

Retrospective Evaluation of Prolonged Post-Anesthesia Care Unit Stay and Associated Perioperative Risk Factors Following Major Surgical Procedures

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Received: 10-03-2026 / Revised: 15-04-2026 / Accepted: 22-05-2026

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Conflict of interest: Nil

Abstract:

Background: Prolonged stay in the Post-Anesthesia Care Unit (PACU) is a frequent postoperative challenge that may delay patient recovery, increase healthcare costs, reduce bed availability, and disrupt operating room efficiency. Identifying perioperative factors associated with delayed PACU discharge is essential for improving patient outcomes and optimizing resource utilization.

Aim: To retrospectively evaluate the incidence of prolonged PACU stay and identify perioperative risk factors associated with delayed recovery following major surgical procedures.

Methodology: A hospital-based retrospective observational study was conducted over one year at a Netaji Subhas Medical College and Hospital, Bihta, Patna, Bihar, India. A total of 126 adult patients undergoing major elective surgical procedures under general or regional anesthesia were included. Demographic, clinical, surgical, anesthetic, and postoperative data were retrieved from hospital records and analyzed using IBM SPSS Statistics version 26.0, with $p < 0.05$ considered statistically significant.

Results: Prolonged PACU stay (>90 minutes) occurred in 33.3% of patients. General anesthesia (AOR=2.91), operative duration >3 hours (AOR=3.84), delayed awakening (AOR=4.62), postoperative pain (AOR=2.67), postoperative nausea and vomiting (AOR=2.95), obesity (AOR=2.08), and age >60 years (AOR=2.43) were significant independent predictors. The predictive model demonstrated good discrimination (AUC=0.86).

Conclusion: Prolonged PACU stay is primarily associated with modifiable perioperative factors. Early identification of high-risk patients and implementation of targeted perioperative management strategies may shorten recovery time, improve patient outcomes, and enhance perioperative efficiency.

Keywords: Post-Anesthesia Care Unit; PACU; prolonged recovery; perioperative risk factors; general anesthesia; postoperative complications; retrospective study.

DOI: 10.25258/ijpqa.17.5.69

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Introduction

Post-Anesthesia Care Unit (PACU) is a special recovery room that is used to care for patients who are recovering from anesthesia after surgery. The PACU has been in existence since the early 20th century and plays an important role in the care of the patient until physiological stability is achieved and the patient fulfills the discharge criteria from the PACU [1]. In the immediate postoperative period, patient monitoring is carried out for vital signs, patency of the airway, neurological status, pain control and recovery from the anesthetic agents. Despite great progress in anesthetic methods, monitoring devices and postoperative care, and associated complications like postoperative nausea and vomiting (PONV), respiratory depression and cardiovascular

instability, delayed awakening, uncontrolled pain, and altered consciousness are still potential risks and often result in an extended stay in the PACU [2].

Defining prolonged length of stay (LOS) in the PACU is somewhat arbitrary at 90 minutes of recovery time but is generally accepted as greater than that. A longer PACU stay not only delays patient recovery but also has a negative effect on hospital efficiency in terms of the length of time patients stay in bed, the number of patients admitted to the hospital, operating room efficiency and health care costs [3]. Additionally, an extended recovery period can suggest complications following surgery that necessitate additional checks and interventions, which can strain the resources and personnel of healthcare

facilities. Therefore, it is important to identify patients at risk of longer PACU stay as an important goal for perioperative quality improvement and patient safety programs [4]. Numerous investigations have shown that many patient, surgical and anesthetic related factors affect prolonged PACU stay. Delayed postoperative recovery has been correlated with patient factors such as advanced age, obesity, diabetes mellitus, hypertension, cardiovascular disease, and American Society of Anesthesiologists (ASA) physical status [5].

Elderly patients may have longer recovery time due to decreased physiological reserve, changes in anesthetic agent pharmacokinetics and multiple comorbidities. In a similar fashion, obesity and diabetes have been associated with complications such as prolonged emergence from anesthesia, postoperative respiratory compromise and greater monitoring needs. Anesthetic used also has a huge impact on PACU recovery time. Delayed awakening, postoperative nausea and vomiting, airway complications and residual neuromuscular blockade have been consistently associated with general anesthesia and prolonged recovery [6]. Regional anesthesia, on the other hand, is typically associated with better postoperative pain control, fewer systemic complications, and shorter PACU stay, although delayed motor recovery sometimes may result in delayed discharge in select patients. Furthermore, the length and complexity of surgery directly affect the post-surgical care, as longer procedures lead to more exposure to anesthesia, more blood loss during surgery, more fluids given during surgery, more post-surgical pain, and more complications requiring longer care in PACU [7].

One of the important factors that contribute to extended PACU stay is the occurrence of postoperative complications. Hypoxia, airway obstruction, respiratory depression and other respiratory problems often require prolonged observation prior to safe transfer to the surgical ward; hypotension, hypertension, tachy- and arrhythmia are also common cardiovascular complications. Previous investigations have found that postoperative pain and PONV are among the most frequent factors associated with delayed PACU discharge and frequently result in repeated administration of analgesics and antiemetics prior to meeting discharge criteria [8]. These complications can make the recovery period longer, make the patient more uncomfortable, delay the patient's ability to get up and move around, and lower the level of satisfaction with the care provided in the peri-operative period. Efficient management of PACU is critical to optimal room operating management. When PACU discharge is delayed, there are fewer beds available and a buildup of bed use in PACU as well as a postponement of surgery that follows.

This can eventually impact operating room efficiency, cost the hospital more and lower satisfaction

rates for the patient and surgeon. Hence, the identification of patients with a risk for prolonged PACU stay preoperatively will help in better planning of patient care, efficient use of resources, and efficient scheduling of surgical cases [9]. Multiple investigators have tried to create predictive models for prolonged PACU stay based on demographic, clinical, anesthetic and surgical parameters [10]. Previous research has identified some specific factors during surgery, including over-hydration, length of surgery, postoperative pain and PONV, as significant factors affecting recovery. More recently, models to predict a prolonged PACU stay have identified patients with morbid obesity, hypertension, planned general anesthesia, surgical specialty, and expected duration of surgery as all being associated with a higher likelihood of a prolonged stay in the PACU following surgery, and these models can be used to guide individualized, perioperative management and resource planning [11].

Although international evidence is available, limited data exist about the factors that predict a longer PACU stay in tertiary care hospitals in India where patient characteristics, case mix, and perioperative practices may differ significantly from those reported in developed countries and healthcare infrastructure may vary widely. A knowledge of these factors is critical for enhancing postoperative recovery, minimizing unnecessary PACU use, maximizing hospital resources, and improving patient safety. Thus, the present retrospective study was conducted to assess various factors that can predict the duration of PACU stay and various factors associated with expected delay in recovery in patients undergoing major surgical procedures at a tertiary care hospital in Bihta, Patna, Bihar to suggest peri-operative factors that may help reduce the PACU stay in patients undergoing major surgery.

Methodology

Study Design: A hospital-based retrospective observational study was conducted to evaluate the incidence of prolonged Post-Anesthesia Care Unit (PACU) stay and identify the perioperative factors associated with delayed recovery among patients undergoing major surgical procedures.

Study Area: The study was carried out at Department of Anesthesiology, Netaji Subhas Medical College and Hospital Bihta, Patna, Bihar, India, where patients undergoing major elective surgical procedures receive comprehensive perioperative and postoperative care, including recovery in a dedicated Post-Anesthesia Care Unit (PACU).

Study Duration: The study was conducted over a period of one year from January 2025 to December 2025.

Sample Size: A total of 126 patients who fulfilled the study eligibility criteria were included in the analysis.

Sample Population: The study population comprised adult patients who underwent major elective surgical procedures under general or regional anaesthesia and were admitted to the Post-Anesthesia Care Unit (PACU) immediately after surgery. Patients from various surgical specialties, including general surgery, orthopaedics, obstetrics and gynaecology, urology, neurosurgery, gastrointestinal surgery, and other major surgical disciplines, were included to obtain a representative sample of the surgical population.

Data Collection: Data were collected retrospectively from hospital medical records, anaesthesia charts, operation theatre registers, PACU records, and electronic hospital information systems using a structured data collection form. Information regarding demographic characteristics (age, sex, body mass index), pre-existing comorbidities (diabetes mellitus, hypertension, cardiovascular disease, respiratory disorders), American Society of Anesthesiologists (ASA) physical status, type of surgery, type of anaesthesia, duration of surgery, intraoperative events, estimated blood loss, intraoperative fluid administration, postoperative pain score, postoperative nausea and vomiting (PONV), delayed awakening, postoperative complications, and PACU length of stay was extracted. The primary outcome variable was prolonged PACU stay, defined as a recovery duration exceeding 90 minutes from admission to discharge from the PACU.

Inclusion Criteria

- Adult patients aged 18 years and above.
- Patients undergo major elective surgical procedures.
- Patients receiving general or regional anaesthesia.
- Patients were admitted to the PACU immediately after surgery.
- Complete medical records containing perioperative and PACU details.

Exclusion Criteria

- Patients undergoing emergency surgical procedures.
- Patients transferred directly from the operating theatre to the intensive care unit (ICU).
- Patients discharged directly from the operating room without PACU admission.
- Minor surgical procedures performed under local anaesthesia.
- Patients with incomplete or missing perioperative records.

Study Procedure: Hospital records of patients who underwent major elective surgery during the one-year study period were screened for eligibility. Patients fulfilling the inclusion criteria were enrolled consecutively until the required sample size of 126 was achieved. Demographic characteristics, clinical history, anaesthetic details, surgical variables, intraoperative findings, and postoperative recovery parameters were retrieved from patient case records, anaesthesia records, operation theatre registers, and PACU documentation. The duration of PACU stay was calculated from the time of admission to discharge from the recovery unit. Patients were categorized into normal PACU stay (≤ 90 minutes) and prolonged PACU stay (> 90 minutes). Potential perioperative risk factors, including age, sex, body mass index, ASA status, comorbidities, type and duration of surgery, anaesthetic technique, intraoperative blood loss, postoperative pain, postoperative nausea and vomiting, delayed emergence from anaesthesia, and other postoperative complications, were evaluated to determine their association with prolonged PACU stay.

Statistical Analysis: The collected data were entered into Microsoft Excel and analysed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean $\pm$ standard deviation (SD), while categorical variables were presented as frequency and percentage. Comparisons between patients with normal and prolonged PACU stay were performed using the Independent Student's t-test for continuous variables and the Chi-square test or Fisher's exact test for categorical variables, as appropriate. Variables showing statistical significance on univariate analysis were included in a multivariable binary logistic regression model to identify independent predictors of prolonged PACU stay. The results were expressed as adjusted odds ratios (AORs) with 95% confidence intervals (CIs). Model fitness was assessed using the Hosmer–Lemeshow goodness-of-fit test, and discriminative ability was evaluated by the receiver operating characteristic (ROC) curve. A p-value < 0.05 was considered statistically significant throughout the analysis”.

Result

Table 1 shows the demographic and clinical characteristics of the 126 study participants. The highest proportion of patients belonged to the 46–60 years age group (33.3%), with a mean age of 48.9 ± 15.2 years. Males constituted the majority (58.7%). Most patients were either overweight (37.3%) or had normal BMI (34.9%). Regarding ASA physical status, ASA II (46.0%) was the most common category, followed by ASA III (28.6%), indicating that the majority of patients had mild to moderate systemic disease before surgery.

Table 1: Demographic and Clinical Characteristics of the Study Population (N = 126)		
Variable	Frequency (n)	Percentage (%)
Age Group (Years)		
18–30	18	14.3
31–45	36	28.6
46–60	42	33.3
>60	30	23.8
Mean Age (Years)	48.9 ± 15.2	
Gender		
Male	74	58.7
Female	52	41.3
BMI		
Normal (<25 kg/m ²)	44	34.9
Overweight (25–29.9 kg/m ²)	47	37.3
Obese (≥30 kg/m ²)	35	27.8
ASA Physical Status		
ASA I	32	25.4
ASA II	58	46
ASA III	36	28.6

Table 2 presents the surgical and anaesthetic characteristics of the study population. General surgery (30.2%) was the most frequently performed procedure, followed by orthopaedic surgery (21.4%) and obstetrics & gynaecology (17.5%). The majority of

patients underwent surgery under general anaesthesia (69.0%), while 31.0% received regional anaesthesia. Most surgical procedures lasted 2–3 hours (38.9%), whereas 30.9% of surgeries continued for more than three hours.

Table 2: Surgical and Anaesthetic Characteristics (N = 126)		
Variable	Frequency (n)	Percentage (%)
Type of Surgery		
General Surgery	38	30.2
Orthopaedic Surgery	27	21.4
Obstetrics & Gynaecology	22	17.5
Urology	15	11.9
Neurosurgery	13	10.3
Gastrointestinal Surgery	11	8.7
Type of Anaesthesia		
General Anaesthesia	87	69
Regional Anaesthesia	39	31
Duration of Surgery		
<2 hours	38	30.2
2–3 hours	49	38.9
>3 hours	39	30.9

Table 3 illustrates the incidence of prolonged PACU stay and postoperative recovery characteristics. A total of 42 patients (33.3%) experienced a prolonged PACU stay of more than 90 minutes, while 66.7% had a normal recovery duration. Postoperative pain was observed in 31.0% of patients, followed by

postoperative nausea and vomiting (21.4%), delayed awakening (14.3%), cardiovascular complications (12.7%), and respiratory complications (10.3%), suggesting that these postoperative events were common during recovery.

Table 3: Incidence of Prolonged PACU Stay and Postoperative Recovery Characteristics (N = 126)		
Variable	Frequency (n)	Percentage (%)
PACU Stay		
≤90 minutes	84	66.7
>90 minutes	42	33.3
Postoperative Pain (VAS ≥4)	39	31
Postoperative Nausea & Vomiting (PONV)	27	21.4
Delayed Awakening	18	14.3
Respiratory Complications	13	10.3
Cardiovascular Complications	16	12.7

Table 4 compares patients with normal and prolonged PACU stay. Patients with prolonged PACU stay had a significantly higher mean age (55.2 ± 15.1 years vs. 45.7 ± 13.8 years; $p=0.002$). General anaesthesia, operative duration greater than 3 hours, postoperative pain, postoperative nausea and

vomiting, and delayed awakening were significantly more common among patients with prolonged PACU stay ($p<0.05$). Although male patients were more frequently represented in the prolonged PACU group, the association was not statistically significant ($p=0.091$).

Table 4: Comparison Between Normal and Prolonged PACU Stay

Variable	Normal PACU Stay (n=84)	Prolonged PACU Stay (n=42)	p-value
Mean Age (Years)	45.7 ± 13.8	55.2 ± 15.1	0.002*
Male Gender	45 (53.6%)	29 (69.0%)	0.091
General Anaesthesia	52 (61.9%)	35 (83.3%)	0.014*
Duration of Surgery >3 hrs	18 (21.4%)	21 (50.0%)	0.001*
Postoperative Pain	18 (21.4%)	21 (50.0%)	0.001*
PONV	11 (13.1%)	16 (38.1%)	0.002*
Delayed Awakening	6 (7.1%)	12 (28.6%)	0.001*

Table 5 presents the multivariable logistic regression analysis of factors associated with prolonged PACU stay. Delayed awakening (AOR=4.62) and operative duration greater than 3 hours (AOR=3.84) were the strongest independent predictors of prolonged PACU stay. General anaesthesia, postoperative nausea and vomiting, postoperative pain,

obesity, and age above 60 years were also identified as significant independent risk factors ($p<0.05$). The regression model demonstrated good calibration (Hosmer–Lemeshow $p=0.72$) and excellent discriminative ability (AUC=0.86) with an overall prediction accuracy of 84.9%, indicating satisfactory performance in predicting prolonged PACU stay.

Table 5: Multivariable Logistic Regression Analysis of Predictors of Prolonged PACU Stay

Variable	Adjusted OR	95% CI	p-value
Age >60 years	2.43	1.11–5.32	0.026*
Obesity (BMI ≥ 30 kg/m ²)	2.08	1.02–4.52	0.041*
General Anaesthesia	2.91	1.26–6.74	0.012*
Surgery Duration >3 hrs	3.84	1.74–8.49	<0.001*
Postoperative Pain	2.67	1.18–6.03	0.018*
PONV	2.95	1.24–7.01	0.014*
Delayed Awakening	4.62	1.71–12.49	0.002*

Discussion

The aim of the present retrospective study was to assess the incidence of PACU (post-anaesthesia care unit) stay and the peri-operative risk factors for PACU stay in patients undergoing major surgical procedures. In our study a prolonged stay in PACU (>90 minutes) was observed in 33.3% of patients suggesting that delayed postoperative recovery remains a challenge in perioperative care. This result is similar to other studies, which have reported that longer PACU stay is responsible for OR congestion, patient transfer delays and higher healthcare costs, highlighting the need for the identification of patients at risk prior to surgery [12]. Patients over 60 years of age had significantly increased odds of prolonged PACU stay (AOR=2.43, $p=0.026$), with many patients being 46–60 years of age with a mean age of 48.9 ± 15.2 years. Gabriel et al. (2017) also reported similar findings, showing that as patients get older, the recovery after surgery is also delayed due to changes in pharmacokinetics, decreased liver metabolism and an increased sensitivity to

anesthetic agents. Similarly, Butterworth et al. found that patients in the elderly age group frequently require extended post-operative monitoring due to delayed emergence from anaesthesia and greater physiological fragility” [13].

Notably, however, Alghamdi et al. found that age was no longer an independent predictor after controlling for other perioperative factors, indicating that this might have been due to variations between institutions and the characteristics of the patients. The male patients constituted 58.7% of our study population and there was no significant association between gender and prolonged PACU stay ($p=0.091$). This finding is in line with Alghamdi et al. (2023) who reported no statistically significant association between sex and prolonged recovery [14]. In contrast, Hartawan et al., however, found that female patients had better postoperative recovery quality and shorter PACU stays while Myles et al., however, proposed that postoperative outcomes may differ depending on the surgical population and management. The differing results suggest gender is

not always a good predictor of a prolonged PACU stay. We found general anaesthesia was used in 69.0% of our patients and to be an independent predictor of a longer PACU stay (AOR=2.91, $p=0.012$). Likewise, Gabriel et al. (2017) reported that general anaesthetic was among the most significant factors associated with a prolonged time to PACU discharge in comparison to monitored anaesthetic care or regional anaesthetic [15].

Regional anaesthesia has consistently been shown to be associated with earlier recovery, lower levels of pain after surgery, less pulmonary complications and a decreased incidence of postoperative nausea and vomiting. These findings help support the growing use of regional anaesthetic techniques when clinically appropriate to maximize recovery outcomes. In our study, there was also a significant association of duration of surgery with prolonged recovery. Patients who received procedures of greater than 3 hours increased their risk of long PACU by almost four times (AOR=3.84, $p<0.001$). These results are consistent with Gabriel et al. (2017) who showed that the longer the surgery the more likely it is to lead to higher exposure to anaesthetic, be more complex and to have a longer postoperative recovery period [16]. Bothner et al. (1999) and Waddle et al. (1998) had also found that the PACU occupancy and amount of postoperative monitoring are significantly increased with longer operating times. Of the postoperative recovery variables, postoperative pain, postoperative nausea and vomiting (PONV) and delayed awakening were found to be significant determinants of prolonged PACU stay. Delayed awakening was the best single predictor (AOR 4.62, $P=0.002$).

There was significant postoperative pain in approximately 31.0% of patients and PONV in approximately 21.4%. Chung (1995) reported similar findings, noting that the factors that caused delay in discharge after ambulatory surgery were inadequate pain control and PONV. Residual effects of anaesthetic and postoperative complications have also been shown to be a significant factor in the postoperative recovery process, as more important than demographic factors alone (Gabriel et al., 2017) [17]. Multimodal analgesia and evidence-based PONV prophylaxis can thus have a significant impact on PACU length of stay. Additionally, obesity was found to be an independent predictor in the current study (AOR=2.08, $p=0.041$). While obesity has been linked to respiratory compromise, difficult airway management and drug elimination, prior studies have shown mixed results. Some investigators did not find body mass index to be a significant predictor of extended PACU stay after the researchers accounted for other factors, whereas Gabriel et al. (2017) did find morbid obesity to be an important predictor [18].

Overall, our regression model was found to show good predictive ability, with a Hosmer–Lemeshow p value of 0.72, an AUC of 0.86 and an overall prediction accuracy of 84.9%, representing excellent discrimination between patients with normal and prolonged recovery. These results mirror previous predictive models created by Gabriel et al. (2017), who found that models based on pre- and perioperative variables were also highly predictive. Thus, early identification of high-risk patients will allow them to be scheduled for surgery optimally, to be anaesthetized individually, to be monitored more closely post-surgery, and to have PACU resources more efficiently allocated. Standardized recovery protocols, multimodal analgesia, and enhanced recovery pathways, along with preventive strategies targeting modifiable perioperative risk factors, may potentially further decrease the risk of prolonged PACU stay and ultimately improve perioperative efficiency in tertiary care hospitals.

Conclusion

This present retrospective study revealed that about one-third of patients who underwent major surgery had prolonged POST-ANESTHESIA CARE UNIT (PACU) stay which was significantly correlated with various peri-operative factors. Important factors associated with prolonged stay in the PACU were advanced age, obesity, general anesthesia, long surgery times, postoperative pain, postoperative nausea and vomiting, and delayed awakening, with delayed awakening and length of surgery being the most significant factors. Identification of these high-risk patients and targeted application of anesthetic strategies, pain management, PONV prevention and enhanced recovery protocols (ERP) during their perioperative period may help in reducing PACU length of stay, patient outcomes, optimizing resources and enhance the overall efficiency of the peri-operative period in a tertiary care hospital.

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