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Cohort Study

Incidence and predictive factors associated with hemodynamic instability among adult surgical patients in the post-anesthesia care unit, 2021: A prospective follow up study

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ABSTRACT

Background: Hemodynamic instability, which is an independent predictor of long-term patient morbidity and duration of stay in the hospital, is a risk for patients in the post-anesthesia care unit. Multiple factors contribute to the development of postoperative hemodynamic instability. Prevention and treatment of these factors may reduce patients' hemodynamic instability, and its associated morbidity and mortality.

Objective: The aim of this study was to determine the incidence and factors associated with hemodynamic instability among adult surgical patients in the post-anesthesia care unit.

Method: An institution-based prospective follow up study was conducted from April 20, 2021 to June 28, 2021. Four hundred and seventeen (417) adult surgical patients were involved in this study. Descriptive and analytic statistics were used to describe our results. Both the bivariable and multivariable logistic regression with crude odds ratio and adjusted odds ratio were used with a 95% confidence interval to evaluate the strength of association. In multivariable regression, a p-value < 0.05 was considered as statistically significant.

Result: The overall incidence of hemodynamic instability was 59.47% (CI: 0.55, 0.64). The incidence of tachycardia, bradycardia, hypotension, and hypertension were 27.34%, 21.82%, 13.67%, and 15.35% respectively. Preoperative use of beta-blockers, ASA class III, procedure longer than 4 h, intraoperative hemodynamic instability, and regional anesthesia were significantly associated with hemodynamic instability in the post-anesthesia care unit.

Conclusion and recommendation: The incidence of hemodynamic instability in the post anesthesia care unit was high. Preoperative use of beta-blockers, intraoperative hemodynamic instability, and prolonged duration of procedures were predictors of hemodynamic instability after operation. Early detection and management of these perioperative risk factors is necessary to reduce hemodynamic instability in the post-anesthesia care unit.

1. Introduction

An estimated 230 million surgical operations are performed per annum around the world. Nearly 18% of patients after surgery will develop a major postoperative complication [1,2] and these incidents are an important predictor of functional recovery and long-term survival [2]. Hypovolemia and cardiac dysfunction are the main causes of perioperative complications and poor outcomes [3,4].

The term hemodynamic refers to a physiological process involved in the movement of blood in the body. Hemodynamic stability requires sufficient blood or fluid in the body for the heart to receive and pump, adequate pressure from the heart to work against the systemic vascular resistance to move the blood around the body, and a correctly working pump to move the received blood [5]. This process may become unstable due to several factors that may lead to inadequate tissue perfusion, organ failure, and possibly death [5]. Hemodynamic instability is an abnormality of the heart, blood vessels, or other organs [6].

Many complications may occur in the post anesthesia care unit

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(PACU). According to the statistics, the three most prevalent complications in the PACU were airway events, hemodynamic instability, and postoperative nausea and vomiting [7–9].

The incidence of hemodynamic instability in the post anesthesia care unit was 21.1%–56.5% [10]. The prevalence of cardiovascular complications in the postoperative period after a specific vascular procedure was 81% [11]. In Africa, cardiovascular complication in the post anesthesia care unit was common. The incidence of hypertension, hypotension, tachycardia, and bradycardia were 12%, 8%, 25%, and 1% respectively [12]. The incidence of postoperative hemodynamic complications in the post-anesthesia care unit in Ethiopia was 21.1% [13].

Hemodynamic instability in the post anesthesia care unit can result in serious complications. It is an independent risk factor of long-term patient morbidity and prolonged hospital stay. Patients with severe hemodynamic events had a 1-h longer stay in the PACU than patients without such events [5,8]. Acute postoperative hemodynamic instability, if left untreated, can lead to postoperative hemorrhage, cerebrovascular accident, myocardial ischemia, arrhythmia, heart failure, and even the rupture of vascular anastomoses [5,11,14,15].

Hemodynamic instability (HDI) is manifested by changes in blood pressure and heart rate [14,16]. Hypotension is a common incident in the post anesthesia care unit. It is more commonly associated with anesthetic drugs, intraoperative blood loss, or postoperative hemostasis instability [5].

Hypertension (HTN) and tachycardia in PACU were associated with increased risk of admission to critical care units and postoperative mortality [17]. Hypertension can be caused by pain, excitement during anesthetic reversal, hypoxemia, hypercarbia, and agitation [5,18].

In the post-anesthesia care unit, bradycardia is also common. It could, however, be a physiologic response to being asleep, young patients, or sportsmen who don't necessarily require therapy [19].

Several risk factors predict postoperative hemodynamic instability. Risks can be patient, anesthesia or surgery related. Age, history of medication, ASA physical status, and chronic disease are common patient related factors. Anesthetics, other drugs, and intraoperative hemodynamic instability are all anesthesia-related factors. Intraoperative blood loss, surgeon expertise, operation type, and urgency may all influence the occurrence of postoperative hemodynamic instability. Postoperative nausea and vomiting, agitation, respiratory adverse events, and postoperative pain may all play a role in the development of hemodynamic instability in the PACU [14,16,20].

Depending on the severity and hospital guidelines, a variety of HDI management options can be applied. However, hemodynamic instability can be reduced or perhaps prevented by paying close attention to risk factors during the perioperative period [5,18,21]. Early detection of HDI in the PACU prompts action, which improves the quality of treatment, reduces PACU stay, lowers overall hospital costs, and hence improves short and long-term outcomes of surgery [22].

This study was aimed to determine the incidence of hemodynamic instability in adult surgical patients in the PACU and identify risk factors of hemodynamic instability.

2. Methods

2.1. Study design and period

An institution-based prospective follow up study was conducted from April 20, 2021 to June 28, 2021 to determine the incidence and predictive factors of hemodynamic instability in the post anesthesia care unit of a comprehensive specialized referral hospital in Ethiopia. This paper was registered in research registry with unique identifying number [23] of 7543 and was guided by STROCSS 2021 checklist [24].

2.2. Eligibility criteria

2.2.1. Inclusion criteria

All adult (≥18 years) fit and stable surgical patients after operation under anesthesia in the post anesthesia care unit during the study period were included in the study.

2.2.2. Exclusion criteria

Patients who were directly admitted to an ICU or ward after operation, patients admitted to PACU in the course of transferring them to the ICU, pregnant patients and patient who had postoperative shivering were excluded from the study.

2.2.3. Sample size determination

Sample size was determined by using single population proportion formula. A recent similar study done in Malaysia on the incidence of hemodynamic events in the post anesthesia care unit reported that 56% of patients after operation had hemodynamic instability [29] and was used to determine sample size of this study. The sample size for this study was calculated by considering 95% confidence interval, 5% margin of error, and 56% level of proportion.

$$\mathrm{n} = \frac{p(1-p)(za/2)2}{d^2}$$

$$n = \frac{0.56 \times [1-0.56][1.96]^2}{[0.05]^2}$$

$$\mathrm{n} = 379$$

Where:

n: sample size

p: proportion

d: absolute precision.

When 10% of non-response rate was added, the total number of patients included in the study was 417.

2.2.4. Sampling technique

The study participants were selected with non-probability consecutive sampling technique from patients waiting for surgical interventions under anesthesia.

2.2.5. Operational definition

Hemodynamic instability: If the patient has at least one of the physiologic parameters including systemic hypertension, hypotension, tachycardia, or bradycardia alone or in combination, then the patient had experienced hemodynamic instability [14].

Hypertension: Defined as an increase in mean arterial pressure by 20% from the baseline mean arterial pressure [19].

Hypotension: Defined as a decrease in mean arterial pressure by 20% from the baseline mean arterial pressure [20].

Sinus Tachycardia: Heart rate ≥100 for adults [11,22,25].

Sinus Bradycardia: Heart rate≤60 for adults [11,22,25].

2.2.6. Data collection procedure

A questionnaire was prepared and data was collected by three anesthetists and one nurse. Both observation and chart review were used to collect data. The questionnaire were prepared to address preoperative data of patients like age, sex, BMI, NPO hour, history of medical illness, and history of medication usage. Blood pressure, heart rate, temperature, and oxygen saturation were recorded in the intraoperative period. Anesthetic and surgical variables like the urgency of surgery, duration of surgery, type of anesthesia, intraoperative estimated blood loss, and timing of surgery, intraoperative fluid administered, and intraoperative hemodynamic instability were recorded in the questionnaire.

At admission to the PACU postoperatively, hemodynamic variables (HR, SBP & DBP) were measured using non-invasive monitoring

apparatus. Peripheral oxygen saturation was also monitored. Post-operative complications (pain, PONV, and respiratory adverse events, and agitation) were also documented. Patient's chart was reviewed to collect demographic, anesthesia, and surgical-related data.

Patient's hemodynamic status assessment was started in the first 15 min of arrival to the PACU. Data of hemodynamic variables (HR, BP) were collected every 15 min of the first 1 h of PACU stay and every 30 min of the second hour of the PACU stay as per PACU monitoring standards [15]. During this period, data were taken and recorded.

2.2.7. Data quality control

Training and orientation about the study and data collection methods were provided to data collectors.

During data collection, the completed questionnaire was reviewed daily to avoid loss of data. Data consistency and completeness were checked during data collection, entry and analysis period.

2.2.8. Data processing and analysis

The collected data was entered to Epi Data version 4.1 and exported to Stata version 14 for analysis. Socio-demographic and related characteristics of patients, anesthetic and surgical related variables were analyzed and presented in texts, tables and graphs. Normality of the distribution of data was tested by Shapiro-wilk test. Normally distributed data were presented by means and standard deviation whereas non-normally distributed data were presented by median or inter quartile range. Chi square test was carried out to determine association between independent factors and the outcome variable. Crude odds ratio (COR) and adjusted odds ratio (AOR) with the corresponding 95% confidence interval were calculated to determine the strength of associated factors with hemodynamic instability. Model fitness was checked using hosmer lemeshow test.

Both bivariable and multivariable logistic regression analyses were performed to assess the association between dependent and independent variables. Independent variables with $P < 0.2$ at 95% CI in the bivariable analysis were transferred to the multivariable binary logistic regression analysis. In multivariable regression, variables with P-value < 0.05 were considered as statistically significant predictive factors for hemodynamic instability in the post anesthesia care unit.

2.2.9. Ethical consideration

Ethical clearance was obtained from ethical review committee of the institution. After a brief explanation and disclosure of the benefit and risk that they will get from participation, verbal and written informed consent was taken from each study participants. Study participants were also informed about the purpose and importance of the study before the data collection process.

3. Result

3.1. Socio-demographic characteristics of patients

A total of 417 adult surgical patients were involved in this study with a 100% response rate. The median age (IQR) of the participants was 35 (27–50) years. About 63.79% were male patients. The median NPO hour (IQR) of the participants was 11(9–13) hours (Table 1).

3.2. Patient related factors

The majority of patients, 67.63%, were ASA I. Only 3 (0.73%) patients had not received postoperative nausea and vomiting prophylaxis. Most patients (63.55%) had preemptive analgesics, whereas 34.98% of patients had received aspiration prophylaxis preoperatively (Table 2).

Most patients had abdominal surgeries of which 39.77% and 47.30% were elective and emergency procedures respectively. Majority of neurologic procedures (19.5%) were emergency (Fig. 1).

About 65.23% of participants who had received general anesthesia were ASA class I whereas 7.33% participants who had spinal anesthesia were ASA class III. Only 36.36% of participants who received sedation as anesthetic technique were ASA II (Fig. 2).

Table 1
Demographic characteristics of Adult Surgical Patients in Post Anesthesia Care Unit, 2021, (n = 417).

Variable	Frequency(n)	Percentage (%)
Age		
18–34	195	46.76%
35–49	114	27.34%
50–64	49	11.75%
>65	59	14.15%
Sex		
Male	266	63.79%
Female	151	36.21%
BMI		
Underweight	38	9.11%
Normal weight	341	81.77%
Pre-obesity	38	9.12%
NPO time		
>= 8hrs.	77	18.47%
<8 h.	340	81.53%

NPO: Nil Per Os, BMI: Body Mass Index.

Table 2
Patient factor among Adult Surgical Patients in Post Anesthesia Care Unit, 2021, (n = 417).

Variable	Frequency(n)	Percentage (%)
ASA classification		
ASA I	282	67.63%
ASA II	96	23.02%
ASA III	39	9.35%
Urgency of procedure		
Elective	176	42.21%
Emergency	241	57.79%
History of medication intake		
Beta blocker & PTU	38	9.12%
Other medications	35	8.39%
None	344	82.49%
History of past medical illness		
Hypertension	12	2.88%
None	377	90.40%
Asthma	12	2.88%
Other disease	16	3.84%

ASA = American Society of Anesthesiologist, Other medication = HAART, Ca-channel blocker, diuretics, ACEI, heparin, insulin, other disease = HIV, Diabetes, cardiac disease, DVT prophylaxis.

3.3. Anesthetic and surgical related factors

One hundred two patients (24.46%) had developed hemodynamic instability in the intraoperative period. Patients who received intraoperative fluid of 2500m1 to 3500 ml were only 22.3%. About 48.68% of patients had an intraoperative blood loss between 200m1 and 400 ml. Two hundred fifty-one operations (60.19%) were performed at the day time (Table 3). About half (50.12%) of patients received opioids and 33.57% had peripheral or neuraxial blocks as analgesic or anesthetic technique (Fig. 3).

3.4. Post-operative factors

Postoperative complications in addition to the outcome variables were also monitored. Most (74.34%) of patients had mild to moderate pain whereas 12.71% of patients had experienced postoperative nausea and vomiting. One hundred eighty-one (43.41%) patients developed agitation. Majority (76.98%) of patients did not experience any respiratory complications in the PACU. About 47% of the patients were hypothermic in the PACU and none of them had severe hypothermia

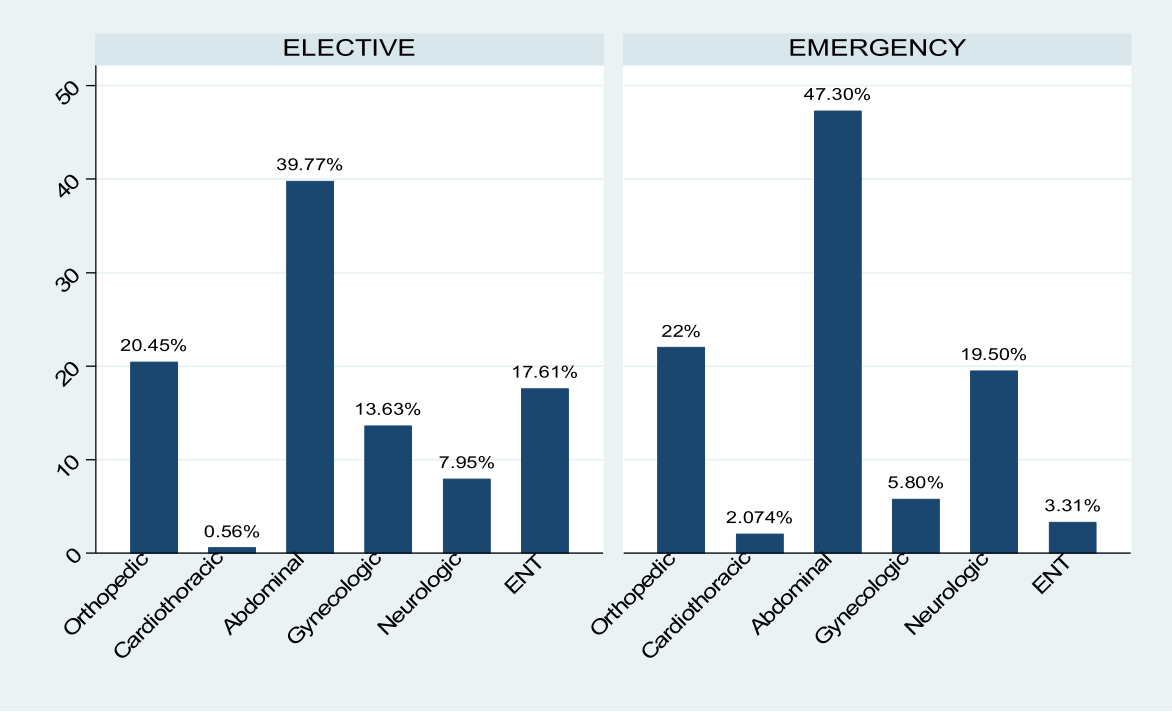

Fig. 1. Type of surgical procedures sorted by urgency of procedure among Adult Surgical Patients in Post Anesthesia Care Unit, 2021.

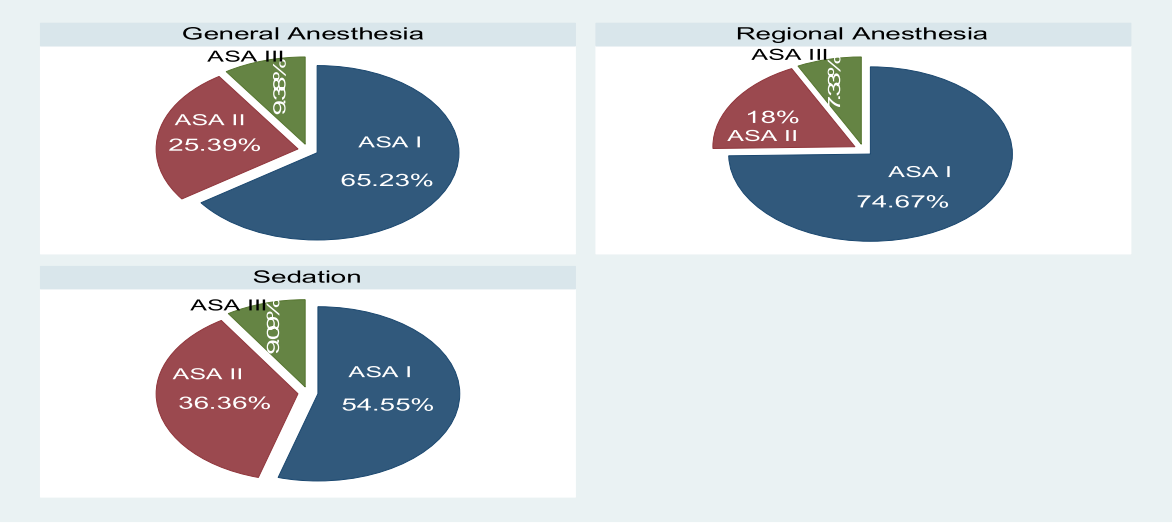

Fig. 2. Type of anesthesia given according to ASA classification among Adult Surgical Patients in Post Anesthesia Care Unit, 2021(n = 417).

(Table 4).

The overall proportion of patients who developed hemodynamic instability in the post anesthesia care unit was 59.47%. Out of these patients, 27.34%, 21.82%, 13.67% and 15.35% had experienced tachycardia, bradycardia, hypotension, and hypertension respectively (Fig. 4).

3.5. Predictive factors of hemodynamic instability in the PACU

Bivariable and multivariable logistic regression analyses were applied to find the predictive variables of HDI. On the Bivariable logistic regression analysis, age, history of past medical illness, ASA class, surgical specialty, urgency of surgery, history of preoperative medication usage, duration of surgery, type of anesthesia, intraoperative blood loss and fluid management, intraoperative HDI, postoperative nausea and or vomiting, postoperative pain, postoperative agitation and respiratory adverse events in the PACU were associated with hemodynamic instability (Table 5).

In multi-variable logistic regression analysis, ASA classification, type of anesthesia, surgical specialty, and history of preoperative medication usage, duration of surgery, intraoperative HDI, and postoperative respiratory adverse events were significant predictors of hemodynamic instability (Table 5).

ASA class III patients were 2.79 times more likely develop HDI in the PACU than ASA class I patients. Moreover, the odd of developing HDI in the PACU after regional anesthesia was 3.9 times more likely than patients who had general anesthesia.

Our study result showed that gynecologic and neurologic procedures were highly associated with postoperative HDI. Patients after neurosurgical procedures were 3.88 times more likely to develop

Table 3
Anesthesia and surgery related factors and percentage of hemodynamic instability among Adult Surgical Patients in Post Anesthesia Care Unit, 2021, (n = 417).

Variable	Frequency (n)	Percentage (%)	Hemodynamic instability in the PACU	
			Stable (n = 169)	Unstable (n = 248)
Intraoperative hemodynamic instability				
Stable	315	65.7%	152	163
Instable	102	24.46%	17	85
Intraoperative fluid administered				
<2500 ml	289	69.3%	126	35
2500 ml-3500ml	93	22.3%	35	58
>3500 ml	35	8.39%	8	27
Intraoperative blood loss				
≤100 ml	58	13.91%	30	28
100 ml-200ml	104	24.94%	46	58
200 ml-400ml	203	48.68%	75	128
≥400 ml	52	12.47%	18	34
Duration in the OR				
≤1 h	99	23.74%	52	47
1-2hr	140	33.57%	68	72
2-4hr	110	26.38%	39	71
≥4hr	68	16.31%	10	58
Timing of surgery				
Day	251	60.19%	101	150
Night	166	39.81%	68	98

OR-operation room.

postoperative HDI than patients who underwent orthopedic surgery. In addition, patients who underwent gynecological surgery were 3.14 times more likely to develop postoperative HDI than patients who underwent orthopedic procedures.

According to our result, patients who received preoperative beta-blocker had a significant association with postoperative HDI. The odd of developing HDI in the PACU was 3.2 times more likely in patients taking preoperative beta-blockers than patients with no history of any preoperative medication usage.

Duration of surgery and intraoperative HDI were found to be significantly associated with HDI in the PACU. Patients who had surgical duration of 4 h and more were 2.68 times more likely to develop HDI in the PACU than patients who had surgical procedures with less than 1 h duration. In addition, patients who developed intraoperative HDI were 3.35 more likely to experience postoperative HDI in the PACU than those who did not develop intraoperative HDI.

Our study also found postoperative respiratory adverse events were also predictors of HDI in the PACU. Patients who had respiratory adverse events in the PACU were 2.24 times more likely to develop HDI than those who did not experience respiratory adverse events.

4. Discussion

In this study, a total of 248 (59.47%) patients had developed hemodynamic instability in the post anesthesia care Unit. About 27.34%, 21.82%, 13.67% and 15.35% of patients had experienced tachycardia, bradycardia, hypotension, and hypertension respectively in the post anesthesia care unit. This could be related to the low PACU staff-to-patient ratio, which makes it more challenging to detect HDI and stabilize patients in the PACU early. In our context, like in other developing nations, the post-anesthesia care unit (PACU) has a high patient flow, making it challenging to organize the PACU according to established protocols. As a result, identifying a critical patient who needs close monitoring from a stable patient is challenging. This leads to a longer stay in the PACU for both stable and unstable surgical patients, and if patients are kept in a high-stress environment like the PACU, the risk of HDI rises even for stable surgical patients.

A study done in Libya showed comparable occurrence rates of hypertension (12%), hypotension (8%), tachycardia (25%), and bradycardia (1%) [12]. The difference in incidence of hypotension and bradycardia from our study could possibly be attributed to the increase in the sample size of our study compared to study done in Libya.

A study conducted in the UK also showed similar incidence of hemodynamic instability where 58% of the patients had experienced postoperative HDI of which 47% had postoperative hypotension [25].

Table 4
Postoperative Variables and their Percentage among adult surgical patients in post anesthesia care unit, 2021, (n = 417).

Variable		Frequency	Percent
Respiratory Adverse Events	Yes	96	23.02%
	No	321	76.98%
Postoperative nausea and/or vomiting	Yes	53	12.71%
	No	364	87.29%
Agitation status	Yes	181	43.41%
	No	236	56.59%
Postoperative pain	Yes	157	62.35%
	No	260	37.65%

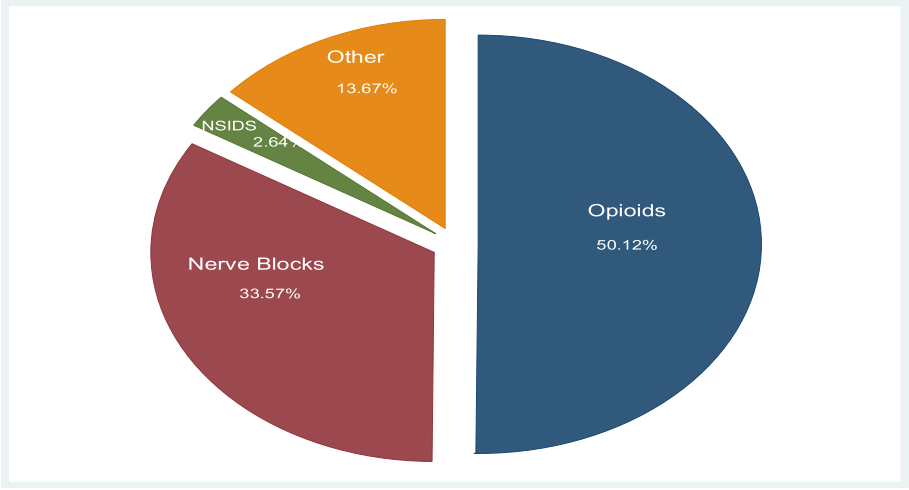

Fig. 3. Analgesia administered in the preoperative and intraoperative period among Adult Surgical Patients in Post Anesthesia Care Unit,2021, (n = 417). Other analgesic options include the combination of opioids, NSAIDS and low dose ketamine.

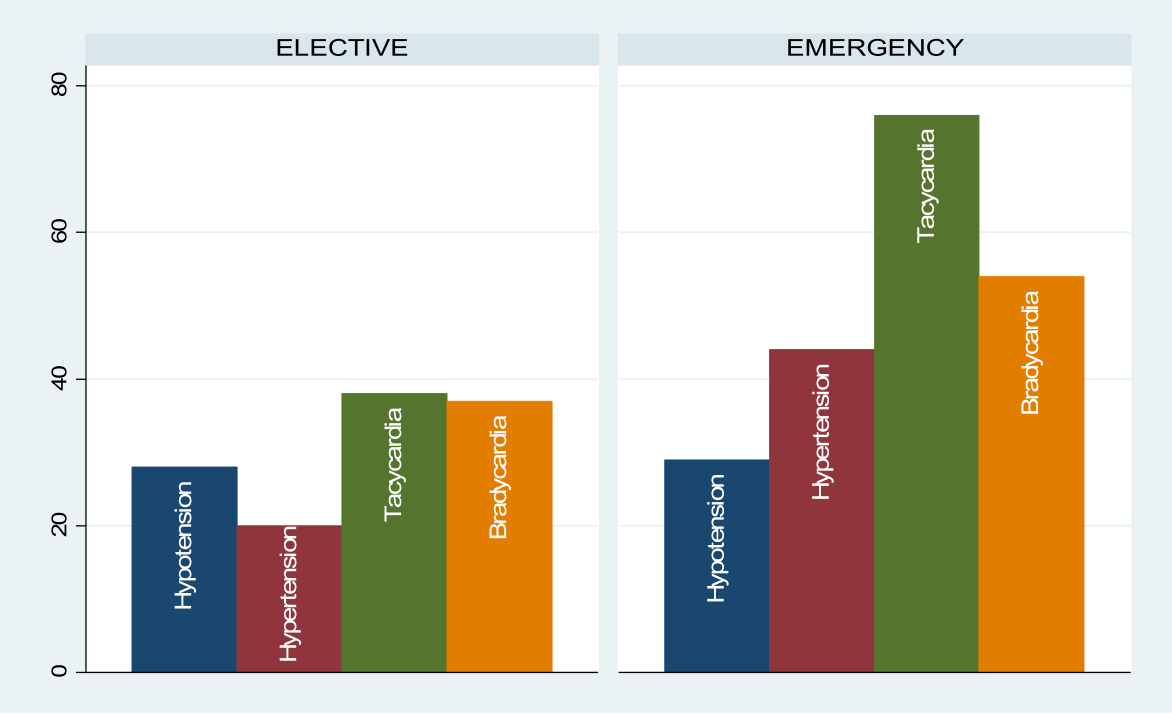

Fig. 4. Hemodynamic instabilities in the PACU according to their urgency among Adult Surgical Patients in Post Anesthesia Care Unit, 2021 (n = 417).

Table 5
Bivariable and multivariable logistic regression analysis of factors associated with hemodynamic instability among Adult Surgical Patients in Post Anesthesia Care Unit, 2021, (n = 417).

Variable		COR (95%CI)	P-value	AOR (95%CI)	P-value
Surgical specialty	Orthopedic	1	0.894	1	0.459
	Cardiothoracic	0.89(0.71–4.67)		0.46(0.06–3.63)	
	Gynecologic	1.94(0.87–4.31)	0.106	3.14(1.16–8.48)	0.024
	Neurologic	3.65(1.71–7.77) *	0.001	3.88(1.51–9.96)*	0.005
	Abdominal	1.16(0.70–1.93)	0.563	1.41(0.05–0.98)	0.339
	ENT	0.85(0.40–1.80)	0.670	1.66(0.53–5.15)	0.381
Type of anesthesia	General Anes.	1		1	
	Regional Anes.	1.32(0.87–2.00)	0.192	3.90(1.80–5.97) **	0.000
	Sedation	0.62(0.18–2.08)	0.436	1.97(0.50–7.69)	0.328
Preoperative medication	None	1		1	
history	Beta-bloc.	2.02(0.95–4.28)	0.068	3.16(1.12–8.97)	0.030
	Other	0.96(0.48–1.94)	0.909	0.73(0.25–2.13)	0.564
ASA classification	ASA I	1		1	
	ASA II	1.79(1.10–2.92)	0.019	1.12(0.61–2.41)	0.579
	ASA III	3.31(1.47–7.46)	0.004	2.79(1.03–7.53)	0.043
Duration of procedure	≤1 h.	1		1	
	1–2hr.	1.07(0.63–1.82)	0.788	0.56(0.28–1.11)	0.097
	2–4hr.	1.83(1.05–3.21)	0.034	0.84(0.39–1.81)	0.654
	≥4hr	5.22(2.49–10.97)**	0.000	2.68(1.08–6.69)	0.034
Postoperative	Yes	4.18(2.37–7.38) **	0.000	2.24(1.05–4.79)	0.036
Respiratory	No	1		1	
Adverse Events					
Intraoperative	Yes	4.66(2.65–8.21) **	0.000	3.35(1.64–6.91) *	0.001
HDI	No	1		1	

1 = reference group, HDI- hemodynamic instability, significant in the Bivariable logistic regression p-value < 0.2: significant in the Multi -variable logistic regression P-value < 0.05, *p < 0.01, **p < 0.001. COR- Crude odds ratio, AOR- Adjusted odds ratio.

Many of these individuals had adrenal gland disorders, which could explain the increased frequency of hypotension.

In comparison to the results we observed, studies conducted in Canada and the United States revealed a lower level of hemodynamic instability [26,27]. This discrepancy could be attributable to differences in PACU organization and the degree of post-operative care provided to patients.

Our findings were comparable to a Malaysian study, which found that ASA III patients in the PACU were at a significant risk of HDI (11.29%) [28]. PACU adverse events were more likely in patients with a higher ASA physical status. This may be attributable to the fact that ASA III patients have more comorbidities.

On the contrary, studies in USA and Singapore reported that patients with ASA I and ASA II had significant critical incidents in the PACU [16,23]. This might be because of the study population of their studies were composed of ASA physical status I and II. In our practice, majority of surgical patients with ASA physical status III were first brought to the PACU due to a lack of critical care resources or because they were stable

enough for PACU admissions, which could put patients in the PACU at higher risk.

According to a study conducted in Addis Ababa, Ethiopia, there was a high correlation between the length of surgery and adverse outcomes in the PACU [13]. This result was consistent with our own research, which found that surgeries lasting 4 h or longer are 3.8 times more likely to cause hemodynamic instability than those lasting less than 1 h. Studies from Canada, Libya, and Iran all agreed that procedures lasting 4 h or longer result in HDI in the PACU [12,14,29]. Patients will be exposed to more anesthetic medicines, hypothermia, blood loss, fluid shift, and tissue stress as the procedure length increases. As a result, an operation lasting 4 h or longer is a predictor of HDI in the PACU(18).

The use of beta-blockers in the preoperative period was a strong predictor of postoperative hemodynamic instability in our study. Similarly, Studies done in Libya and UK showed that the use of beta-blockers preoperatively was an independent predictor of postoperative hypotension and bradycardia respectively [12,25]. The use of beta-blockers prior to surgery reduces the cardiac sensitivity to hemodynamic alterations that could lead to HDI or compromises the patient's stress response mechanism to unfavorable events that contribute to HDI [18].

The present study showed that patients who underwent gynecologic and neurologic procedures were 3.14 and 3.88 times more likely to have hemodynamic instability in the PACU respectively. Similarly, a Canadian study found that gynecological operations were substantial risk factors for postoperative hypotension [30]. The majority of the gynecological procedures in our study were cancer cases with a higher risk of metastasis, which could lead to organ malfunction and pain after surgery. This, in turn, causes HDI in the post-operative care unit.

In the current study, the majority of neurosurgical procedures were performed on emergency and trauma patients who had a likelihood of developing elevated intracranial pressure (ICP). Increased blood pressure, respiratory depression, and bradycardia are common postoperative manifestations of an increase in ICP [18]. A study in USA also reported that intracranial procedures had a positive association with the incidence of postoperative hemodynamic instability(10).

Our study finding also showed that regional anesthesia had a significant correlation with HDI in the PACU. Similarly, a study done in Iran reported that the incidence of hypotension was the second-highest incidence of complication experienced after spinal anesthesia in the post-anesthesia care unit. After regional anesthesia, patients with unstable physiological characteristics are more likely to develop HDI [31]. Scientifically, patients who received regional anesthesia develop temporary hypotension due to peripheral vasodilation [18].

On the contrary, a study in the USA stated that choice of anesthesia did not contribute to hemodynamic instability which was not similar to our study finding [14]. The difference in adjuvant medications, dosages, and type of local anesthetic agent utilized to reduce the incidence of hypotension associated with regional anesthesia could be one possible explanation.

According to a study conducted in the USA, respiratory adverse events such as inadequate ventilation and patients presented to the PACU with airway maintaining equipment and maneuvers had increased risk of developing tachycardia in the post-anesthesia care unit [14]. This is similar to our study finding which revealed that patients with airway and ventilation problems had a high risk of developing HDI. This is explained by the fact that an elevated stress response and oxygen demand in the post-anesthesia care unit may raise the risk of hemodynamic instability.

5. Conclusion and recommendation

In general, the incidence of hemodynamic instability was high. The preoperative use of beta-blockers, intraoperative HDI, ASA class III, post-operative respiratory adverse events, neurologic and gynecologic procedures, use of regional anesthesia and prolonged duration of procedures were predictors of hemodynamic instability in the post-anesthesia care unit.

Clinicians should be concerned about postoperative hemodynamic instability in the PACU. Close follow-up of vulnerable patients, early detection and intervention of perioperative predictors of HDI and adherence to local protocol on patient handover were recommended to decrease the incidence of post-operative hemodynamic instability in the post anesthesia care unit.

6. Strength and limitation

Limited researches were conducted on the hemodynamic instability occurred in the post anesthesia care unit either in our hospital or in the nation at large. Hence, this finding will benefit and alarm the clinicians that hemodynamic instability in the post anesthesia care unit is still significant.

However, we used non-invasive monitoring apparatus that may not represent the exact reading of hemodynamic parameters.

Availability of data and materials

The data sets used and analyzed during the study are available from the corresponding author on reasonable request.

Ethical approval

The study was approved by the ethical committee of the institution.

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Author contributions

M.M. Abebe, N.R. Arefayne, M.M. Temesgen and B.A. Admass were involved in conception and design of the study, acquisition of the data, analysis and interpretation of data, drafting of the manuscript and approval of the final version of the manuscript.

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Declaration of competing interest

There is no conflict of interest among the participants of the article.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amsu.2022.103321.

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