

Magnitude and Associated Factors of Immediate Postoperative Hypoxemia among Elective Surgical Procedures at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia

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Abstract

Background: Definition of Hypoxemia is insufficient amount of oxygen in the blood. There are different contributing risk factors for occurrence of post-operative hypoxemia which may lead to myocardial ischemia, organ dysfunction, wound infection, hospital stay and increase cost for the hospital and patient.

Objectives: To assess the magnitude and associated factors of immediate post-operative hypoxemia in elective surgical procedures at Tikur Anbessa specialized Hospital from January 30, 2017 to March 31, 2017 G.C.

Methods: Institutional based cross-sectional study design was conducted. Using Systemic random sampling technique and structured questioners data was collected from sampled elective surgical patients' age ≥ 18 that came during the 2 months period. Data was entered into Epi info version 7 computer software by investigators and transported to SPSS version 20 computer program for analysis. Variables that demonstrated a significant relationship on bivariate analysis (p -value <0.2) were included Multivariate regression analysis was applied to evaluate independent variable relationships with a dependent variable that was continuous. A p -value <0.05 was considered to represent a statistically significant relationship.

Results: Among sampled 238 elective surgical patients magnitude of hypoxemia was 54 (22.7%). Frequency of hypoxemia was high in first 10 min after admission to post anesthesia care unit. The independent predictors of hypoxemia were who had Respiratory co morbidity [(AOR=8.8; CI 2.264, 34.117)] ($p=0.002$) and cardiothoracic surgery [AOR=4.904; CI1.385, 17.368] ($p=0.014$).

Conclusion and recommendation: Magnitude of hypoxemia was high and so specials consideration should give co morbid diseases patients by pre-operative optimization of patient that has other factors additional to the surgical procedure.

Keywords: Hypoxia; General anesthesia; Surgical patients

Abbreviations : TASH: Tikur Anbessa Specialized Hospital

Introduction

Hypoxemia 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 hypoxemia. As well as these respiratory causes, cardiovascular causes such as shunts may also result in hypoxemia. The most common causes of hypoxemia are ventilation-perfusion mismatch, hypoventilation, and shunts [1,2].

Pulse-oximetry commonly used in hospitals and by critical-care professionals to define blood oxygen levels and diagnose hypoxemia. On an average, the normal oxygen levels in our blood stream between 80 and 100 mm Hg. In people suffering from hypoxemia, this falls down to as low as 60 mm Hg. Normal pulse oximeter readings can range from 95 to 100% [2-4].

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 quickly. 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 haemoglobin 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 [3,5].

There is large variation in the incidence of critical respiratory events in the PACU, with several prospective observational studies reporting an incidence of between (22-30%) [6-11]. Randomized evaluation of subgroup of patients showed that PACU mild hypoxemia (SpO₂ 86-90%) was recorded in 53% and 55% of the patients, respectively. Severe hypoxemia with SpO₂ values $<81\%$ was recorded in 20% and 13% of the patients, respectively [12].

They are different contributing risk factors occurrence of post-operative hypoxemia includes, anesthesia drug, shock, prolonged surgery, pre-existing cardiovascular and respiratory disease, positioning, acute trauma, ASA level, age and obesity which may lead to myocardial ischemia, organ dysfunction, wound infection, hospital stay and increase cost for the hospital and patient. Factors cause hypoxemia [10,13].

Even though no published literature found in Ethiopia studying magnitude, associated factors of postoperative. Therefore, this study aims to answer which presumptive cause (Anesthesia, patient, Surgical) factors may predispose to post-operative hypoxemia. It can reduce mortality and morbidity due to post-operative hypoxemia. In addition, it can reduce economic pressure of hospital and patient by reducing hospital stay. There is no any study conducted on this topic in our country so that it can be used as a base line data for further researchers.

Method and Materials

Study area and period

This study was conducted at Tikur Anbessa specialized Hospital which is located in the capital city Addis Ababa, Ethiopia from JANUARY 30, 2017 to MARCH 31, 2017 G. Tikur Anbessa specialized hospital is multi-specialist tertiary care teaching hospital in Ethiopia, opened since 1972 and, in 1998 transferred to school by FMOH since then it became a university teaching hospital. TASH is now the main teaching hospital for clinical and preclinical trainings of most disciplines. It is also an institution where specialized clinical services that are not available in other public or private institutions are rendered to the whole nation. It has 800 beds, 12 operation theatres, annually 6000-8000 operation done and more than 900 health professionals in the different specialties dedicated to providing health care services, and the various departments' residents under specialty training in the school of medicine also provide patient care in the hospital.

Study design: Cross sectional study was employed.

Source of population: All surgical patients who undergo surgery at Tikur Anbessa specialized Hospital.

Study population: Selected patients who undergo elective surgery in Tikur Anbessa specialized Hospital in the specified time period.

Sample population: Sampled patient who undergo elective surgery transferred to post anesthesia care unit in Tikur Anbessa specialized Hospital.

Exclusion criteria: Patients who already intubated and transferred to post anesthesia care unit or intensive care unit, and those whose ages was less than 18 years.

Sample size determination: The sample size was calculated using the single population proportion formula

$n = (Z_{\alpha/2})^2 \times p \times q / d^2$ Where: n= number of sample size. Z= desired 95% confidence, Z=1.96.

p=0.5 maximum population proportion, since no previous studies found.

q = 1-p = 1-0.5=0.5 d = is the margin of sampling error tolerated (5%)

By using correction formula for finite population since source population were less than 10,000.

$$n_f = \frac{n}{1 + n/N} \text{ where } n = \text{the sample size} = 384$$

Where N=Total No of pts who undergo elective operation=600

nf = Final sample study

$\frac{384}{1 + 384/600} = 234$ Mean of midyear population was used to get total number of elective patients who undergo operation in 2 months duration and age 18 or above. The midyear population in six month from situational analysis was 1800. So, the size of population in 2 months is 1800 divided by 3 gives 600. From this the final sample size was 234. Adding 5% contingency it was 246 after data collection 8 questioners' not completely filled 238 questioners was used for analysis.

Sampling technique: Systemic random sampling technique was used to select study participants by using skip interval of $K = N/n = 600/246 = 3$

n=total sample size; K=skip interval; N=Total study population

The first study participant was selected by lottery method first cases that undergo surgery in each department.

Data collection tools and procedure: Data was collected using pretested structured questionnaires with observing saturation level and patient cared. After patient come to post anesthesia care unite saturation level measured immediately with pulse oximetry then every 5minute. A positive post-operative hypoxemia screen will defined episodes of $SpO_2 \leq 94\%$, on room air or nasal cannula supplemental oxygen. Intraoperative data was collected by two trained anesthetist. Postoperative data was collected by two trained post anesthesia care unit nurse and the principal investigator was supervised the completeness of the data daily.

Data quality assurance: Pre-test was done on 5% of the sample size. During data collection, regular supervision and follow up was made. Investigators cross check for completeness and consistency of data on daily basis. Once the data had collected and checked for completeness, consistency and accuracy, it was sorted, categorized and summarized. Then, the data was entered in to the computer using developed data entry, format, coded for each category of variables and again cross check for errors.

Data analysing and processing: Data were checked manually for completeness, coded and entered in to Epi Info version 7 and exported to SPSS version 20 computer program for cleaning, transformation and analysis. Statistical analysis was performed using the SPSS version 20. Frequency and cross tabulation was conducted to describe relevant variables in relation to the outcome variables. Variables that demonstrated a significant relationship on bivariate analysis ($p < 0.2$) were included Multivariable regression analysis was applied to evaluate independent variable relationships with a dependent variable that was continuous. A $p < 0.05$ was considered to represent a statistically significant relationship.

Ethical consideration: Ethical clearance and approval was obtained from ethical review committee, Anesthesia department, Addis Ababa University. Permission to conduct was obtained from Tikur Anbessa Hospital. Informed Verbal consent was secured from every study participants. The obtained data was used for study purpose. Confidentiality and anonymity was ensured.

Operational definition

Anesthetist: Is a licensed professional to administer general as well as regional anesthesia to the Patient undergoing surgery.

Duration of surgery: The time starting from incision to end of surgery (skin suturing).

Duration of anesthesia: The time starting from administration of anesthesia to end of administering anesthesia.

Elective surgery: Is surgery done before on set (appearance) of any complication that might constitute urgent indication.

General anesthesia: Is type of anesthesia administered with loss of consciousness.

Hypotension: A fall in systolic blood pressure greater than 20-30% of the preoperative baseline.

Pulse oximetry: n instrument used to measure oxygen saturation.

Post anesthesia care unit: Place where patient admitted after surgery and anesthesia in order to give care.

Regional anesthesia: Is type of anesthesia administered at site or near to the site of procedure without loss of consciousness.

Severe hypoxemia: A positive post-operative severe hypoxemia will defined as episodes of SpO₂ <90%, on room air or supplemental oxygen.

Spinal anesthesia: Administering of local anesthetics agents in subarachnoid space.

Hypoxemia: SpO₂ ≤ 94% and Hypoxemia Both mild and severe combined.

Mild hypoxemia: A positive post-operative mild hypoxemia will defined as episodes of SpO₂ ≤ 94%, on room air or supplemental oxygen.

Socio-demographic and clinical characteristics

Characteristics	Frequency	Percentage %	Hypoxemia (%)		
			Normal	Hypoxemia	
Sex	male	131	55	74	26
	Female	107	45	81.3	18.7
Age	<60	195	82	83.7	16.3
	≥ 60	43	18	76.4	23.6
BMI	<18.5	28	11.8	78.6	21.4
	18.5-24.9	181	76.2	78.5	21.5
	24.9-29.9	30	12.6	70	30
ASA	I	145	60.9	83.4	16.6
	II	82	34.5	68.3	21.7
	III*	11	4.6	54.5	45.5

Smoking**	4	1.7	25	75
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Table 1: Socio-demographic and clinical characteristics of elective surgical patients at TASH Hospital, Ethiopia, From January to March, 2017 Gc.

A total of 238 sampled patients were included in two month period with 131 males and 107 females (Male: Female ratio of 1.2:1. Hypoxemia distribution of Male and female were 26% and 18.7% respectively. Percentage of hypoxemia in age greater than or equal 60 and less than 60 were 23.6, 16.3 respectively. From total sampled patients, magnitude of hypoxemia was 22.7%. Body mass index was less than 18.5 (11.8%), 18.5-24.9 (76.2%) and 25-29.9 (12.6%) and Hypoxemia distribution in each range of body mass index were 21.4%, 21.5% and 30% consequently. Frequency of patient in each ASA class were 145 (60.9%), 82 (34.5%) and 11 (4.6%) respectively. ASA-I and hypoxemia was increased with increased ASA class of patients. Smoker patient were 4 (1.7%), in which case (75%) smokers were hypoxemic (Table 1).

Co- morbidity and hypoxemia

From all patients the magnitude of co-morbidity was sixty eight (28.6%). Respiratory and cardiovascular co-morbidities were (8.4%) and eight (8%) respectively. The occurrence of hypoxemia was more common in patients with a retroviral infection (66.7%), followed by patients with respiratory (65%) and renal (60%) co-morbidities. Two hundred ten (77.6) patient had haemoglobin level greater than or equal to eleven. Patients' haemoglobin greater than equal to eleven was 22.4% hypoxic and less than eleven 25% hypoxic (Figure 1).

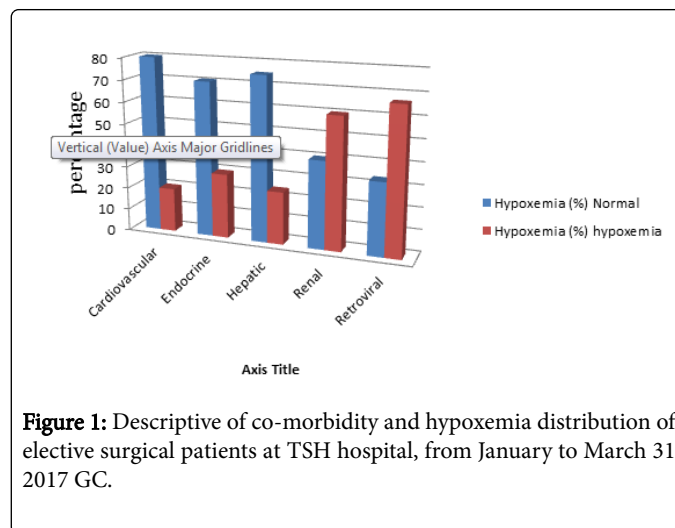


Figure 1: Descriptive of co-morbidity and hypoxemia distribution of elective surgical patients at TSH hospital, from January to March 31 2017 GC.

Anesthesia drugs and hypoxemia

Among sampled patient 197 patients induced with general anesthesia. Patients who are induced by Propofol+fentanyl eighty eight (37%) followed by Thiopental+fentanyl (19.7%) and Propofol +pethedine (7.6%). Drugs used for maintenance of general anesthesia used during were, halothane seventy (29.4%), halothane+fentanyl fifty six (23.5%) and isoflurane thirty three (13.9%). Hypoxemia distribution patients maintained with Isoflurane+pethedine (50%), isoflurane (33%) and halothane+fentanyl (25%). For muscle relaxation, one hundred eighteen (49.6%) were given Succinylcholine+Vecronium,

whereas the rest was relaxed using Succinylcholine+Pancronium (13.4%) and Vecronium (12.6%), respectively. Hypoxemia distribution of patients relaxed with Succinylcholine+pancronium and Succinylcholine+Vecronium, 37.5% and 26.3% (Table 2).

Induction drug	frequency	Per cent (%)	Hypoxemia (%)	
			Normal	Hypoxemia
Propofol	19	8	84.2	15.8
Ketamine	14	5.9	71	29
Propofol+fentanyl	88	37	67.8	32.2
Propofol+pethedine	18	7.6	72.2	27.8
Thiopental+fentanyl	48	19.7	85.4	14.6
Ketamine+fentanyl	10	4.2	70	30
Total	197	82.8		

Table 2: Induction drugs and Hypoxemia distribution of elective surgical patients at TASH Hospital, Ethiopia, from January to March 31, 2017 GC.

Hypoxemia vs. Time

Of 238 cases, hypoxemia occurred within the first min 56 (23.8%), within five min 58 (24.8%) and within 10 min 45 (18.9%). Frequency of hypoxemia was highest first 10 min and decreased when time increased (Figure 2).

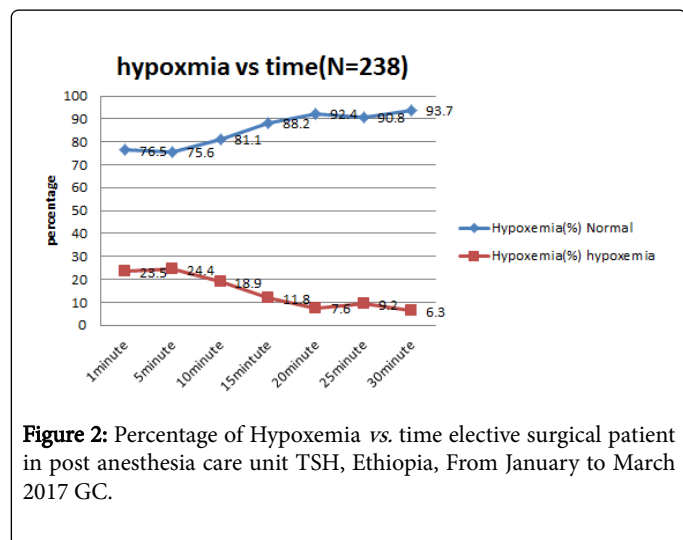


Figure 2: Percentage of Hypoxemia vs. time elective surgical patient in post anesthesia care unit TSH, Ethiopia, From January to March 2017 GC.

Factors associated with immediate postoperative hypoxemia

In Multivariate analysis, when 95% CI for the adjusted odds ratios were calculated among these variables, respiratory co-morbidity, urology and cardiothoracic surgery statistically significant association with postoperative hypoxemia P-value (0.002, 0.014 and 0.014). Among study subjects, who had Respiratory co morbidity 8.8, are more likely to have post-operative hypoxemia than other co-morbidities (AOR=8.8; CI 2.264, 34.117) and patients who had cardiothoracic surgery 4.904 were likely to be hypoxemic than other surgeries (AOR=4.904; 1.385, 17.368). Smokers and patients with Body mass

index of (25-29.9) 15, 1.136 developed more post-operative hypoxemia than other patients with (AOR=15; CI 0.478, 469.529) and (AOR: 1.136; CI 0.282, 4.569) respectively (Table 3).

Variables	Hypoxemia (%)		Adjusted Odds Ratio (95% CI)	P-Value
	Normal	Hypoxemia		
Sex	74	26	0.86 (0.396,2.185)	0.93
Female				
Male	81.3	18.7		
ASA II	68.3	21.7	1.770 (0.785,3.989)	0.168
III	54.5	45.5	1.834 (0.32, 9.919)	
Smoking Smoker	25	75	15 (0.478,469.5)	0.123
Department cardiothoracic	37.5	62.5	4.904 (1.385,17.368)	0.014
Type of anesthesia GA	73.6	26.4	4.464 (0.467, 42.618)	0.194
RA	95.1	4.9		
Duration of anesthesia ≥ 120min	72	28	1.570 (0.676,3.648)	0.294
Co-morbidity Respiratory	35	65	8.788 (2.264,34.117)	0.002

Table 3: Factors associated with immediate postoperative hypoxemia elective surgical patients at TASH Hospital, Ethiopia, From January to March 31, 2017 GC.

Discussion

Hypoxemia has been recognized as a risk to patients in the operating room and post anesthesia care unit. In this study magnitude of postoperative hypoxemia was 54 (22.7%) percentage of hypoxemia more in age greater than or equal to 60. Majority of patient's body mass index was between 18.5 and 24.9 (76.2%). Hypoxemia was found more in patients with body mass index between 25 and 29.9 kg/m² (30%). Hypoxemia was increased with increased ASA class of patients. Smokers were more hypoxemic (75%) than non-smokers.

While Dunham et al. studied the magnitude of post-operative hypoxemia to be (30%) [13]. There is large variation the incidence of critical respiratory events in the PACU, with several prospective observational studies reporting an incidence of post-operative hypoxemia between (22-30%) [6-11]. So magnitude of postoperative hypoxemia was similar to other studies.

Study done in Brazil, socio demographic data indicated, 204 patients were with mean age of 54.2 ± 17, gender (m/f) 118/86, ASA (I-II-III-V) 83/100/20/1, COPD5/199. Numbers of patient who took general and regional anesthesia were similar, smoking 61/143 and superficial/abdominal surgery 74/130 (10). Socio demographic data of Study in USA indicated 500 patients were with mean age of 54.2 ± 17, M/F197/303. The mean ASA level was 2.8 ± 0.6 (I-IV), pre-existing lung diseases 69 (13.8%), and weight (86.2) ± 24.3. Operation room stay in minutes was less in non-hypoxic group and high among the

hypoxic group. The mean ASA level low in non-hypoxic group and high in hypoxic group [13].

While in this research socio demographic factors revealed gender (m/f) 131/107, smoking (4), ASA (II, III) 145/82/11 Respiratory comorbidity (20) (8.4%), cardiovascular (19) (8%), renal (5), E-endocrine (17), RVI (3), hepatic co-morbidity (40), cardiothoracic surgery (32), general surgery (60) and urology (54) from total of 238 patients. Mean duration of anesthesia hypoxic group 156 minute non hypoxic group 131 minute. This study showed that patient who had comorbidity and duration of anesthesia greater or equal to 120 min had high probability of being hypoxemic due to comorbidity have its Owen deleterious effect on cardio respiratory system. Similarly as duration of anesthesia increase administration of anesthesia drug also increases.

According to research done in Germany, the choice of opioid and muscle relaxant had an effect on post-operative hypoxemia [10]. This study revealed that using Succinylcholine+Pancronium and Propofol +fentanyl had high probability to result hypoxemia. This is possibly due to residual effect of the drugs, altered metabolism and redistribution. previous studies, variables associated to higher probabilities of immediate postoperative hypoxemia were: males, diabetes mellitus, urgency of surgery, medication with opioid and fentanyl doses above $2 \mu\text{g}\cdot\text{kg}^{-1}\cdot\text{h}^{-1}$, association of fentanyl and morphine, thiopental as compared to Propofol, obesity, more than 60 years of age [6,13,14].

Research studied by identified the following variables as predictors for postoperative hypoxemia: body mass index ≥ 25 (odds ratio [OR], 5.6; 95% confidence interval [CI], 2.1-15.01; $P < 0.001$) [15]. According to Dunham et.al. ASA level and duration of surgery independently associated with hypoxemia [13]. Study studied by Moller JT independent risk factors postoperative hypoxemia was duration of anesthesia, history of smoking and patients who had regional anesthesia had lower hypoxemia [16].

According to this research independent factors associated with postoperative hypoxemia were cardiothoracic-surgery P-value 0.014 (AOR=4.904; CI 1.385, 17.368), respiratory coexisting diseases with P-value of 0.002 (AOR=8.8; CI 2.264, 34.117). Smokers were more (15) likely develop hypoxemia with p-value 0.123 (AOR=15; CI 0.478, 469.5). Cardiothoracic surgery, respiratory coexisting diseases and smoking carried high risk of hypoxemia, because of their significant affect respiratory physiology and airway patency. Even though ASA level, smoking, history of smoking co-related with hypoxemia in this research not independent factors post-operative hypoxemia may be due to number of smokers were low in this research compared Moller JT and most of patient in this research were ASAI as morbidity and mortality increase ASA level.

Conclusion

Most patients were given general anesthesia and hypoxemia was more common in general anesthesia as compared to regional anesthesia. It was more frequent in first 10 minute of surgery. Patient who had respiratory co-morbidity were more prone to postoperative hypoxemia when compared to others co-morbidity illness. It was also found that patient with ASA class II and III, smokers, general anesthesia and duration of anesthesia greater than 120 minute were co-related with hypoxemia. Therefore, Surgeon and anesthetist should do preoperative optimization and special consideration to a patient who had co-morbidity as most of hypoxemia was found among patients who had co morbidity illness. Porter, surgeon and anesthetists should

transport the patients to recovery room soon after discontinuation of oxygen from oxygen source in the operation theatre and provide oxygen supplementation with Ambo bag for those who were prone to be hypoxic. Post anesthesia care unit nurse should administer oxygen for patients who are hypoxic. Hypoxemia was common immediately after transporting patients to recovery.

Declarations

Ethics approval and consent to participate

Paper of approval and letter of permission was obtained before the beginning of data collection from departmental review board of Anesthesia, college of health science, Addis Ababa University. Permission letter was provided to TASH for proceeding data collection. The data collected was confidential and handled with care. The objective and confidentiality of the study was explained orally to all patients.

Availability of data and material

The data used in this study was collected by data collectors and submitted to authors, who are willing to share the data upon request from peer researchers.

Competing interests

We declared that we had no competing interests.

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Author's Contributions

GD and MS have contributed to conception, design of the study, data acquisition, data entry, data analyses, result interpretation, manuscript development and revision. MA, NG, EN and AD have contributed to conception, initial design of the study, data acquisition, data analyses, result interpretation and manuscript development. All authors read and approve the final manuscript.

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