COLLEGE OF HEALTH SCIENCE SCHOOL OF MEDICINE

INCIDENCE AND ASSOCIATED FACTORS OF EARLY POSTOPERATIVE HYPOXIA AMONG PATIENTS UNDERGOING ELECTIVE SURGERY AT TIKUR ANBESSA SPECIALIZED HOSPITAL, ADDIS ABABA, ETHIOPIA

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A Research

Presented To

The School Of Medicine

College Of Health Science

In Partial Fulfillment

Of The Requirement for Specialty Certificate in Anesthesiology

Educational Research and Ethical Standards

By

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Incidence and associated factors of early postoperative hypoxia in patients undergoing elective surgery in Tikur Anbesa specialized hospital, Addis Ababa, Ethiopia.

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APPROVED BY THE BOARD OF EXAMINATION

The thesis here, entitled "incidence and associated factors of early postoperative hypoxia among adult patients undergoing elective surgery in Tikur Anbesa specialized hospital, Addis Ababa, Ethiopia" is accepted in its present form by the board of examiners as partial fulfillment of the requirement for specialty certificate In Anesthesiology, Critical Care and pain Medicine.

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STATEMENT OF DECLARATION

I hereby declare and affirm that this research is my own original work as a partial fulfillment of the requirements for the specialty certificate training in Anesthesiology. I have followed all the ethical considerations in the preparation, data collection, data analysis and completion of this research. All the sources of the materials used for this research and all people and institutions who gave support for this work are fully acknowledged. I affirm that I have cited and referenced all the sources used in this document.

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ABBREVIATIONS

AAU-Addis Ababa University

ASA -American Society of Anesthesiologists

BMI-Body Mass Index

OR-Operating Room

PACU-Post Anesthesia Care Unit

SPSS- Statistical Package for Social Sciences

TASH-Tikur Anbesa Specialized Hospital

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ABSTRACT

Background

Hypoxia refers to insufficient oxygen in the blood. Any cause that influences the rate, volume of air entering the lungs (ventilation) or any cause that influences the transfer of air from the lungs to the blood may cause hypoxia. Hypoxia is a major complication in the post-anesthesia care unit (PACU) which is also the leading cause of anesthesia-associated mortality and morbidity. And there are few studies done to determine incidence and associated factors of early postoperative hypoxa in our country for which this study will be additional input in understanding the burden of the problem and its associated factors.

Objectives

To assess the incidence of early postoperative hypoxia and associated risk factors.

Methods

Institutional-based prospective observational study design was conducted from January 2022 – March 2023. A single population formula was used to estimate the sample size .Data was collected by anesthesiology residents and anesthetists preoperative and intraoperatively and by PACU nurses postoperatively. The collected data was verified, entered coded cleaned and analyzed using SPSS version 25 software. Multiple regression was applied to identify the determinant factors and association declared at p value<0.05.

Result: The incidence of early postoperative hypoxia is found to be 32%. Participant whose age ≥50 years (AOR=2.4, 95%CI=1.22, 4.83), BMI 25-24.9 and 30-39.9 (AOR=7.5, AOR=1.78, 31.29 & AOR=15.8, 95%CI=2.90, 86.31 respectively), anesthesia duration taking more than 2 hrs (AOR=4.3, 95%CI=2.04, 9.24) and estimated blood loss >500ml (AOR=5.2, 9%CI=2.04, 13.46) likely of develop early postoperative hypoxia.

Conclusion and recommendation: The incidence of early postoperative hypoxia is significant and knowing the magnitude and paying attention to relevant predictive factors will help the clinician make better clinical decisions to ensure patient safety and postoperative recovery

1. INTRODUCTION

1.1 Background

Hypoxia refers to insufficient oxygen in the blood. Any cause that influences the rate, volume of air entering the lungs (ventilation) or any cause that influences the transfer of air from the lungs to the blood may cause hypoxia. As well as these respiratory causes, cardiovascular causes such as shunts may also result in hypoxemia. The most common causes of hypoxia are ventilation-perfusion mismatch, hypoventilation, and shunts (1). On an average, the normal oxygen levels in our blood stream between 80 and 100 mm Hg. In people suffering from hypoxia, this falls down to as low as 60 mm Hg. Normal pulse oximeter readings can range from 95 to 100% (2)During anesthesia and recovery from anesthesia the oxygen saturation should always be 95-100%. If the oxygen saturation is 94% or lower, the patient is hypoxic and needs to be treated, even mild hypoxemia can cause neurological damage, acute severe hypoxia may cause a sudden loss of consciousness. Monitoring pulse oxygen saturation (SpO2) enables anesthesiologists to better detect hypoxia and hypoxia-related events; despite of this, the overall incidence of hypoxia remains largely unchanged.(3)

Many perioperative factors may induce the development and progression of hypoxia, such as preoperative underlying diseases, surgical injury, anesthetics, and postoperative respiratory events(2)

1.2 Statement of the problem

Hypoxia in postoperative period is an important complication, and its incidence has been quoted as high as 55% in literature from the 1990s (4)which decreased to 28% by 2012 (5) (10). In our country incidence of hypoxia reported between 24% and 45% with patient's age, BMI ,preoperative oxygen saturation, type of anesthetic, level of pain, and postoperative muscular strength being the major risk factors(11)(12)Hypoxia can have potential deleterious effects, such

as cardiovascular morbidities (6)mental confusion , delirium , postoperative wound and even mild hypoxia can cause neurological (7)

1.3 Significance of the study

At present, it is difficult to detect hypoxia early, and most cases of hypoxia are not detected or treated in a timely manner(13). Thus, attention must be paid to monitoring hypoxia in PACU, identifying patients at risk for hypoxia, and keeping risk stratification methods up to date.

A saturation of less than 90% is a clinical emergency in postoperative patients; the acceptable lower limit for PaO2 varies with individual patient characteristics. A PaO2 below 65 to 70 mm Hg causes significant hemoglobin desaturation, although tissue oxygen delivery might be maintained at lower levels. Maintaining Pao2 between 80 and 100 mm Hg (saturation 93 to 97%) ensures adequate oxygen availability to the tissue.(14) So determining the incidence, early detection, determining risk factors and timely treatment of hypoxia plays a key role in reducing hypoxia-induced serious complications. And there are few studies done on this topic in our country and none at our hospital for which this study will be additional input in understanding the burden of the problem and its associated factors.

2.LITERATURE REVIEW

Russell and associates studied 100 patients who were transferred to the PACU breathing room air before receiving at least 40% oxygen by aerosol face tent in the unit. All patients had an Sao2 greater than 97% before the 2-minute transport to the PACU. Fifteen percent of patients experienced transient desaturation on arrival in the PACU (<92% saturation for >30 seconds). This immediate desaturation correlated positively with patient age, body weight, ASA classification, general anesthesia, and increased volume of intravenous fluid greater than 1500 mL. An even larger percentage of patients (25%) desaturated 30 to 50 minutes later in their PACU stay despite prophylactic oxygen administration. These later desaturations were more severe (71%-91%) and lasted longer (5.8 ± 12.6 minutes) than those that occurred on admission. Additional correlating factors included duration of anesthesia and female gender.(8)

Institution based prospective study conducted in US Colorado reported incidence of hypoxia up to third day postoperatively to be 24.9%. Patients who were older, those who had respiratory and other comorbidities, underwent longer surgeries, received greater opioid doses on the day of surgery and postoperative day 1, and those who received more continuous pulse oximetry monitoring have higher incidence(13)

A prospective observational study conducted in India on 452 patients, 61 developed SpO2 ≤94% requiring oxygen therapy (13.5%). Oxygen therapy by face mask was required in 51 patients, BiPAP in 8 and ventilatory support with endotracheal intubation in 2. Age, body mass index (BMI), smoking status, presence of preoperative respiratory disease, SPO2 (on room air) at baseline and immediately after the transfer to the post-anesthesia care unit (PACU) were independently associated with postoperative oxygen therapy and desaturation(3)

A 2 year retrospective matched cohort study conducted to assess respiratory adverse events in PACU showed hypoxia as the commonest respiratory adverse event with incidence of 55.7%(15)

A study done in Thailand presented that obesity, epidural analgesia, and subcostal incision are risk factors for postoperative oxygen desaturation. Similarly, Xue FS et al. showed that severe hypoxia is highly associated with thoracoabdominal surgeries(13)

The retrospective cohort assessed 14604 postoperative patients who were admitted to PACU between January 2015 and December 2015. A pulse oximeter was used to monitor and record pulse oxygen saturation (SpO2) every 5 minutes. Clinical data were collected for all these

patients, and the incidence of and risk factors for postoperative hypoxemia were analyzed. The total incidence of hypoxemia was 21.83% (SpO2 ≤ 95%) and 2.79% (SpO2 ≤ 90%). And the risk factors were age ≥50-year old, body mass index (BMI) ≥25kg/m2, American Society of Anesthesiologists (ASA) II and III, limb surgery, and thoracic surgery(7)

A study conducted in Colombia, over 365 patients were included. Median age was 49 years (interquartile range 36-63 years), half of them were women (55.3%), and 7.4% had lung disease. Of the total number of patients, 60 developed early postoperative hypoxia, for an incidence of 16%. Age, a history of obstructive sleep apnea syndrome (OSAS), and anesthesia time were statistically significant associated factors. The type of anesthesia, the type of surgery, and the surgical site were not significant associated factors (9)

Observational quality assurance study done in Canada of 502 patients admitted to the PACU, breathing room air during transport was the single most significant factor to correlate with hypoxemia (SaO2 <90%) on arrival. Other significant factors included elevated body mass index (BMI), sedation of 2 to 3 score, and respiratory rate<10. When these observations were adjusted by supplementation with oxygen, no risk factors remained significant.(16)

A retrospective study conducted on 1156 patients in japan in 2015 to identify incidence of postoperative desaturation and bradypnea after general anesthesia found incidence of desaturation to be 12.1% and age ,BMI current smoking status and postoperative opioid administration significantly associated with postoperative desaturation.(17)

A study conducted to determine nurse understaffing and adverse events in PACU found two hundred eighty-one (12.7%) patients manifested at least one episode of hypoxemia, and 307 hypoxemia episodes were totally detected. Hypoxemia was more common in patients who had received general anesthesia (15.3% vs. 0.8%, $p < 0.001$), and had pre-existing respiratory disease (17.1% vs. 11.8%, $p = 0.005$). Unadjusted and adjusted ORs for hypoxemia were significantly higher in the high understaffing group compared with the sufficient staffing group. Hypoxemia episodes manifested by high understaffing group patients were of significantly higher severity compared with those manifested by sufficient staffing group ones(18)

A single prospective observational study conducted at Debra tabor Ethiopia on early postoperative hypoxemia was found to be in 149 patients(45.8%). In this study, obesity was significantly associated with postoperative hypoxemia. Patients who had a BMI of 25-29.9

kg/m2 were 2.6 times more likely to develop postoperative hypoxemia than normal patients (AOR = 2.588, 95% CI: 1.269, 5.276)(14)

Another research done in Dessie showed the incidence of postoperative hypoxemia is 24.5% (n = 73). The study was conducted from March to June on 298 patients. The patient's age, preoperative oxygen saturation, type of anesthetic, level of pain, and postoperative muscular strength were all independent risk factors for postoperative hypoxemia in this study. Preoperative patients hemodynamic status is the main factor for postoperative hypoxia among those a patient who had a preoperative SPO2 below 95% had four times a chance of developing postoperative hypoxia. General anesthesia was the main predictor for postoperative hypoxemia in this study. Patients who had mild pain scores and no pain had 82% and 88% less likely to develop postoperative hypoxia respectively when compared a patient who had severe pain. Another finding is postoperative muscular strength was highly associated with postoperative hypoxemia with an AOR of 0.39 (0.193, 0.796)(12)

2.1 Conceptual frame work

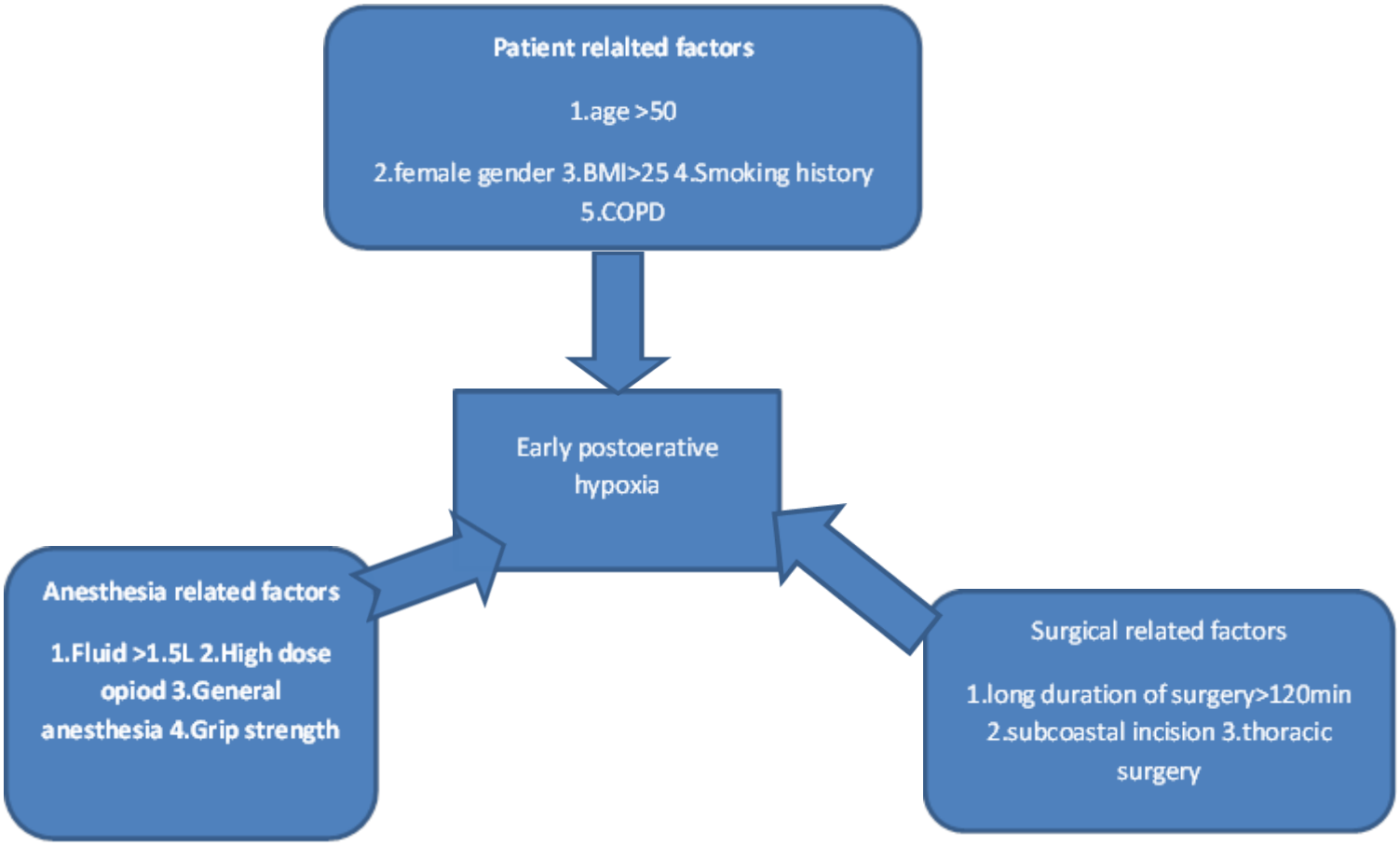

Figure 1. The conceptual frame work adopted from the literature by the author.

3. OBJECTIVE OF THE STUDY

3.1 General Objective

To assess the incidence of early postoperative hypoxia and associated factors among patients undergoing elective surgery at TASH, Addis Abeba, Ethiopia

3.2 Specific Objectives

To assess incidence of early postoperative hypoxia

To assess associated factors with early postoperative hypoxia

4.0 METHODS

4.1 Study Design

A single-center observational prospective survey

4.2 Study Setting and Period

The study was conducted at Tikur Anbessa specialized hospital Addis Ababa, Ethiopia.

It is located in the Central part of Addis Ababa city Administration, the capital of Ethiopia.

Tikur Anbessa specialized hospital is a tertiary hospital that gives services for referral cases from other specialized referral hospitals throughout the country. It has 12 elective surgery operating rooms and 3 post anesthesia care units and the largest having 4 functional beds. An average of 400 elective surgeries are conducted per month .

The study will be conducted from January 2022 to March 2023.

4.3 Population

4. 3.1 Source Population

All patients who undergone elective surgery at Tikur Anbessa specialized hospital during the study period

4.3.2 Study Population

All patients who had undergone elective surgery that fulfilled inclusion criteria during the study period

4.4 Inclusion and Exclusion Criteria

4.4.1 Inclusion criteria

Patients undergone elective surgery age >18 years and available during the study period

4.4.2 Exclusion Criteria

Patients transferred directly to ICU and ward from operating tables

4.5 Sample Size

The actual sample size for the study was determined by using the single population proportion formula for single proportion population considering the following assumption that the

incidence of early postoperative hypoxemia underwent surgery is 24.5% according to a research taken done Dessie,Ethiopia(12)

$$n = \frac{z^2_{1-\frac{\alpha}{2}} \times p \times (1-p)}{d^2}$$

Where:

n= Initial estimated sample size

Z = Confidence level (alpha, α), 1.96

P = prevalence from previous study (0.24)

d= marginal error (0.05)

N= $(1.96)^2$* 0.24*0.76/ $(0.05)^2$ = 280

Adding 10% non-response rate the final sample size = 308

4.6 Sampling Method

All consecutive patients during the study period until sample size attained

4.7 Study Variable

4.7.1 Dependent Variable

Early postoperative hypoxia

4.7.2 Independent Variables

Age, Sex, Type of surgery, ASA class, BMI, comorbidities , duration of surgery, duration and type anesthesia, type of nerve block, estimated blood loss, amount of crystalloid given ,type and dose of drugs given ,hemoglobin level ,oxygen therapy, shivering, residual neuromuscular blocker drugs

4.8 Operational Definition

Early postoperative hypoxemia: the appearance of hypoxemia (SpO2 <90%) at arrival up to 20min postoperatively in the PACU

Elective surgery: a procedure that is scheduled in advance because it does not involve a medical emergency.

Grip Strength: a measure of muscular strength to monitor residual neuromuscular blockade, clinically muscular strength score (1 = keeps grip for >15 seconds and 0 = does not keep grip or keeps it for less than 15 seconds)(19)

4.9 Data Collection Procedure

Preoperative and intraoperative data was collected by pretested questionnaire prepared by English language by document review, direct patient observation, and measurement of oxygen saturation by pulse oximetry by anesthesiology residents and anesthetists. For patients who received general anesthesia reversal of muscle blockage which is done with reversal agents was checked by grip strength. Patients were checked whether they respond to command after the completion of the surgery. Peripheral arterial oxygen saturation measurement with pulse oximetery was started immediately when the patient was transferred to the PACU then measured continuously up to 20min and any episode of hypoxia or the lowest oxygen saturation in between was recorded every 5 min .Data was collected post-operatively by reviewing the charts with a structured questionnaire which includes age, sex, physical status, type of surgery, history of co-morbidities, and their post-operative events and outcomes was recorded carefully by PACU nurses.

4.10 Data Analysis Procedure

The quality of data was maintained by checking the consistency, clarity, and completeness of the anesthetic sheet, individual patient chart and the principal investigator was supervising and checking the completeness of the data daily .The data was entered cleaned coded and analyzed by SPSS 25.00 version statistical software. . Binary logistic regression was used to identify an association between the dependent and independent variables. Variables with a p-value < 0.2 on binary logistic regression analysis were subjected to logistic multivariable regression analysis. The variables which have an independent association with poor outcomes were identified and reported with OR, with 95% CI and a p-value less than 0.05. Finally, the level of significance was declared at a p-value of less than 0.05.

4.11 Data Quality Assurance

The data collectors were trained before data collection and there were daily meetings during data collection to clear up if there is any ambiguity during data collection. Data was cleaned on daily basis.

4.12 Ethical Statement

The data collection was carried out after securing an ethical clearance from the ethical review committee of department of anesthesiology and critical care. Written consent was taken from the patients before going to the operating room. Data anonymity was maintained by avoiding patient identifiers in the data extraction process.

5. RESULTS

5.1 Socio demographic characteristics and background data of the study participants

In this study 304 participants were involved making a response rate of 98.7%. Half (50.7%) of the participants were female and 55.7% of the participants were age<50 years old with mean and SD of 45.4±15.1. Almost fifty six percent of the participants had a body mass index of 18.5-24.9kg/m^2 and 43.4% of the participants were ASA class one. 46.7% of the participants had coexisting disease and 14.1% of the participants are smokers and 35.5 and 9.5% of the participants had mild and moderate anemia respectively.

Table 1. The sociodemographic characteristics and background data of the study participants who undergo elective surgical procedure in TASH, Addis Ababa.

Variable	Frequency	Percent
Sex of the study participants		
Male	150	49.3
Female	154	50.7
Age in years		
<50	168	55.3
≥50	136	44.7
Body mass index		
<18.5	34	11.2
18.5-24.9	170	55.9
25-29.9	82	27.0
30-39.9	18	5.9
ASA class		
One	132	43.4
Two	117	38.5
Three	55	18.1
History of smoking		

No	261	85.9
Yes	43	14.1
Coexisting disease		
No	162	53.3
Yes	142	46.7
Hemoglobin		
7-9	29	9.5
9.1-13	108	35.5
>13	167	54.9

5.2 The List of coexisting disease other than the surgical indication

The finding showed that major coexisting disease were hypertension followed by DM, heart disease, HIV and COPD.

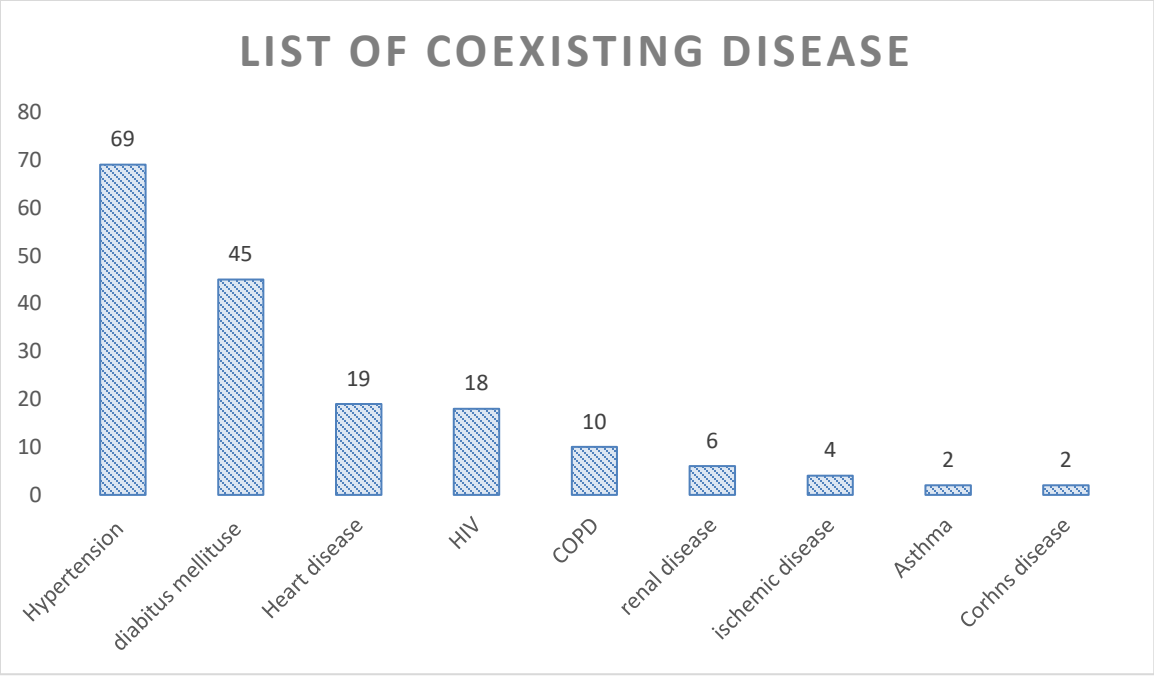

Figure 2. The List of coexisting disease other than the surgery indication

5.3 Pre and Intraoperative characteristics of the study participants

Ninety six percent of the participants had preoperative oxygen saturation above 90% and 2/3rd of the participants took general anesthesia and 16.4% procedure were in gastrointestinal followed by hepatobiliary, urology, gynecology and thoracic. Forty four percent of the surgery duration and 64.5% of the anesthesia duration took more than two hours. More than eighty seven percent of the study participants bleed less than 500ml and 7.2% of the participants needed blood transfusion as shown in table 2. below

Table 2. Pre and Intraoperative characteristics of the study participants

Variable	Frequency	Percent
Preoperative Pso_2		
<90	12	4
≥90	292	96
Anesthesia		
General anesthesia	212	69.7
Regional anesthesia	82	27.0
Sedation	10	3.3
Procedure		
Thoracic	33	10.9
Urology	49	16.1
Vascular	18	5.9
Neurologic	21	6.9
Hepatobiliary	46	15.1
GI	50	16.4
Gynecologic	28	9.2
Orthopedic	9	3.0
Obstetric	27	8.9
ENT	11	3.6

Others	12	3.9
Site of incision		
Thorax	33	10.9
Upper abdomen	70	23.0
Lower abdomen	142	46.7
Lower extremity	2	.7
Ear ,nose and throat	10	3.3
Lower extremities	11	3.6
Bronchoscopy	2	.7
Cervical	2	.7
Cystoscopy	8	2.6
Other sp	22	7.2
Scalp	21	7
Duration of surgery		
<120 min	169	55.6
≥120min	135	44.4
Duration of anesthesia		
<120 min	108	35.5
≥120min	196	64.5
Estimated blood loss in ml		
<500	265	87.2
>500	39	12.8
Intraoperative blood transfusion		
yes	22	7.2
no	272	92.7
Crystalloid		
<500	121	44.3
500-1000	84	30.8

1000-1500	42	15.4
>1500	26	9.5

5.5 The specific types of nerve block

Majority of the nerve block were tap block followed by, rectus sheath, epidural, field block femoral nerve and plane block.

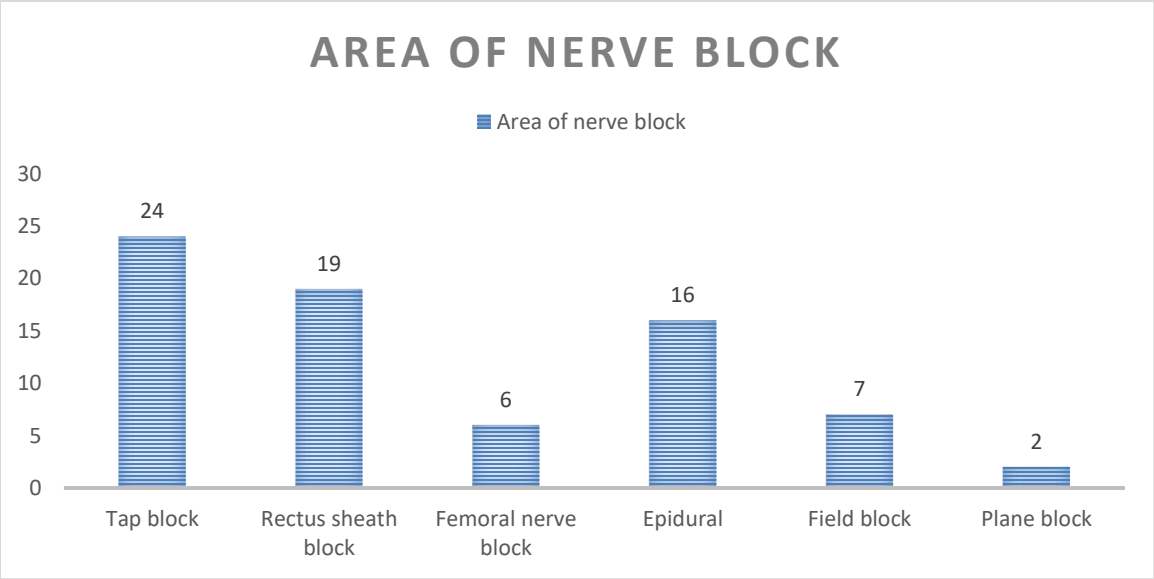

Figure 3. The specific types of nerve block

5.6 The type and dose of drugs given for the participants

53.9% and 44.7% of the participants took fentanyl and morphine respectively to as intraoperative analgesia. Propofol and ketamine were the sole induction agents and isoflurane and halothane were the most frequently used maintenance agents as shown in the table below.

Table 3. The characteristics of the drugs and its dose given for the participants

Drugs	Min dose	Max dose	Mean dose	Number of participants
Analgesic type and total dose				

Morphine	2mg	10mg	5.4mg	136
Fentanyl	50mcg	200mcg	88.56mcg	164
Tramadol	50mg	100mg	81.1mg	10
Pethidine	50mg	100mg	66.6mg	9
Induction Agents and dose in mgs				
Propofol	60	200	123.0	187
Ketamine	20	50	35.4	120
Maintenance agent and doses in MAC				
Halothane	1	1	1	10
Isoflurane	0.7	12	1	178
Intraoperative muscle relaxant and doses in mg				
Vecuronium	4	12	7.2	188
Succinylcholine	75	150	112	28

5.7 Postoperative oxygen saturation and other characteristics

The finding of the study showed that, 32% of the study participants developed hypoxia in the PACU

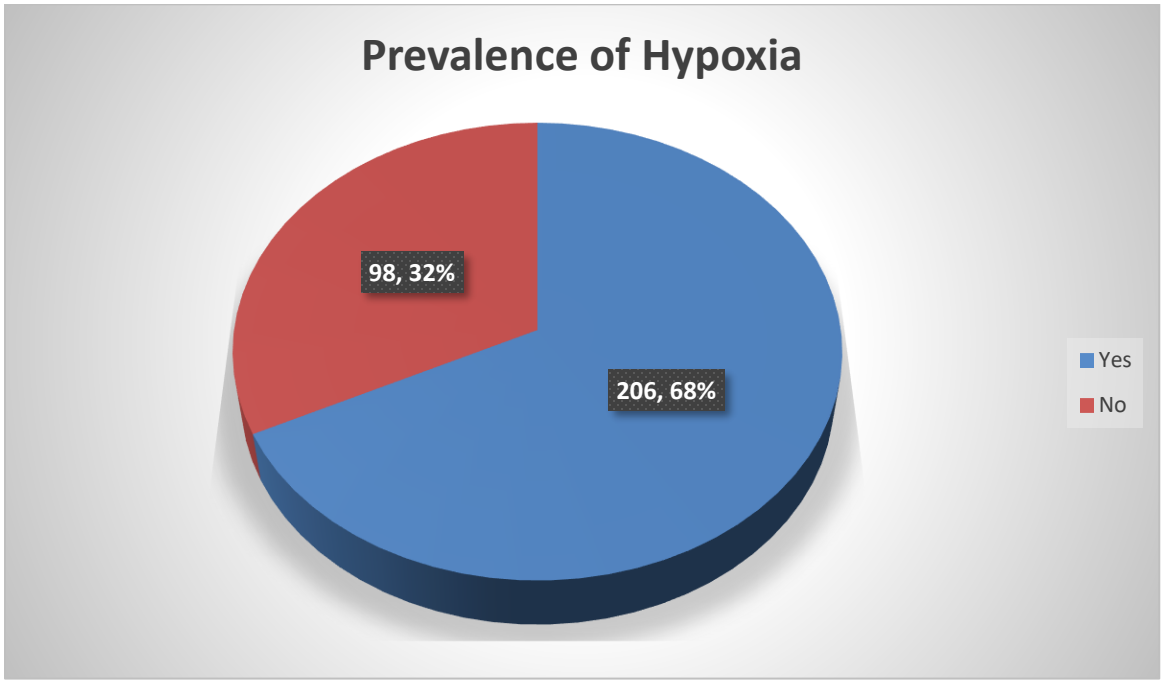

Figure 4. The prevalence of hypoxia among immediate postoperative patient

The finding showed that, 8.9%, 16.1%, 16.1%, 6.3and 6.3% developed hypoxia on arrival, after five minutes, between five and ten minutes, between ten and fifteen minute and between fifteen and twenty minutes of admission to PACU with most of them developing hypoxia in the first 10 minutes after admission to PACU. 8.2% were not obeying command and 15.2% had shivering as shown the table below

Table 4. Postoperative characteristics of the study participants

Variable	frequency	Percent
Oxygen supplementation during Transport to PACU		
Yes	0	0
No	304	100
Oxygen supplementation At arrival to PACU		
Yes	72	23.7
No	232	76.3

Level Oxygen saturation		
Immediately on arrival		
≥90	277	91.1
<90	27	8.9
After five minutes		
≥90	255	83.9
<90	49	16.1
After ten minutes		
≥90	285	93.8
<90	49	16.1
After fifteen minutes		
≥90	285	93.8
<90	19	6.3
After twenty minutes		
≥90	255	83.9
<90	19	6.3
Level of pulse of the study participants		
Pulse on arrival		
60-89	116	38.2
≥90	188	6.3
Pulse on five minutes		
60-89	185	60.9
≥90	119	39.1
Pulse on ten minutes		
60-89	187	61.5
≥90	117	38.5
Pulse on fifteen minutes		
60-89	216	71.1
≥90	88	28.9
Pulse twenty minutes		
60-89	172	56.6
≥90	132	43.4
Oxygen therapy		
INO2	67	22
FMNO2	51	17%
None	201	66
Shivering		
yes	47	15.5
no	257	84.5
Grip strength		

Zero	16	5.3
One	288	94.7

5.8 The determinant factor that affects the occurrence of hypoxia

The strength of association between independent and outcome variable (hypoxia) measured by using odds ratio and 95% confidence interval. Sex, age, BMI, ASA class, smoking cigarrete, coexisting disease, hemoglobin level, duration of anesthesia and EBL were associated with hypoxia by bivariate logistic regression.

The multivariate logistic regression revealed that, participant whose age ≥50 years had 2.4 fold increased risk of being hypoxic than age <50 years (AOR=2.4, 95%CI=1.22, 4.83) and participant whose BMI 25-24.9 and 30-39.9 had 7.5 and 15.8 folds increased likelihood of being hypoxic when compared to BMI of <18.5 (AOR=7.5, AOR=1.78, 31.29 & AOR=15.8, 95%CI=2.90, 86.31 respectively).

Participants who were smoking and had coexisting illnesses are 1.9 and 1.6 folds likely to develop hypoxia than their compartment. Participants who took anesthesia for more than 2 hours had 4.3 folds more likely being hypoxic than those less than 2hrs. (AOR=4.3, 95%CI=2.04, 9.24)Participant whose estimated blood loss was more than 500ml were 5.2 folds likely of developing hypoxia than EBL of less than 500ml (AOR=5.2, 9%CI=2.04, 13.46).

Table 5. The bivariate and multivariate logistic regression of association between independent and hypoxia among postoperative patients in TASH Addis Ababa, Ethiopia.

Variable	**Hypoxia**		**p-value**	**COR with 95%CI**	**p-value**	**AOR with 95%CI**
	yes	no				
Sex of the study participants						
Male	63	87	0.000	**2.5(1.49, 4.05)**	0.217	1.5(0.78, 2.95)
Female	35	119	1		1	
Age of the study participants						

<50	43	125	1		1	
≥50	55	81	0.006	1.9(1.21, 3.21)	0.012	**2.4(1.22, 4.83)**
BMI						
<18.5	6	28	1		1	
18.5-24.9	44	126	0.312	1.6(0.633, 4.19)	0.057	3.7(0.96, 13.99)
25-39.9	36	46	0.10	3.6(1.36, 9.77)	0.006	**7.5(1.78, 31.29)**
30-39.9	12	6	0.001	**9.3(2.49, 34.88)**	0.001	**15.8(2.90, 86.31)**
ASA class						
One	33	99	1		1	
Two	44	73	0.033	**1.8(1.05, 3.11)**	0.138	1.8(0.82, 4.18
Three	21	34	0.072	1.8(0.95, 3.63)	0.120	2.0(0.84, 4.81)
Smoking history						
No	77	184	1			
Yes	21	22	0.014	**2.3(1.18, 4.39)**	0.049	**1.9(1.41, 2.49)**
Coexisting disease						
No	43	119	1		1	
Yes	55	87	0.024	**1.7(1.08, 2.84)**	0.046	**1.6(1.49, 2.19)**
Hemoglobin						
7-9	15	14	0.029	**2.4(1.09, 5.42)**	0.053	2.6(0.98, 6.86
9-13	32	76	0.873	0.96(0.57, 1.62)	0.562	1.2(0.63, 2.32)
>13	51	116	1		1	
Types of anesthesia						

GA	66	146	1		1	
RA	26	56	0.924	1.1(0.59, 1.78)	0.409	1.4(0.62, 3.23)
Sedation	6	4	0.070	3.3(0.91, 12.51)	0.15	5.6(0.24, 25.11)
Duration of anethesia						
<120min	41	128	1		1	
≥120min	57	78	0.001	**2.3(1.39, 3.73)**	0.000	**4.3(2.04, 9.24)**
Estimated blood loss in ml						
<500	78	187	0.203	4.8(0.43, 53.65)	0.517	2.3(0.18, 29.89)
>500	20	19	0.015	**2.4(1.19, 4.85)**	0.001	**5.2(2.04, 13.46)**

6. DISSCUSION

Our study indicates the incidence and risk factors for postoperative hypoxia in the immediate postoperative period in the PACU. Most hypoxemic events occur during the 10 minutes following patients' admission to PACU consistent with the study done in brazil(10). Postanesthetic hypoxemia is related to a higher incidence of complications during the immediate postoperative period, longer PACU stay and increase in unplanned ICU admissions.(20)

Hence, it is important to clarify incidence and risk factors for desaturation. The incidence of hypoxia spo2 <90% with the 20 minute of arrival to PACU in our study was only 32% , Dunham et al. studied the magnitude of post-operative hypoxemia to be (30%)(21) similar to our study and its incidence has been quoted as high as 55% in literature from the 1990s (4)which decreased to 28% by 2012 (5). In our country also its incidence were reported as 45.8% in Debre tabor(11) and 24.5% in Dessie(12) .

In contrary to our finding studies showed a lower incidence of early postoperative hypoxemia such as studies conducted in Japan by Ishikawa et al. (17)(12.7%), a study done in Brazil by Filho et al.(10) (24.1%), and a study in the USA by Ramachandran et al..7-22%(2) despite we followed patients for a short period of time . This discrepancy might be due to a variation in study settings where the above developed countries may have a better perioperative patient care as compared to the developing ones like Ethiopia and none of our patient received oxygen supplementation during transport to PACU which has been shown as single important factor for the incidence of postoperative hypoxia Russell and associates. (8)

In our study participant whose age ≥50 years , BMI 25-24.9 and 30-39.9 .Smoking and presence of coexisting disease ,longer anesthesia of more than 2 hrs and intraoperative blood loss of more than 500ml has been significantly associated with postoperative hypoxia.

The risk of hypoxemia varies a great deal with age. This study showed that age was a sensitive indicator for predicting the risk of hypoxemia especially in elderly patients over 50-year-old showed particularly prone to hypoxia. Elderly patients were susceptible to hypoxemia(20)(22).

This reasons may be that elderly patients are more likely than younger patients to have residual postoperative muscle relaxation,(23) which affects the hypoxic ventilatory response and respiratory muscle strength, increasing the risk of airway obstruction and hypoxemia. Moreover, respiratory reserve decreases with age for elderly patients; low lung capacity, high residual volume, low ventilatory efficiency, low blood vessel elasticity, and low lung perfusion lead to an imbalance in the pulmonary ventilation/blood flow ratio, further increasing the risk of hypoxemia in cases with surgical and anesthesia stress.(24)

The study also, revealed that participant BMI were a statistically significant factor. Having a BMI 25-24.9 and 30-39.9 had 7.5 and 15.8 folds increase their hypoxic when compared to BMI of <18.5 respectively. This was may be due to overweight/obese patient are prone to desaturate rapidly due to attribution of decrease oxygen reserve (decreased functional residual capacity), increased oxygen consumption and increase pulmonary resistance and airway obstruction. This finding was supported by the study findings of Debre Tabor(11) ,Canada(25), India and China.

Various studies in literature have found smoking to be one of the major and most important risk factor for postoperative hypoxia. Most of the studies have identified current smokers to have an increased risk (26)(27)(28), smokers may have varying degrees of undetected pulmonary disease. Niewoehner et al. showed that in a group of young otherwise healthy cigarette smokers there was evidence of bronchiolitis and pathologic changes in the small distal airways consistent with early prodromal COPD. Pulmonary function tests also reveal that smokers have smaller forced expiratory volumes, reduced functional residual capacities (FRC) and lower diffusion capacities compared to non-smokers. In addition, cigarette smokers have increased airway resistance and greater closing capacities (CC). Cigarette smokers also demonstrate elevated levels of carboxyhaemoglobin in the blood which can result in a decrease in the amount of haemoglobin available for combination with oxygen and a shift in the oxygen dissociation curve to the left.(29)

Anesthesia time is directly related with the incidence of hypoxemia, as described by Smith and Crul (30)in 1988, Denise et al(31) in 1991, Dunham et al in 2014(21) and a study in Colombia 2018(28). Anesthesia time lasting longer is associated with a higher incidence of early

postoperative hypoxia. A possible cause may be the progressive development of abnormal ventilation/ perfusion ratios and atelectasis..

A new and interesting finding in our study is patients with estimated blood loss of more than 500ml are likely to develop postoperative hypoxia and the most plausible explanation is the decreased delivery of oxygen to the peripheral tissue with increased blood loss and subsequently resulting in oxygen desaturation.

Preoperative oxygen saturation, type of anesthesia, type of surgery and incision site, the type and dose of drugs used has not been shown to be statistically significantly associated with early postoperative hypoxia.

7. THE STRENGTH AND LIMITAION

7.1. Limitation of the study

This study was observational so doesn't describe the causal relationship between the primary outcome and the risk factors and single center study. Follow up of patients were done for a short period of time postoperatively which may affect results if patients were followed a longer period as described in various literatures despite of this incidence of hypoxia found to be very high and did not follow hypoxemic patients after being discharged from PACU and also excludes patients that are transferred to ICU. The study didn't follow these patients who developed hypoxia for long time to reach at secondary complications that accompany hypoxia.

7.2. Strength of the study

The finding of the study revealed that, the incidence of hypoxia was significant. This study enabled to find new risk factor for the development of hypoxia and adding new knowledge to the existing body of literature and representative of various group of patients with varying comorbid conditions and with different surgical procedures.

8. CONCLUSION AND RECOMMENDATION

8.1 Conclusion

The study noted that there was a high incidence of postoperative hypoxemia (32%) among surgical patients and the determinant factor affecting the incidence of hypoxia were age ≥50 years, BMI 25-24.9 and 30-39.9, smoking, longer duration of anesthesia more than 2 hours, estimated blood loss of more than 500ml were a statistically significant factors.

8.2. Recommendation

The prevalence of hypoxia in this study was significantly palpable. I believe that clinicians should carefully monitor at-risk patients before, during, and after operation and pay attention to relevant predictive factors because early postoperative in PACU is independently associated with increased risk of early postoperative respiratory complications(2) and will help the clinician make better clinical decisions to ensure patient safety and postoperative recovery.

Policy makers to pay special attention to equipment needed for monitoring and management in PACU considering the higher incidence of hypoxia

Also I recommend further study to be done to determine incidence of hypoxia in pediatric age group, patients transferred to ICU, emergency procedures and secondary complications that accompany postoperative hypoxia.

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10, ANNEXES

10.1 Annex 1

Subject information sheet

Addis Ababa University

School of medicine

Subject information sheet

Hello, my name is ----------, I am here on behalf of Dr. Zelalem Getnet, a year three Resident in Anesthesiology Critical care and Pain Medicine, School of medicine, Addis Ababa University. He is conducting research on, Assessment of prevalence of early postoperative hypoxia and associated factors at Addis Ababa University, college of health sciences, TASH". He has received permission from Addis Ababa University School of medicine and Tikur Anbessa Specialized Hospital officials to conduct the study.

You are selected to participate in this study because you got surgery and anesthesia service at this hospital, your participation in this study will only be based on your willingness to participate. You have the right to choose not to take part in this study. If you are willing, you have the right to stop at any time or withdraw without giving any reason and you will not be subjected to any ill-treatment. There will be no direct benefit from participating in this study but in the future information gathered by this study will help the hospital, policymakers, programmers, and researchers to give appropriate attention to issues of interest and design specific treatment options.

The information that you provide will be kept confidential by using only code numbers and locking the data. Only the members of the study team will have the access to the non-coded data and the data will not be used for purposes other than the study. Your willingness and active participation are very important for the success of this study. If you need any further information or explanation regarding the study, you can have this address to contact. Name: Dr. Zelalem Getnet Tel- +251-973653664 Email- zoolaget@gmail.com

10.2 Annex 2

Informed consent form

Consent Form

RISKS There is no anticipated risk to you if you participated in this study.

BENEFITS You will be contributing to the improvement of surgery anesthesia services in the hospital and Ethiopia as a whole.

CONFIDENTIALITY

Every effort will be made by the researcher to preserve your confidentiality including the following by assigning code names/numbers for participants that will be used on all research notes and documents.

CONTACT INFORMATION

If you have questions at any time about this study, you may contact the researcher whose contact information is provided above.

VOLUNTARY PARTICIPATION

Your participation in this study is voluntary. If you decide to take part in this study, you will be asked to sign a consent form. After you sign the consent form, you are still free to withdraw.

CONSENT

I have read and understand the provided information and have had the opportunity to ask questions. I consent to take part in the research study "Assessment of incidence of early postoperative hypoxia and associated factors at Addis Ababa university college of health science, TASH Ethiopia"

Participant's Signature _____ Date _____

Researcher's Signature _____ Date _____

10.3 Annex 3

	Patient number _____	Medical record number _____	
No	Question	Response	Skip pattern
Seciton 1: Demograhic and background data			
101	Sex	1. Male 2. Female	
102	Age (in years)		
103	ASA class		
104	BMI	1. <18.5 2. 18.5–24.9 3. 25–29.9 4. 30–39.9	
105	History of smoking	0. No 1. Yes	
106	Coexisting diseases	0. No 1. Yes	If " No " Skip to question 108
107	Type of comorbidity (Multiple answer possible)	1. Hypertension 2. Diabetes mellitus 3. Heart disease 4. COPD 5. Renal disease 6. other specify	

108	Hemoglobin(mg/dl)		
Section 2: Pre and Intraoperative data			
201	Preoperative pso2		
202	Type of Anesthesia	1. General anesthesia 2. Regional anesthesia 3. Sedation 99. Other specify	
203	Type of procedure	1. Thoracic 2. Vascular 3. Neurologic 4. Hepatobilliary 5. GI 6. Gynecological procedures 7. Orthopedic procedures 8.Obstetric 9. Other specify	
204	Duration of surgery (in minutes)		
205	Duration of anesthesia (in minutes)		
206	Estimated blood loss (in ml)		
207	Intraop blood transfusion and units	1.yes_____ 2.no	
208	Total number of crystalloid's given(in ml)		
209	Incision site	1.Thorax 2.Upper abdomen 3. Lower abdomen 4.Lower extremity	

		5. other specify----------	
210	Nerve block	1.TAP block 2.Rectus sheath block 3.Femoral nerve block 4. other specify	
211	Analgesic type and total dose	1.morphine_____ 2.fentanyl_____ 3.tramadol_____ 4.pethidine_____ 5.other specify_____	
212	Induction Agents and dose	1.propofol 2.ketamine 3,thiopental 4. other specify----------	
213	Maintenance agent and MAC	1.halothane 2.isoflurane 3.other specify	
214	Intraoperative muscle relaxant and dose	1.vecuronium 2.succinylcholine 3.other specify----------	
Section 3: Postoperative data			
301	Did patient came with supplemental o2 to PACU and L/min	1.Yes_____ 2.No	
302	Did the patient put on oxygen arrival to PACU	1.yes 2.No	
302	Pso2 at arrival to PACU		
303	At 5 min		
304	At 10min		
305	At 15min		
306	At 20min		
307	O2 therapy and l/min	1.INO2_____ 2.FMO2_____ 3.other specify_____	
308	Shivering	1.Yes 2.No	
309	Grip strength	1.0 2.1	
310	Pain score(numeric score)		