1 ASA PS classification of patients undergoing elective and emergency surgeries

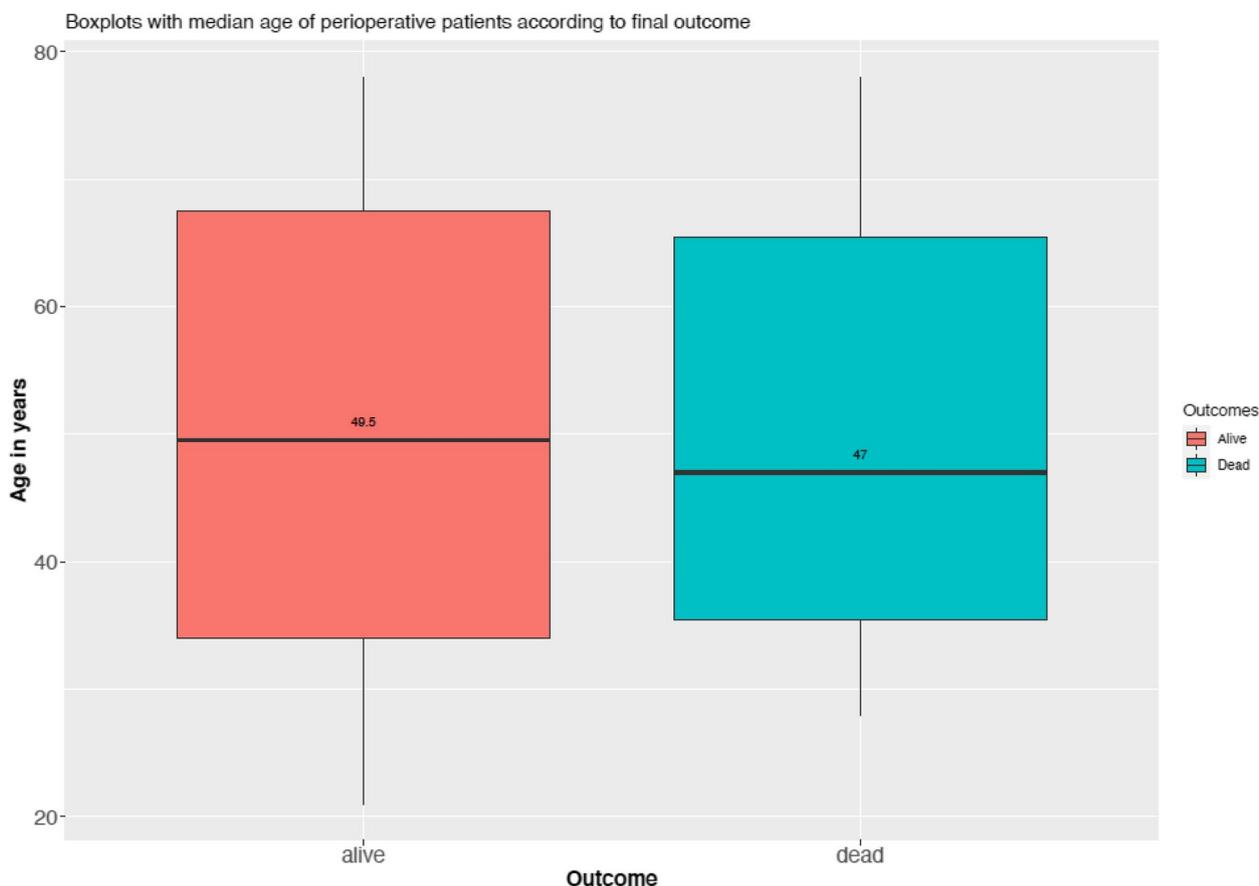


Fig. 2 Median age of the patients with outcomes

Table 1 Type of surgery and outcomes

Surgery setting	Outcomes		Total
	Dead	Recovered	
Elective	1	35	36
Emergency	8	21	29
Total	9	56	65

$\chi^2 = 6.338$, $df = 1$, $\phi = 0.357$, Fisher's $p = 0.008$

critical care services. The commonest near-miss events seen were mainly due to (a) cardiac related events such as Tachy/Brady-arrhythmias, complete heart block, and cardiac arrest seen in 37.5% ($n = 25$) of patients, (b) hemorrhage in 24.6% ($n = 16$), and (c) airway-related issues seen in 16.1% ($n = 11$) patients and the most common adverse events were due to drug-related errors seen in 20% ($n = 13$) of patients and were mainly due to anaphylactic reactions, wrong dose, wrong medication due to improper labeling, and look-alike/sound-alike drugs (see Fig. 4).

The near-miss cardiac events seen were due to (a) intraoperative tachyarrhythmias requiring cardioversion and anti-arrhythmics (b) Bradyarrhythmias, and complete heart block requiring intraoperative transvenous cardiac pacing, and (c) cardiac arrest managed with chest compressions and intravenous adrenaline according to the advanced cardiac life support protocol (ACLS) and by targeted temperature management (TTM) in the post-resuscitation period. The second common intraoperative near-miss event seen was hemorrhage (25%) secondary to iatrogenic causes, i.e., during surgical manipulation and accidental injury to a major artery/vein resulting in massive hemorrhage, managed by resuscitating with aggressive fluid and blood and component therapy, surgical ligation, antifibrinolytic therapy, and by interventional radiological procedures.

Intraoperative drug errors (21.4%) were the third most important cause of adverse events and were mainly due to incorrect drug doses or drug labeling errors, especially opioids, local anesthetics, and neuromuscular blocking agents, which resulted in delayed postoperative recovery and residual neuromuscular paralysis leading to

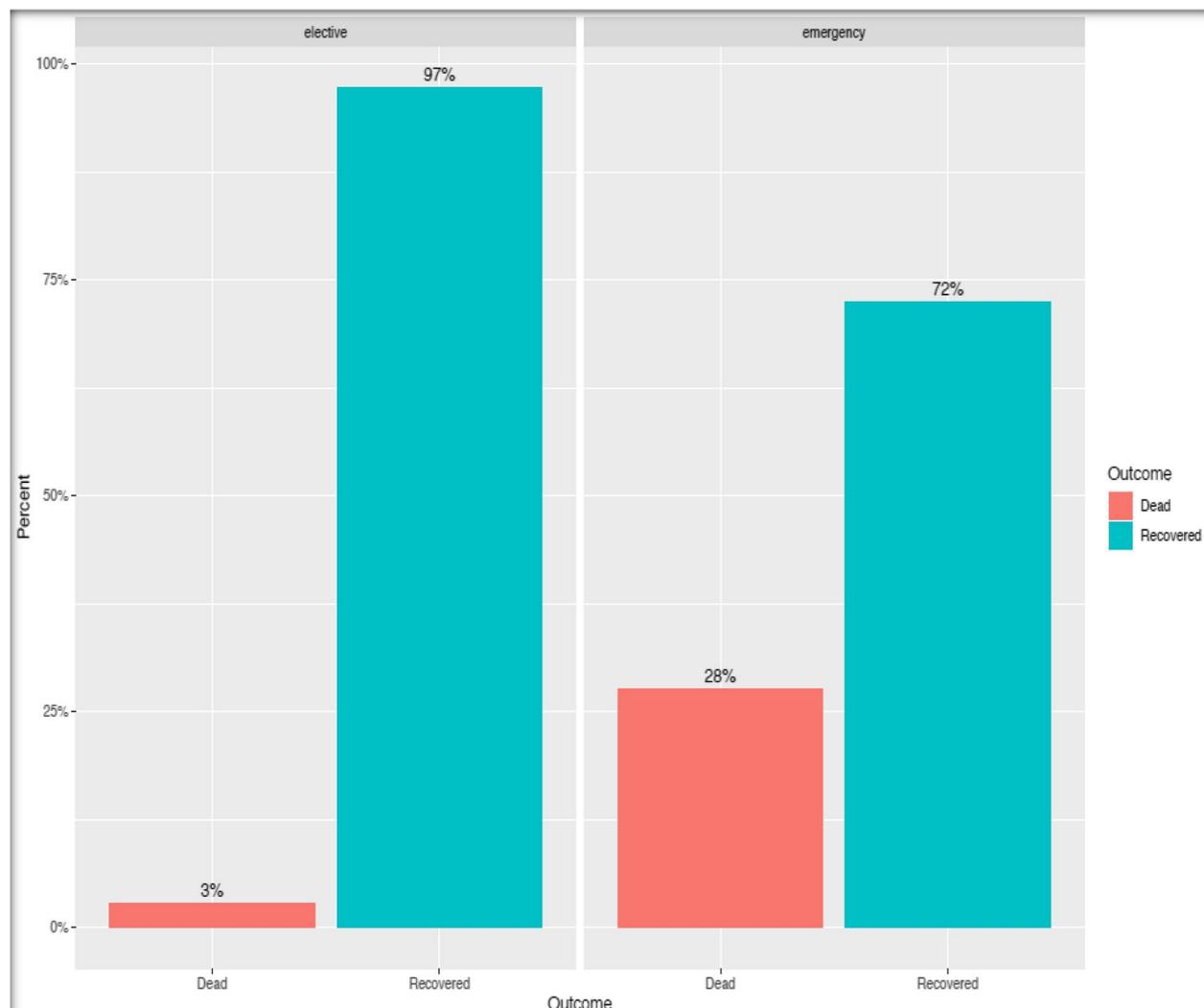


Fig. 3 Type of surgery and outcomes

unnecessarily prolonged duration of mechanical ventilation. Apart from the above anesthetic drugs, anaphylactic reactions to antibiotics and transfusion-related adverse reactions resulted in unplanned admissions to the ICU. The fourth cause of the intraoperative near-miss event was due to airway-related issues (16.1%) and was secondary to unanticipated difficult intubation, severe bronchospasm, laryngospasm, and tension pneumothorax and was managed by early identification and management resulting in better outcomes in these group of patients. Though the institution is a teaching hospital for postgraduate students, we had not noticed any difference in the number of events based on the experience of the surgeon/anesthetist and, or whether the surgical procedure was performed during working or off-hours due to well-established protocols in our centers. The study group involved patients from both oncological

and non-oncological surgeries with diabetes and hypertension being the most common comorbidities, 86.1% ($n=56$) patients had survived because of the effective critical care services provided by continuous cardiac monitoring, mechanical ventilation, hemodynamic/cardiac support with balloon pump/pacemakers, and dialysis in the intensive care unit. The duration of the surgery/anesthesia had not shown to have any impact on the type of adverse/near-miss critical event.

Discussion

Adverse/near-miss events are common during elective/emergency surgeries while undergoing major surgical or invasive procedures due to patient, surgical, or anesthesia-related factors, most of these events were documented in patients with higher ASA PS grades requiring admission to the ICU with higher rate of

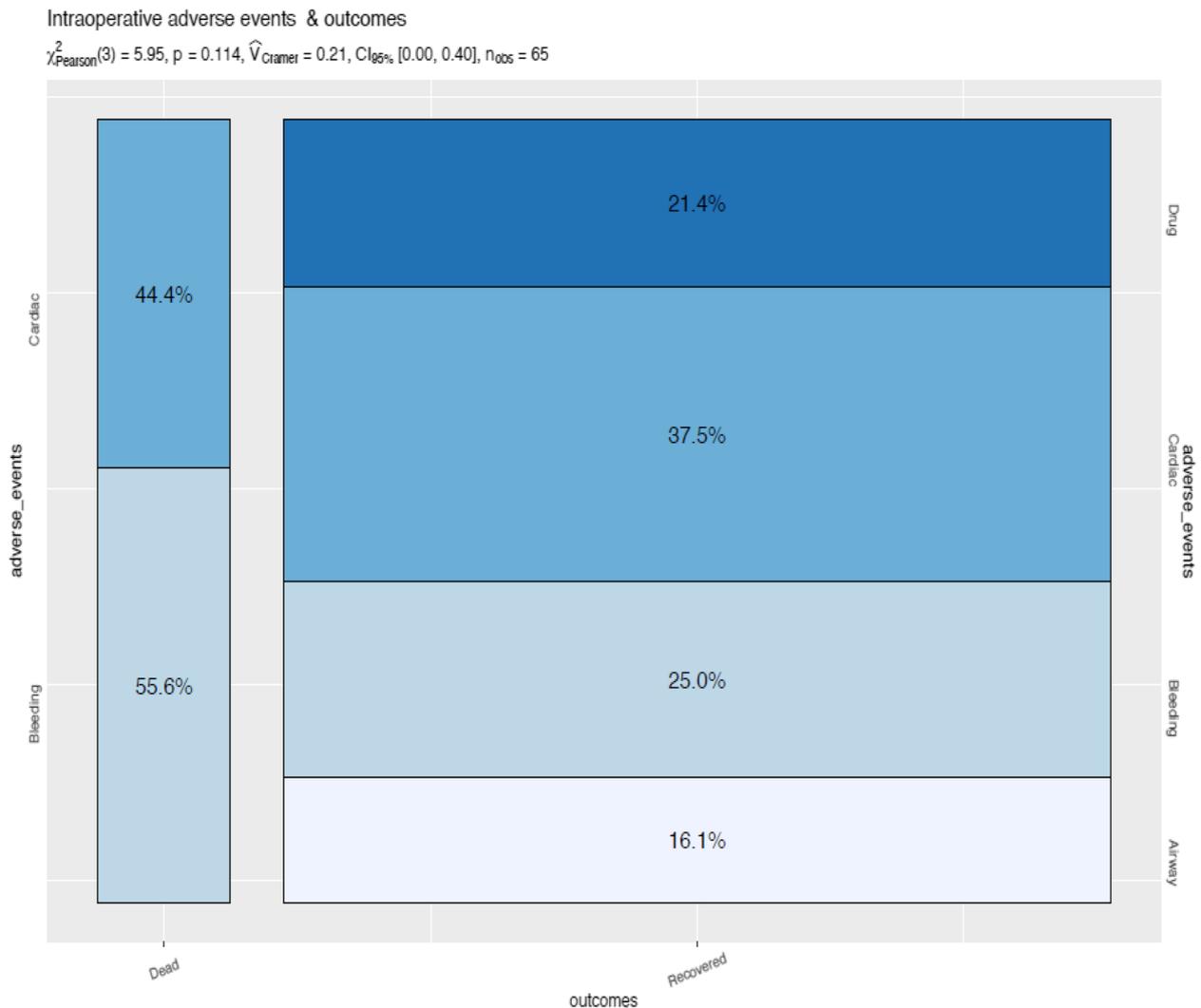


Fig. 4 Intraoperative adverse events and outcomes

mortality (Vlayen et al. 2012; Weissman and Klein 2008). The reported rates of adverse events were in the range of 10 to 30% during hospital admissions, of which half were preventable, in our study, it was less than 1% due to effective intervention and management of critical care services (Wacker and Staender 2014; Connolly et al. 2021). The implementation of the World Health Organization (WHO) surgical safety checklist, first published in the year 2008 was an important step in improving communication skills and reducing postoperative complications (Walker et al. 2012). It was also shown to reduce near-miss/adverse events during surgical/invasive procedures, with some studies showing improved outcomes and decreased mortality (Dinesh et al. 2018). Anesthesiologists play a vital role in the perioperative operative period in identifying, managing, and preventing perioperative complications which may help in improving patient safety

and outcomes (Wacker and Staender 2014). The surgical adverse events that were documented were sepsis secondary to infection at the surgical site due to poor infection control practices and were not reported in our study (Simone et al. 2020). Perioperative adverse cardiovascular events (PACE) commonly seen are myocardial infarction, intraoperative and postoperative arrhythmias, stress cardiomyopathy, and sudden cardiac arrest usually following regional nerve/central neuraxial blockade, which may be due to poor optimization of the patient’s cardiac function in the perioperative period, especially during emergency surgeries (Sellers et al. 2018; Pollard and Pollard 2001). The mortality in patients who had PACE was significantly higher when compared to those who did not have it (Oh et al. 2022). Central neuraxial blockade-related intraoperative cardiac arrest had a higher chance of survival inside the operating room because of continuous cardiac and

hemodynamic monitoring and trained manpower (An et al. 2011). The most common respiratory adverse events were pneumothorax following central venous cannulations, bronchospasm, aspiration, obstructive sleep apnea, postoperative atelectasis and pneumonia, and pulmonary thromboembolism. Age greater than 50 years, presence of oro/nasogastric tube, and intraoperative pulmonary complications have been shown to increase the risk of postoperative pulmonary complications (Diaz-Fuentes et al. 2016). The Common reasons attributed were due to inadequate implementation of protocols/guidelines, lack of teamwork, inter-departmental conflict, lack of resources, inadequate implementation of evidence-based practices, poor work culture, and poor communication skills by healthcare providers before, during, and after surgical procedures, burnout, and poor leadership qualities. Although recent studies have shown a reduction in anesthesia-related perioperative respiratory complications, most of them were due to airway-related concerns, which was reported in the fourth national audit project (NAP4) conducted in the UK (Cook et al. 2016). ASA PS which was amended in 1980 has important prognostic implications, the presence of higher grades which is greater than II and above had shown to increase perioperative risk and morbidity, which was similar to our study (Olters et al. 1996). Patients with multiple comorbidities have a higher incidence of developing adverse events during the perioperative period independent of the ASA PS class, but our study could not draw definitive conclusions as the age group was younger (Cavalli et al. 2022). There is a high risk of perioperative cardiac complications such as myocardial injury, Thromboembolic phenomena, and stroke in patients who have had major intraoperative bleeding, requiring optimal massive transfusion protocols to improve the patient outcome (Desai et al. 2018; Widimský et al. 2014; Ghadimi et al. 2016). Adverse drug events during the perioperative period were due to errors in drug labeling and administering wrong doses, 50% of which can be preventable, and could have resulted in significant to serious life-threatening reactions (Nanji et al. 2016). The availability of critical care services though had shown to improve the outcomes in managing perioperative adverse events (Hare and Hayden 2020; Story et al. 2004), it is of paramount importance to prevent such future events by optimizing the patient comorbid conditions preoperatively, using minimally invasive surgical approach and modifying the anesthesia techniques such regional nerve blocks and by continuous vigilance during and after the surgical procedure.

Limitations

The study being retrospective has its drawbacks. The study was conducted in noncardiac surgical adult

patients and excluded the pediatric population. Objective scoring tools such as Portsmouth Physical and Operative Severity Score (P-POSSUM), or surgical outcome risk tools were not used to identify at-risk patients in the preoperative period; and the admission to the critical care unit was based on the clinical judgment by the treating clinician. Objective and protocol-driven algorithms though imperfect may be used as an adjunctive tool to determine admission to the critical care unit (Schonborn and Anderson 2019).

Conclusions

Perioperative adverse/near-miss events are associated with poor functional outcomes and increased morbidity and mortality. The role of the anesthesiologist during the intraoperative period and the intensivist in the postoperative period in early detection and management may result in better outcomes.

Abbreviations

ASA PS	American Society of Anesthesiologists physical status
AHRQ	Agency for Health Care Research and Quality
ICU	Intensive care unit
ACLS	Advanced cardiac life support
TTM	Targeted temperature management
PACE	Perioperative adverse cardiovascular events
WHO	World Health Organization
NAP4	National Audit Project
P-POSSUM	Portsmouth Physical and Operative Severity Score

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Authors' contributions

Primary author KMK was involved in conceptualizing, permissions, data entry, collecting, reference managing, and writing the article. The second author AJ was involved in collecting and editing the data, and the third author RK was involved in analysis, data visualization, and interpretation using "R" software. All authors have read and approved the final manuscript.

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Declarations

Ethics approval and consent to participate

Approval from the hospital's ethics committee, COMMAND HOSPITAL (EC) KOLKATA-700027. Written informed consent was taken from all the participants.

Consent for publication

Written informed consent was taken from the participants.

Competing interests

The authors declare that they have no competing interests.

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