Incidence and associated factor of intraoperative cardiac arrest in patients undergoing elective non-cardiac surgery at public Hospitals Ethiopia, Addis Ababa

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Abstract

Background: Intraoperative cardiac arrest (IOCA) is a rare but potentially deadly event that can occur during surgical event. Globally, the incidence of IOCA ranges between 1.1 and 34.6 cardiac arrests per 10,000 procedures, with a survival rate of 35% to 46.6%. In most Ethiopian hospitals, there is still a shortage of resources which makes it difficult to provide patients with standard care.

Objectives: The main objective is to determine the incidence of Intraoperative cardiac arrest and the risk factors associated with it among patients undergoing elective non-cardiac surgery at public hospital in Addis Ababa, Ethiopia.

Methodology: An institutional based retrospective cohort study was conducted at Tikur Anbessa Specialized Hospital, St. Paul's Hospital Millennium Medical College and Yekatit 12 Hospital on patients who underwent elective non-cardiac surgery on the year between 2019 and 2024 by reviewing medical records from March 25/2025 up to May 5th. All patients who had documented incidence of IOCA during the study period and who fulfilled the inclusion criteria were included. Data were entered and analyzed using SPSS version 25. Both bivariable and multivariable logistic regression were applied. In multivariable logistic regression, a P value < 0.05 significant level was used to identify factors for IOCA.

Results- Out of the 4000 reviewed cases, the incidence of IOCA was 2.8% (110/4000). Significant independent predictors of IOCA included advanced age (AOR=2.53), ASA class III & IV (AOR=670.3), Asthma (AOR=9.9), and the use of halothane as maintenance agent (AOR=4.41).

Conclusion and recommendation: The incidence of IOCA on elective non-cardiac surgeries in this study was higher than HIC. Multiple patient related, anesthesia related and surgery related factors were independently associated with IOCA. These findings shows there is a need for better perioperative screenings, improved training, safer anesthetic practice and better resource allocation is needed to decrease the risk of IOCA in Ethiopia hospitals.

Keywords: cardiac arrest , surgery, anesthesia, Adiss Abeba, Ethiopia, Cohort

Introduction

Intraoperative cardiac arrest (IOCA) is a rare but fatal condition that can occur during surgery with incidence rate between 1.1 and 34.6 times per 10,000 procedures worldwide with survival rate of 35% to 46.6%. However, there are little recent figures on how often IOCA happens or what causes it. (1, 2).

Elective non-cardiac surgeries include a wide range of procedures that are planned in advance and are not related to the heart. Despite being elective, this surgeries still carry major perioperative risk, including cardiac arrest, which is rare but critical event associated with high risk of morbidity and mortality (3).

In highly developed nations healthcare system the incidence of IOCA is two to seven times out of every 10,000 procedures when examining bigger patient populations. Perhaps, the risk level of surgery, advanced age, ASA physical status classification, low functional status, and anesthesia related (primarily caused by respiratory event) and pre-existing medical conditions can all increase the incidence of IOCA. (1, 4).

In most Ethiopian hospitals, there is still a shortage of resources even with the expansion of surgical access. According to studies there is a shortage of operational anesthesia machines, airway equipment, suggested monitoring devices, such as capnography, and specific medications, such as emergency pharmaceuticals. This will make it difficult to provide patients undergoing elective non-cardiac operations with standard care and also has a positive contribution on the incidence of IOCA (5).

However, data from middle- and low-income nations, such as Ethiopia, where surgical techniques and healthcare resources may differ significantly, is not available. It's critical to understand the frequency of IOCA and the contributing causes so that we can develop risk-reduction and patient safety solutions.

This study will look into past cases from selected public hospitals in Addis Ababa, Ethiopia. It's an effort aimed at filling this knowledge gap. The findings will contribute to improving perioperative care and guide physicians in preventing these critical incidents in the future.

Methodology

Study setting and period

Given the rarity of the case situational analysis was done at 3 public Hospitals selected from Addis Ababa, which is the capital city of Ethiopia. In the city administration a total of 13 hospitals are found. Three public hospitals were used for this study. These were Black Lion Hospital, St. Paul's Hospital Millennium Medical College (SPHMMC) and Yekatit 12 Hospital. The study was conducted from March 31, 2025 to May 5th 2025.

Study Design and participants

An institutional based retrospective cohort study was conducted on IOCA on patients who underwent elective non-cardiac surgery using pre-recorded data from 2019-2024 by reviewing medical chart at selected governmental hospitals.

All complete records of patients who had elective non-cardiac surgeries at Tikur Anbesa Speciaized Hospital, St. Paul's Hospital Millennium Medical College and Yekatit 12 Hospital from January 1, 2019 up to December 31, 2024 were included in this study. Events that occurred outside the operating rooms, such as postoperative transportation to the recovery room or Intensive Care Unit and charts which has incomplete data were excluded.

Data collection

A structured and pre-tested checklist was used to assess the incidence and associated factor of IOCA on patients who underwent elective non-cardiac surgery from Hospital records, both digital and paper. Over the course of five years, this study reviewed all patients having records of IOCA during anesthesia in all 3 hospitals. An anesthetic database and surgical log books was used to identify IOCA. The data was collected by 4 selected and trained Junior Anesthetists by using pretested structured data extraction form (checklist) which included, age, gender, ASA Class, metabolic equivalent, Disease Characteristics, Preoperative Comorbidities, intraoperative complications and treatment outcome. At the end of data collection, patient's charts was placed with its original place properly. Data collectors were provided with a one-day training covering the purpose of the study, questionnaire content, and field procedures.

This study used purposive sampling technique or consecutive sampling due to the low incidence of IOCA in elective non-cardiac surgeries resulting 4000 cases. The sampling interval was calculated as K=Tp/Sp = 25 A random starting point between 1 and 25 was selected and using lottery method. Thereafter, every 25th recorded was included until the required sample size was achieved. Ineligible cases were excluded and replaced by the next eligible record.

To ensure the quality of data, pretest of the data collection was done on 10% of the samples which was not included in the main study. Data was checked for completeness, accuracy, and clarity on the day of collection by the principal investigator. Data clean up and crosschecking was done before analysis. Supervision was done by the principal investigator.

Data analysis

Data was entered and analyzed by using SPSS version 27 statistical package software. Results were presented as mean and standard deviation (SD) for continuous data, and as a number and percentage for categorical data. An independent sample t-test was used to compare numerical variables, while chi-square or Fisher exact test was used to compare categorical variables. Statistical analysis involved descriptive statistics to compare demographics and clinical factors of patients who had CPR, while forward stepwise logistic regression identified independent variables associated with IOCA. Variables that are significant on bivariate analysis at $p<0.25$ was considered as a potential independent variable. A multivariate logistic regression models then was constructed using only statistically significant variables. The magnitude of associations direction of relationship, the 95% CI and odds ratio (OR) was applied. Model fitness was assessed using Hosmer-Lemshow test and NagelkerkeR^2.

Ethical considerations

Letter of permission was obtained from Addis Ababa University, School of Medicine and Health Science, department of Anesthesia, Addis Abeba Health Bureau and also from SPHMMC. Since medical records are institutionally owned, permission was sought from the Hospital administration to access necessary data. Given the study involves retrospective data with no patient contact, a waiver of informed consent was requested from the IRB. Information obtained were used only for study purposes and the privacy of every patient's information were confidential. After completion of the research, records were returned to

their original place. The data was collected by data collectors and the data collector was briefed about the purpose of the study and each point of a checklist, and they were under supervision.

4.11 Result dissemination plan

After the finalization of the study, the findings will be communicated to the participants. The study result will be submitted to Addis Ababa University, School of Medicine and Health Department of Anesthesia. Efforts will be made to publish the findings of the study and disseminate them through different journals and scientific publications.

Results

Socio-demographic factors

A total of 4,000 surgical patients were included in this retrospective cohort study. Of this, 1049(24.8%) were children less than 1 years.

TABLE 1: SOCIO-DEMOGRAPHIC FACTORS THAT ARE ASSOCIATED TO IOCA

Factors	IOCA (no) n=3890	IOCA (yes) n=110	p-value
Age			<0.01
<18 yrs	1576(39.4%)	76(69.1%)	
≥18 yrs	2424(60.6%)	34(30.9%)	
BMI			<0.01
19-24	1673(43%)	28(25.5%)	
25-29	919(23.6%)	14(12.75)	
30-39	343(8.8%)	6(5.5%)	
>40	24(0.6%)	1(0.9%)	
Pediatrics age group	931(23.9%)	61(55.5%)	
MET			<0.01
<4	3008 (77.3%)	27(24.5%)	
>4	882(22.7%)	83(75.5%)	
Sex			0.05
Female	1499(38.5%)	57(51.8%)	
Male	2391(61.5%)	53(48.2%)	

Patient related factors of IOCA

From the study group, total of 42.2% (1686) patients had at least one comorbidity. The most common comorbidities was Hypertension 1369 (32.4%). Majority of participants who had cardiac arrest were ASAIII and IV (70.9%, n=110).

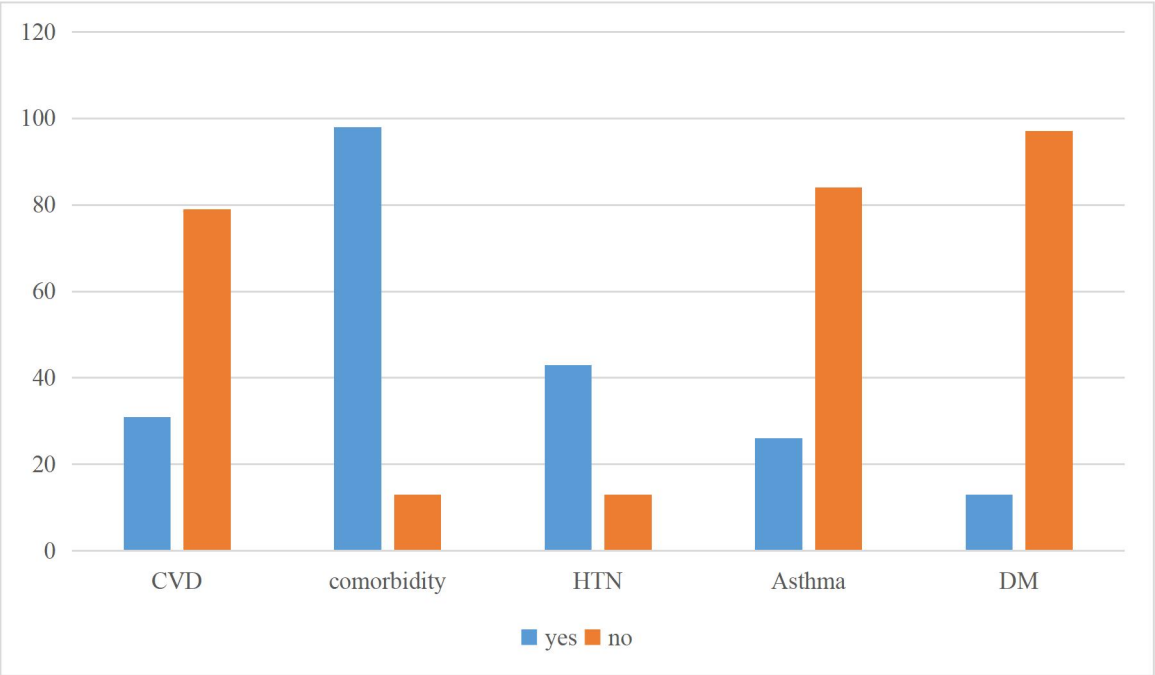

FIGURE 3: DISTRIBUTION OF IOCA BY PATIENT FACTOR

Surgery related factors of IOCA

From the total of 4000 patients, nearly one third of cases were Urologic surgery accounting 1302 cases (32.6%), followed by General surgery 683cases (17.1%) and Neurosurgery with 585 cases (14.6%). Key surgical factors included surgical type, surgery time, blood loss, and blood transfusion, with their distributions summarized in Table 2.

TABLE 2: FREQUENCY AND PERCENTAGE OF DISTRIBUTION OF SURGICAL-RELATED FACTORS BY IOCA STATUS OF THE STUDY PARTICIPANTS

Factor	IOCA (Yes) (n=110, 2.8%)	IOCA (no) (n=3,890, 97.3%)
Surgical Type		
General	25(22.7%)	658(16.9%)
Neurosurgery	23(20.9%)	562(14.4%)
Urologic	19(17.3%)	1283(33%)
Vascular	17(15.5%)	374(9.6%)
Surgery Time		
<2 hours	20(18.2%)	2010(51.7%)
2-4hrs	28(25.5%)	1072(27.6%)
>4hrs	62(56.4%)	808(20.8%)
Blood Loss		
<1000ml	41(37.3%)	1306(33.6%)
>1000ml	69(56.4%)	2584(66.4%)
Blood transfusion		
No	10(9.1%)	953(24.5%)
<4 unit	43(39.1%)	1960(50.4%)
4-6 unit	36(32.7%)	971(25%)
>6 unit	21(19.1%)	6(0.2%)

Anesthesia related factors of IOCA

Out of the study population, majority of the cases 3268 (81.7%) were done under GA, while 729 cases (18.2%) were RA. From the GA cases, 1571 (39.3%) patients were induced by

propofol and 1692(42.3%) patients used ketamine and the rest ketofol. 1918 cases (47.9%) were maintained by Isoflorane and the rest used Halothane which was 1353(33.8%).

Of the total sample, Halothane was more common in IOCA cases (51.8%, n=110) than non-IOCA cases (33.3%, n=1,296). This suggests halothane may be associated with higher IOCA risk, possibly due to its cardiovascular effects. The key anesthesia-related factors included maintenance agents, anesthesia personnel, anesthesia type, and induction agents, with their distributions summarized in Table 3.

TABLE 3: FREQUENCY AND PERCENTAGE DISTRIBUTION OF ANESTHESIA-RELATED FACTORS BY IOCA STATUS

Factors	IOCA (Yes) (n=110, 2.8%)	IOCA (No) (n=3,890, 97.3%)
Maintenance Agent		
Isoflurane	45(40.9%)	1873(48.1%)
Halothane	57(51.8%)	1296(333%)
Anesthesia Personnel		
Physician anesthesia personnel	60(54.5%)	2552(65.6%)
Non-physician anesthesia personnel	50(45.5%)	1338(34.4%)
Anesthesia Type		
General anesthesia	99(90%)	3169(81.5%)
Regional anesthesia	8(7.3%)	721(18.5%)
Induction agent		

Propofol	58(52.7%)	1513(38.9%)
Ketamine	36(32.7%)	1656(42.6%)

Incidence of IOCA

The incidence of IOCA was 2.8% (95%CI: 2.32-3.36). Of which, 84(76.4%) was returned to spontaneous circulation while 26(23.6%) didn't. The major cause of arrest was hypoxia which accounts for 47(42.73%), followed by brady-arrhythmia 29(26.36%), and hemorrhage 19(17.27%). Out of patient who doesn't return to spontaneous circulation, the major cause of arrest was pulmonary embolism (PE), which was 26.9% (7). The highest incidence of IOCA, 53.7%, was found among patients less than 1 year of age. Majority of the cardiac arrest happens during induction time (47.3%).

Analytical statistics

In the binary logistic regression analysis, age is statistically significant predictor with (COR=3.56, 95%CI 2.36-5.36, p<0.001) showing, as age decreases the likelihood of the incidence of IOCA increases more than twice. Body mass index (BMI) also shows statistically significant association with (COR=1.37, 95% CI: 1.18-1.60, p<0.001), which means for each unit increase in BMI, the odds of IOCA also increased by 37%. A Mann-Whitney U test was done to compare MET value between patients who had IOCA and the one who don't and there was statistically significant difference between the two groups (U=101025.00, Z= -12.756, p<0.001).

In the binary logistic regression analysis for surgery related factors, the duration of surgery influenced the likelihood of intraoperative cardiac arrest. Patients who had surgical time of <4 hours had nearly 80% less risk than patients who had surgical time of >4 hours with (COR=0.203, CI: 0.13-0.29, p<0.001).

Variables with p-value <0.25 in the bivariate analysis were included in a multivariable regression model to control potential confounders and to identify independent predictors of IOCA. Adjusted odds ratio (AOR) with 95% CI were reported. A p-value <0.05 was considered statistically significant.

The regression progressed includes age, ASA, MET value, asthma, maintenance agent, and surgery time. Results are summarized in Table 4, with detailed interpretation below.

TABLE4: MULTIVARIABLE LOGISTIC REGRESSION TO IDENTIFY FACTORS THAT ARE ASSOCIATED TO IOCA.

Variable	Category	IOCA		COR	AOR	p-value
		Yes	No			
Age	<18 yrs	76(69.1%)	1500(38.6%)	3.56(2.36-5.36)	24.96(9.13-68.2)	<0.01
	≥18yrs	34(30.9%)	2390(61.4%)		1	
Met value	<4	27(24.5%)	3008(77.3%)	0.095 (0.061-0.148)	1	<0.001
	≥4	83(75.5%)	882(22.7%)		0.025(0.013-0.05)	
ASA Physical Status	I&II	78(70.9%)	1285(33%)	0.202(0.133-0.30)	656.4(186.8-2306)	<0.001
	III & IV	32(29.1%)	2605(67%)		1	
Maintenance	Halothane	57(55.9%)	1296(40.9%)	1.80(1.23-2.64)	4.4(2-9.9)	<0.001
	Isoflorane	45(44.1%)	1873(59.1%)		1	
Asthma	Yes	26(23.6%)	146(3.8%)	7.93(4.9-12.6)	9.9(4.3-22.9)	<0.001
	No	84(76.4%)	3744(96.2%)		1	
Surgery time	<4hrs	48(43.6%)	3082(79.2%)	4.93(3.35-7.22)	0.04(0.02-0.09)	<0.001
	>4hrs	62(56.4%)	808(20.8%)		1	

Notes; Sig. = p-value;

Age (AOR=24.96, 95% CI: 9.13-68.2, p<0.001): as age decreased the odds of IOCA increased, this finding aligns with physiological expectations and previous models.

Higher MET values significantly decreased IOCA odds (AOR=0.025, CI: 0.013-0.05 p<0.001) showing that poor functional capacity as a strong risk factor with a near-zero OR, this is also consistent with clinical expectations confirming poor functional capacity as a critical risk factor.

ASA Physical Status (AOR=656.4 CI: 186.8-2306, p<0.001) shows that patients with ASA III & IV had very high odds of having IOCA. Similarly the presence of asthma was also significantly associated to increased incidence of IOCA (AOR=9.9, CI: 4.3-22.9, p<0.001).

Data quality

Sensitivity and specificity was calculated for various outcomes and models. Model fitness was assessed using Hosmer-Lemshow test and NagelkerkeR^2.The model had Nagelkerke R^2 value of 0.59. The Hosmer-Lemeshow test was significant (p<0.001) usually interpreted as poor fit. But, this test is known to be highly sensitive to large sample sizes and in rare event like IOCA it may overestimate the lack of fit. Due to the explanatory power of the model performance, the multivariable model is still valid for identifying the independent predictors in this population. Multi-collinearity was also checked using the Variance Inflation Factor (VIF).

Discussion

This study aimed to identify the incidence and associated risk factors of intraoperative cardiac arrest (IOCA) among patients undergoing elective non-cardiac surgery at selected public hospitals in Addis Ababa, Ethiopia. Understanding this in low- and middle-income countries (LMICs) like Ethiopia is important because surgical techniques and healthcare resources differ significantly from high-income countries (HICs), which potentially will contribute to increased risk of complications such as cardiac arrest (5).

The study found an incidence of IOCA 2.8% (110/4000 patients) with a survival rate of 76.4% among patients undergoing elective non-cardiac procedures under anesthesia. Which means approximately 280 cardiac arrests per 10,000 procedures. This result is considerably higher than highly developed nations which were reported as two to seven out of every 10,000 procedures (8), 3.5 in 10,000 anesthetics in a UK study, 0.03% (3 per 10,000) in another study, and approximately 5.6 per 10,000 cases on a paper from 2021 (11). The high survival rate might be associated with the cause of cardiac arrest, which was hypoxia and most the patients were pediatrics and this aligns with other study that was conducted in 2023, which shows pediatrics patients had high survival rate (20-30%) for hypoxia related cardiac arrest (6, 7).

The study shows, the intraoperative cardiac arrest rate was 6.5% per 1000 surgeries which is lower than the 2.5% per 1000 surgeries reported in 1 year study that was conducted in Togo (14). The 76.4% survival rate is also higher than that of global estimates (35%–46.6%), possibly due to effective resuscitation in simpler procedures or underreporting of outcomes.

The comparatively high incidence observed in this study may show challenges faced by the healthcare system in Ethiopia, including shortages of resources such as operational anesthesia machines, airway equipment, suggested monitoring devices like capnography, and specific emergency medications. These resource limitations, in addition to the varying levels of medical expertise, are mentioned as contributing factors to increased complication risks, including cardiac arrest, particularly during elective non-cardiac surgeries. This also aligns with other studies that was done in Africa (5).

This study also found that the major cause of arrest was hypoxia (42.7%), followed by brady-arrhythmia (26.3%) and (17.27%) being hemorrhage. This contrasts with other studies that showed the most common cause of arrest being major hemorrhage (8).

Different factors showed a significant association with IOCA in the multivariable analysis. From the socio-demographic variables, the multivariable analysis showed that decreased age (pediatrics age) was associated with high odds of IOCA (AOR= 24.96 95% CI; 9.13-68.2). This aligns with other literatures showing that pediatrics age group increases the risk of IOCA secondary to both anatomic and physiologic changes. Which also aligns with literature that was done in a tertiary Hospital showing that age as a major risk factors for cardiac arrests, particularly in LMICs (9, 10).

ASA physical status was also a significant predictor, with ASA III &IV (AOR=670.33, 95% CI: 183.85-2444.05) showing a large odds ratios. The large ORs and wide CI suggest sparse data. Other than this, the association of higher ASA status with IOCA aligns with a literature that was done in the UK, where 73% of the cases who had IOCA were ASA 3–5 (8). It also aligns with other research from southern Ethiopia, which shows ASA status as a significant predictor for intraoperative cardiac complication. The high odds of ASA III&IV may be due to challenges to manage high profile cases in a resource limited set up. In general it shows the high burden of comorbidities in Ethiopia's surgical patients (7).

Lower MET values (poor functional capacity) were found to increase the odds of IOCA in the multivariate analysis (AOR=0.025, 95%CI: 0.013-0.050). This indicates reduced cardiovascular reserve, increases the risk to intraoperative cardiovascular stress, which may lead to IOCA. This aligns with other studies showing that preoperative functional status as a critical risk factor (1, 4). The high prevalence of low MET values (<4) shows the need for standard preoperative screening in Ethiopia, where resource limitations may affect the routine exercise testing.

The presence of asthma also increases the odds of IOCA almost 10 times (AOR= 9.97, 95%CI: 4.33-22.93). This aligns with the physiologic and anatomic effect of asthma, which complicates both ventilation and oxygenation especially on people who are under anesthesia. Similar studies also shows that having comorbidities increases the odds of having IOCA higher. So, this patients required detailed preoperative assessment and optimization (11).

Using Halothane as the maintenance agent significantly increased the odds of having IOCA by nearly 4 times compared to Isoflorane (AOR=4.41, 95%CI: 1.93-10.05) in the multivariate analysis. This aligns with cardiovascular depressant effects of halothane, including myocardial sensitization to catecholamine and high risk for cardiac arrhythmias(12). And given that most of the patients who had IOCA were ASA III & IV, the effect of halothane is profound. This shows the importance of anesthetic drug of choice, which is mentioned as a potential anesthesia-related factor and also shows its risk in Ethiopia, because high cost of Isoflorane and also the resource shortage may limit its access. Otherwise Isoflorane had lower odds of causing IOCA (13).

Compared to surgeries that took less than 4 hours, those had >4hours had decreased odds of IOCA (AOR=0.45, 95% CI: 0.19-0.108). This finding contrasts with the literature suggesting that longer and more complex procedures contribute to increased odds of having IOCA due to high stress and blood loss (1, 3). This finding might be due to sparse data.

Factors that did not show a significant association with IOCA in the bivariate analysis (p-value > 0.05) included blood loss, blood transfusion, and type of surgery, contrasts with some literature that links significant blood loss, blood transfusion, and certain surgical types (like vascular or thoracic) with higher odds of having IOCA (8).

In this paper BMI had inverse association with the incidence of IOCA. This might be due to sparse data or because most of the patients who had cardiac arrest were pediatrics age group.

Strength and limitation

Overall, the study's findings on the incidence of IOCA in this specific Ethiopian setting provide valuable context-specific data that shows a significant gap in literature from LMICs. The identified risk factors are largely align with factors mentioned in the literature review. Also to the best of our knowledge this research is the first to be conducted in Ethiopia.

The study acknowledges several potential limitations due to its retrospective design. These include:

Incomplete chart.

Sparse data issues.

Conclusion and Recommendation

In summary, this study assessed data on incidence and associated factors of IOCA among patients that undergo elective non-cardiac surgeries in three public Hospitals in Addis Ababa, Ethiopia, which was 2.8%. This result is higher than that of HIC. Multivariable analysis identified some independent predictors including younger age, lower MET-values, higher ASA classification (III & IV), and use of halothane as a maintenance agent.

Recommendation

Based on the findings the findings suggests some recommendations for Ethiopia's resource-limited hospitals:

To anesthesia department and

- Routine MET value assessments, standard preoperative examination can identify patients with poor functional capacity and other comorbidities, so as to optimize patients preoperatively.
- Replacing halothane with Isoflorane, it could reduce IOCA risk.
- Improve the intraoperative chart recording practice.

To future researchers

- Conduct prospective, multicenter studies and also include factors such as monitoring practice that may influence the incidence of IOCA.

To policy makers

- Policy advocacy for subsidized safer anesthetics is needed.

ABBREVATIONS/ACRONYMS

ASA- American Society of Anesthesiology

CO- Cardiac output

CPR- Cardio-pulmonary resuscitation

GI- Gastro-intestinal

HIC- High income countries

IOCA- Intraoperative cardiac arrest

LMIC- Low- and medium-income countries

SPHMMC- St. Paul Hospital Millennium Medical College

TASH- Tikur Anbesa Specialized Hospital

UK- United Kingdom

Declaration

Ethics approval and consent to participate

The research was conducted after obtaining ethical clearance from Addis Ababa University College of Health Sciences, Department of Anesthesia, Institutional Review Board with a grant number of Anes/13/2024/2025. The Information Acquired was used only for study purposes, and the privacy of each patient's information was kept confidential.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Competing interests

The authors declare that they have no competing interests

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Authors' contributions

HA: Conceptualization, methodology, formal analysis, software, investigation, data curation, visualization, writing-original draft WA: Methodology, Conceptualization, Validation, Supervision, writing-reviewing and editing. FF: Conceptualization, Supervision, writing-reviewing, supervision. All authors have read and approved the final manuscript.

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