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Early postoperative hypoxia – incidence and associated factors: A Prospective Observational Study

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Abstract
Background: Early postoperative hypoxia is one of the postoperative complications which can be detected promptly with the use of a pulse oximeter and treated by supplementing oxygen. By studying the factors associated with early postoperative hypoxia, we can provide vigilant monitoring to high-risk patients and streamline oxygen therapy only to those in need ensuring both patient safety and cost effectiveness.
Objectives: Our study aims to assess the incidence and associated factors of early postoperative hypoxia among adult patients who underwent surgery under anaesthesia in an urban tertiary care hospital.
Methods: This prospective observational study was conducted among 309 elective/ emergency surgical patients under anaesthesia over a period of 4 months. 17 different factors (patient related, anaesthesia related, surgery related) were studied for its association with early postoperative hypoxia.
Results: We observed that the incidence of early postoperative hypoxia among our study population was 16.2%. Of the 17 different factors studied for its association with hypoxia, the statistically significant factors were age $\geq$ 50 years (p = 0.000), OSA patients (p = 0.000), preoperative SpO_2 < 95% (p<0.01), use of general anaesthesia (p = 0.000), laparoscopic surgeries (p<0.01), and use of opioids post-extubation (p<0.000).
Conclusion: Our study concludes that the factors significantly associated with early postoperative hypoxia were patients aged $\geq$ 50 years, OSA patients, patients with preoperative saturation < 95%, use of general anaesthesia, laparoscopic surgeries, use of opioids post-extubation.

Keywords: Early postoperative hypoxia, oxygen, anaesthesia

Introduction
Hypoxemia refers to insufficient oxygen in the blood. Any cause that influences the rate or 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 [1].
Postoperative patients are susceptible to hypoxia because of incomplete lung re-expansion, reduced chest wall and diaphragmatic activity caused by surgical injury, pain [2], consequences of hemodynamic impairment, residual effects of anaesthetic drugs [3, 4] which may result in atelectasis, ventilation–perfusion mismatch, alveolar hypoventilation, and impaired upper airway patency. Postoperative shivering may also increase oxygen consumption, thereby increasing the risk of hypoxia [5]. Accordingly, prolonged hypoxia may promote serious consequences including arrhythmias [6, 7], myocardial ischemia [8], and cognitive dysfunction [9]. Craig [10] considered postoperative hypoxia to occur in two phases: an early phase which may be due to anaesthetic drugs and techniques; and a late phase due to administration of opioid drugs. The incidence of early postoperative hypoxia ranges from 3% to 65% [11, 13], depending on definitions, the presence of risk factors and type of surgery. Pulse oximetry is commonly used monitoring to diagnose hypoxia. If the oxygen saturation is 94% or lower, the patient is hypoxic and needs to be treated quickly [14]. Treatment is supplementation of oxygen via a nasal cannula, face mask, venturi depending on individual patient need.
However, oxygen has also been known to promote harmful effects. High fraction of inspired oxygen (FiO_2) can impede minute ventilation in spontaneously breathing patients,

worsen ventilation–perfusion matching by countering hypoxic pulmonary vasoconstriction and shift the carbon dioxide dissociation curve to the right (Haldane effect). Supplemental oxygen in patients with spontaneous ventilation has been found to potentially promote delayed recognition of deteriorating lung function in the post-anaesthesia care unit (PACU) [15]. Thus routine supplemental oxygen administration to prevent hypoxia might not be necessary in most postoperative patients in recent years. In fact, a before and after comparison study showed that the shift from routine postoperative supplemental oxygen administration to titrated postoperative oxygen administration to maintain SpO_2 levels at 90% or higher could increase the number of patients not needing supplemental oxygen therapy [16]. And the goal of postoperative oxygen therapy should be to maintain normoxemia and avoid unnecessary oxygen administration.

Methodology

After approval by the Institutional Ethical Board and Scientific Committee, a prospective observational study was conducted among all elective/ emergency surgical patients under anaesthesia from September 2023 to December 2023, excluding patients who refused to participate, aged less than 18 years of age, required oxygen supplementation preoperatively and required postoperative ventilation. The study was conducted at Sundaram Medical Foundation, an urban tertiary care hospital.

Study procedure

In a standardized preoperative visit, after obtaining informed consent the independent variables of the study participants were noted (age, gender, BMI, h/o smoking, COPD, OSA, haemoglobin level, preoperative SpO_2 level, ASA class, emergency or elective surgery). Standard fasting protocol and premedication were followed for all patients. On the day of surgery, preoperative baseline hemodynamic parameters were recorded. The type of anaesthesia was determined by the attending consultant anaesthetist, taking into consideration individual patient characteristics and the type of surgery.

Standard monitoring of ECG, NIBP, SpO_2, RR / $EtCO_2$ were done intraoperatively. The intraoperative variables noted were – type of surgery, site of incision, blood loss, duration of surgery, and anaesthesia ended time [13] (day / night time). All patients were shifted to a dedicated Post Anaesthesia Care Unit. In case of postoperative pain with VAS > 3/10, patients were given Inj. Pethidine (1 mg/kg IM). In the PACU, POSS sedation score was assessed in all patients who underwent surgery under general anaesthesia. Patients with POSS scores of 3 and 4 were excluded from the study, whereas patients with a score of S, 1, 2, continuous SpO_2 monitoring was done. All other patients after neuraxial anaesthesia/ LAMAC/ IV sedation, continuous SpO_2 was monitored. The SpO_2 values were recorded in the proforma at 0-minute, 5-minute, 10 minutes, 15 minutes, 30 minutes, at the time of transfer from PACU and when hypoxia occurred (SpO_2 < 94%).

If a hypoxic event (SpO_2 < 94%) occurred in any patient under observation in PACU, they were given supplemental oxygen necessary to achieve SpO_2 > 94%. In case of any delay in the detection of plethysmographic waveform by the pulse oximetry (shivering, cold peripheries, restless patient, equipment problems) the patient was given supplemental oxygen and was excluded from the study. Patients were observed in the PACU for a minimum of 30 minutes to a maximum of 1 hour and were then discharged from PACU after a Modified Aldrete score ≥ 8, with SpO_2 ≥ 94% either in room air or with the lowest possible oxygen supplementation required to achieve it.

POSS (Passero Opioid – induced Sedation Scale)
S – Sleep, easy to arouse
1 – Awake and alert
2 – Slightly drowsy, easily aroused
3 – Frequently drowsy, arousable, drifts off to sleep during conversation
4 – Somnolent, minimal or no response to verbal and physical stimulation

Sample size calculation:

Single Proportion - Absolute Precision
According to Debas *et al* [19], 2019, Ethiopia study, the proportion of hypoxemia is 27% and considering a precision of 5% and desired confidence level of 95%, the required sample size is 303 using the formula, $n = t^2 \times p(1-p) \div m^2$, where n - required sample size, t - confidence level at 95% (standard value of 1.96), p - estimated incidence of hypoxia, m - margin of error at 5% (standard value of 0.05).

Data analysis

Data was entered in Microsoft excel. Descriptive analysis was represented as proportions in charts and graphs. Statistical significance tests were done using SPSS version 20.0 (Statistical packages for Social Sciences). Incidence of hypoxemia was calculated. Chi-square test was done to find the associated factors of early postoperative hypoxia among operated patients under anaesthesia. p value was considered significant if $p<0.05$.

Results

The study was done over a period of 4 months involving 309 patients. The incidence of early postoperative hypoxia among our study population is 16.2% (Fig. 1).

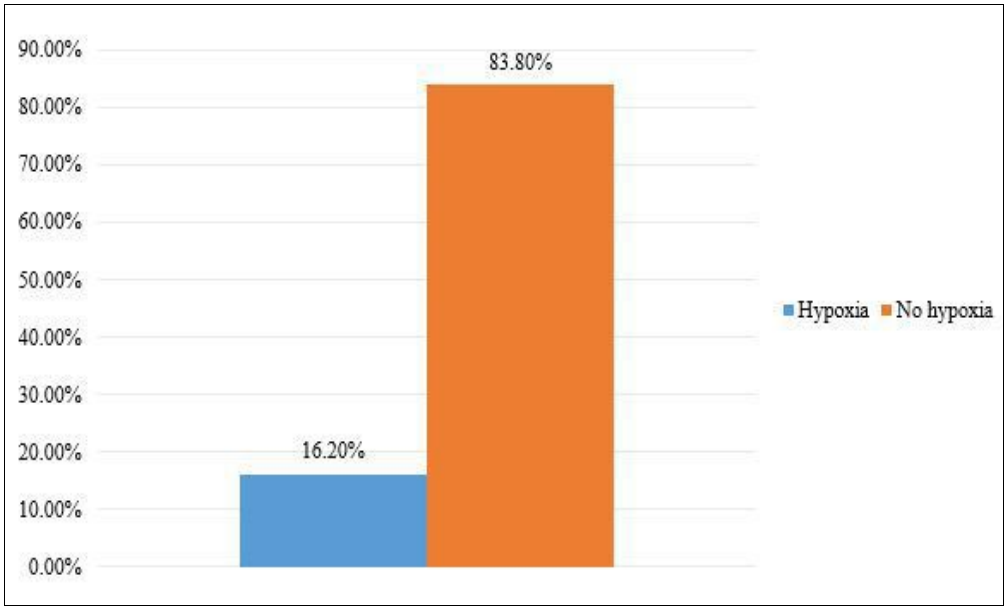


Fig 1: Incidence of early postoperative hypoxia

The association of early postoperative hypoxia were analysed among 17 different factors (patient-related, anaesthesia-related and surgery-related factors).

Table 1: Frequency distribution of the study participants for patient related factors with early postoperative hypoxia

Variables	Hypoxia Yes, n (%)	Hypoxia No, n (%)	Total, n (%)
Age (years)			
< 50	18 (5.8)	162 (52.4)	180 (58.3)
> 50	32 (10.4)	97 (31.4)	129 (41.7)
Gender			
Male	31 (10.1)	165 (53.4)	196 (63.4)
Female	19 (6.1)	94 (30.4)	113 (36.6)
BMI (kg/m²)			
< 18.5	0	4 (1.3)	4 (1.3)
18.5 – 24.9	11 (3.6)	71 (22.9)	82 (26.5)
25 – 29.9	21 (6.8)	97 (31.4)	118 (38.2)
> 30	18 (5.8)	87 (28.2)	105 (34)
ASA class			
I	8 (2.6)	53 (17.2)	61 (19.8)
II	28 (9)	153 (49.5)	181 (58.5)
III	14 (4.5)	53 (17.2)	67 (21.7)
Smoking			
Smoker	2 (0.6)	6 (2)	8 (2.6)
Non-smoker	48 (15.5)	253 (81.9)	301 (97.4)
OSA			
Not on CPAP	1 (0.33)	2 (0.64)	3 (0.97)
On Nocturnal CPAP	1 (0.33)	0	1 (0.33)
No OSA	48 (15.5)	257 (83.2)	305 (98.7)
COPD			
Yes	1 (0.3)	1 (0.3)	2 (0.6)
No	49 (15.9)	258 (83.5)	307 (99.4)
Preoperative Hb value			
< 11 g/dL	13 (4.2)	66 (21.4)	79 (25.6)
> 11 g/dL	37 (11.9)	193 (62.5)	230 (74.4)

BMI: Body Mass Index, **ASA:** American Society of Anaesthesiology, **OSA:** Obstructive Sleep Apnea, **CPAP:** Continuous Positive Airway Pressure, **COPD:** Chronic Obstructive Pulmonary Disease, **HB:** Hemoglobin

Table 2: Frequency distribution of the study participants for anaesthesia related factors with early postoperative hypoxia

Variables	Hypoxia Yes, n (%)	Hypoxia No, n (%)	Total, n (%)
Preoperative SpO_2			
> 95%	40 (13)	257 (83.2)	297 (96.2)
< 95%	10 (3.2)	2 (0.6)	12 (3.8)
Anaesthetic technique			
GA	34 (11)	97 (31.4)	131 (42.4)
GA + Epidural	3 (0.9)	0	3 (0.9)
Central Neuraxial	12 (4)	159 (51.5)	171 (55.5)
Nerve block	1 (0.3)	3 (0.9)	4 (1.2)
Anaesthesia ended time			
Day time	50 (16.2)	250 (80.9)	300 (97.1)
Night time	0	9 (2.9)	9 (2.9)
Use of opioids post-extubation			
Yes	20 (6.5)	35 (11.3)	55 (17.8)
No	30 (9.7)	224 (72.5)	254 (82.2)

SpO_2: Saturation of Peripheral Oxygen, GA: General Anaesthesia

Table 3: Frequency distribution of the study participants for surgery related factors with early postoperative hypoxia

Variables	Hypoxia Yes, n (%)	Hypoxia No, n (%)	Total, n (%)
Urgency of surgery			
Elective	50 (16.2)	251 (81.2)	301 (97.4)
Emergency	0	8 (2.6)	8 (2.6)
Type of surgery			
Head and Neck	0	1 (0.3)	1 (0.3)
Maxillofacial	0	3 (1)	3 (1)
ENT	4 (1.3)	17 (5.5)	21 (6.9)
Obstetric	3 (1)	54 (17.5)	57 (18.5)
Gynaecological	10 (3.2)	50 (16.3)	60 (19.4)
General surgery	17 (5.5)	47 (15.2)	64 (20.7)
Plastic surgery	3 (1)	15 (4.9)	18 (5.9)
Urological surgery	3 (1)	23 (7.4)	26 (8.4)
Vascular	1 (0.3)	7 (2.3)	8 (2.6)
Orthopaedic	9 (3)	41 (13.3)	50 (16.3)
Site of incision			
Head and neck	5 (1.61)	24 (7.8)	29 (9.41)
Breast	1 (0.32)	8 (2.6)	9 (2.92)
Abdomen	10 (3.2)	91 (29.4)	101 (32.6)
Breast and Abdomen	0	1 (0.32)	1 (0.32)
Laparoscopic surgery	12 (3.9)	17 (5.5)	29 (9.4)
Pelvis	8 (2.6)	54 (17.5)	62 (20.1)
Limbs	13 (4.21)	59 (19.1)	72 (23.31)
Spine	0	4 (1.3)	4 (1.3)
Others	1 (0.32)	1 (0.32)	2 (0.64)
Intraoperative blood loss			
< 500 mL	45 (14.5)	211 (68.3)	256 (82.8)
> 500 mL	5 (1.7)	48 (15.5)	53 (17.2)
Duration of surgery			
< 120 minutes	29 (9.4)	170 (55)	199 (64.4)
> 120 minutes	21 (6.8)	89 (28.8)	110 (35.6)

ENT: Ear Nose Throat

In our study, 17 of the above described factors were studied for its association with early postoperative hypoxia. Among them six of the factors - patient's age, patients with OSA, preoperative saturation level, type of anaesthesia, site of incision and use of opioids in the postoperative period were statistically significant. Patients who were $\geq$ 50 years of age had the highest frequency of hypoxia (24.8%), compared to those aged less than 50 years (10%) with statistical significance (p 0.000). Distribution of OSA patients were 4 (1.3%), and the incidence of hypoxia was 50%, thereby making it a significant factor (p = 0.000). Preoperative SpO_2 level < 95% is a statistically significant variable with a p value of < 0.01.

Among the study group, 55.5% patients underwent surgery under central neuraxial anaesthesia, 42.4% patients under GA, 1.2% patients under nerve block, 0.9% patients under GA + epidural. The incidence of hypoxia was higher among GA + epidural group (100%) followed by patients who underwent surgery under GA (26%). Thus type of anaesthetic technique is a significant variable (p = 0.000). In relation to the site of incision used, the incidence of hypoxia is statistically significant with laparoscopic surgeries (p<0.01). After extubation. opioids (Inj. PETHIDINE) were used in 82.2% patients and the incidence of hypoxia among them is 36.4%, thus obtaining a statistically significant association with post-extubation opioids use (p<0.000).

Table 4: Factors associated with early postoperative hypoxia

Variables	Hypoxia Yes	Hypoxia No	p Value
Age (years)			
< 50	18	162	
> 50	32	97	0.000
OSA			
Not on CPAP	1	2	
On Nocturnal CPAP	1	0	
No OSA	48	257	0.000
Preoperative SpO_2			
> 95%	40	257	
< 95%	10	2	< 0.01
Anaesthetic technique			
GA	34	97	
GA + Epidural	3	0	
Central Neuraxial	12	159	
Nerve block	1	3	0.000
Use of opioids post-extubation			
Yes	20	35	
No	30	224	< 0.01
Site of incision			
Head and neck	5	24	
Breast	1	8	
Abdomen	10	91	
Breast and Abdomen	0	1	
Laparoscopic surgery	12	17	
Pelvis	8	54	
Limbs	13	59	
Spine	0	4	
Others	1	1	< 0.000

OSA: Obstructive Sleep Apnea, CPAP: Continuous Positive Airway Pressure, SpO_2: Saturation of Peripheral Oxygen, GA: General Anaesthesia

Discussion

Early postoperative period is the critical period for the development of hypoxia. In this prospective observational study, our aim was to determine the incidence of early postoperative hypoxia and its associated factors. In our institute, all patients after general anaesthesia on shifting to PACU, were given supplemental oxygen (4 L O_2 via face mask) irrespective of the SpO_2 level. Literature suggests the supplementation of oxygen only in cases of hypoxia, which lead us to do this study. In this study, we aim to find the incidence of hypoxia in our setting, and to identify the patients at risk for early postoperative hypoxia thereby reducing unnecessary oxygen supplementation. In addition to the 14 common factors studied in literature for their association with early postoperative hypoxia, we also decided to study the association of OSA, laparoscopic surgeries and use of opioids post-extubation with early postoperative hypoxia as these are well known to alter respiratory mechanics. After excluding patients who refused to participate, < 18 years of age, and those who required oxygen preoperatively or ventilation postoperatively, a total of 309 patients were studied in the PACU over a period of 4 months. The incidence of early postoperative hypoxia in our study was 16.2% (n = 50). Almost similar incidence was reported in the studies done by Tang *et al* [20] (21.8%), Getahun Dendir *et al* [21] (22.7%), Amare Agmas *et al* [17] (24.5%), and Debas Yaregal *et al* [19] (26.7%). A higher incidence was noted by Moges Gelaw *et al* [20] (45.8) possibly due to the inclusion of patients operated only under general anaesthesia. Arunatoi Sirussawakul [23] *et al*., also had a higher incidence of about 38%, the reason may be that they had focussed only on abdominal surgery. Whereas the study done by Amanor-Boadu [24] *et al* had a lower incidence of 12% and the reason might be a lower sample size (66 patients). Mohammed Irfan *et al* [22] also showed a lower incidence of 2.4%. In their study, after shifting to PACU, patients who underwent surgery under general anaesthesia (91.3%) were supplemented oxygen though nasal cannula or face mask, which might be the reason for the lower incidence. In our study, among the 17 different factors studied for its association with early postoperative hypoxia, patient's age, patients with OSA, preoperative saturation level, type of anaesthesia, site of incision and use of opioids in the postoperative period were statistically significant for the development of early postoperative hypoxia. In our study, patients aged above 50 years were associated with the risk of early postoperative hypoxia (p = 0.000). In accordance with our study, literature has demonstrated that elderly patients are prone to develop early postoperative hypoxia due to decrease in respiratory reserve, mechanical changes in the chest wall and changes in pulmonary volumes and capacities. And also elderly population are more sensitive to the depressant effects of inhalational anaesthetics, sedatives and opioids, thereby increasing the incidence of early postoperative hypoxia. Similar finding has been found in the studies by Amare Agmas *et al* [17] (p = 0.001), Tang *et al* [20] (p<0.01), and Mohammed Irfan Akthar *et al* [22]. The incidence of early postoperative hypoxia was statistically significant among patients with obstructive sleep apnea (p = 0.000). Patients with OSA after sedation/anaesthesia, and opioids use have increased pharyngeal collapse, decreased ventilatory response, and impaired arousal response, thereby worsening sleep apnea in the perioperative period [17], and increasing the risk for early postoperative hypoxia. However, among

the literatures reviewed, none of the authors had specifically studied the statistical significance between OSA patients and early postoperative hypoxia. In our study, early postoperative hypoxia was statistically significant among patients with a preoperative saturation level < 95% (p = < 0.001). Similar to our study, reports by Amare Agmas *et al* [17] (AOR 4.497), Moges Gelaw *et al* [18] (AOR 3.011), Debas Yaregal *et al* [19] (AOR 18.28), showed a statistically significant relationship between preoperative saturation < 95% and development of early postoperative hypoxia. It is possible that a preoperative SpO_2 level below 95% might be due to respiratory diseases including asthma, COPD, OSA, recent history of upper/lower respiratory tract infection, hypoventilation, and abnormality in ventilation/perfusion ratio due to lung disease/systemic illness. These conditions might persist or worsen postoperatively increasing the risk for developing early postoperative hypoxia and oxygen requirement. In our study, among the anaesthetic types studied, general anaesthesia had a statistical difference compared to other types (p = 0.000) in causing early postoperative hypoxia. The induction of general anaesthesia results in cephalad displacement of the dependent part of the diaphragm which results in a reduction in pulmonary compliance and functional residual capacity. When the functional residual capacity falls below the closing volume, alveoli close. The immediate consequence is appearance of atelectasis responsible for a shunt effect, an inadequacy of gas exchange with a ventilation/perfusion ratio <1. These are the areas in which perfusion is normal, but ventilation is impaired. Also, in the early postoperative period, the residual effects of anaesthesia agents/ neuromuscular blockers predispose to early postoperative hypoxia. This finding was comparable with the study reports by Amare Agmas *et al* [17] (p = 0.001), Debas Yaregal *et al* [19] (p<0.001), Mohammed Irfan *et al* [22] and Amanor-Boadu *et al* [24]. Getahun Dendir *et al*[21] reported that patients who had general anaesthesia had 4.464 times increased risk to develop early postoperative hypoxia compared to patients who had regional anaesthesia. The studies done by Moges Gelaw *et al* [18], Arunatoi Sirussawakul *et al* [23], Tang *et al* [20], included patients who underwent surgery under general anaesthesia only, hence these studies were not able to demonstrate a correlation between the type of anaesthesia and early postoperative hypoxia. Likewise, among the type of incisions studied, laparoscopic surgeries had a definite correlation with early postoperative hypoxia (p = 0.008). However, on reviewing the literature, subcostal incision was significant among the type of incisions studied. We could not demonstrate this correlation, as none of our patients required subcostal incision during the study period. In laparoscopic surgeries the combined effect of pneumoperitoneum and sedation can lead to hypoventilation and arterial oxygen desaturation. Forced expiratory volume, forced vital capacity and forced expiratory flow are reduced by approximately 25 % and can persist for at least 24 hours postoperatively, thereby predisposing to early postoperative hypoxia [18]. Hence, we decided to study the association between early postoperative and laparoscopic surgeries and we were able to demonstrate its significance. However, none of the authors had specifically studied the correlation between laparoscopic surgeries and early postoperative hypoxia. In our institute, Inj. Pethidine (1 mg/kg IM) is the 1st line of rescue analgesic given postoperatively in the PACU. As opioid induced ventilatory depression and its sedative effect can both contribute to hypoxia, we decided to study its correlation. And we were able to demonstrate a statistically significant difference with the use of opioids post-extubation and early postoperative hypoxia (p = 0.000). Of the literatures reviewed, none of the authors had specifically studied the association of postoperative opioid use and hypoxia. In our study, the incidence of early postoperative hypoxia among smokers is 25%, and there was no demonstratable statistical significance. The reason might be due to the prevalence of a lower number of smokers, 2.6% (8 patients) in our study. Around 20% of smokers develop chronic obstructive pulmonary disease which is characterized by small airway obstruction and a reduction in FEV_1. Smoking may be associated with emphysematous and bullous changes to lung tissue. Smokers can have premature small airway closure occurring during expiration which can result in an increase in closing volume and altered ventilation/perfusion ratio. Smoking increases mucus production and viscosity and impairs mucus clearance through damage to ciliary structure and function. This promotes sputum retention and increases the risk of developing pneumonia and respiratory failure. These changes seen with smoking contribute for its definitive association with early postoperative hypoxia. The study report by Moges Gelaw *et al* [18] demonstrated a significant association (p = 0.027) between smoking and early postoperative hypoxia. Studies by Moges Gelaw *et al* [18], Debas Yaregal *et al* [19], Mohammed Irfan *et al* [22], and Arunatoi *et al* [23], showed a statistically significant relationship between obese patients (BMI > 25) and early postoperative hypoxia. Obese patients have a reduction in functional residual capacity, increased total lung resistance and decreased thoraco-pulmonary compliance thus increasing the risk for developing early postoperative hypoxia. However, our study did not show any significant association. The possible reasons might be the use of regional anaesthesia for obese patients (58.3%) and most of the obese patients were younger (< 50 years) (62.8%) in our study population. The incidence of hypoxia among ASA class III patients was 14%. There was no demonstratable statistical significance noted between ASA class and early postoperative hypoxia in our study. In accordance with our study, reports by Amare Agmas *et al* [17], Moges Gelaw *et al* [18], Debas Yaregal *et al* [19], Getahun Dendir *et al* [21], also showed no significant association between ASA class and early postoperative hypoxia.

The study by Moges Gelaw *et al* [18], showed an increased risk of early postoperative hypoxia among patients undergoing emergency surgery. As these procedures are done as emergencies there is inadequate time to optimise respiratory, hemodynamic and fasting conditions. Also, the requirement of general anaesthesia further increases the risk of early postoperative hypoxia. However, our study did not demonstrate this finding, and the reason might be due to the inclusion of a lower number of patients (8 patients, 2.6%) who underwent emergency surgery during the study period and among them most received neuraxial anaesthesia (87.5%). In accordance with our study, Debas Yaregal *et al* [19], also showed no significant difference between emergency surgery and early postoperative hypoxia.

In our study, among the type of surgeries studied, the largest proportion were patients who underwent general surgery, 20.7% (64 patients). Of the literatures reviewed, hepatobiliary, cardiothoracic, ENT and general surgery

patients were associated with an increased risk for early postoperative hypoxia. In our study, there were no open hepatobiliary or cardiothoracic cases done during the study period. Among ENT patients, 19% had early postoperative hypoxia, 26.6% had hypoxia among general surgical patients. In our study there was no demonstratable statistical significance with the type of surgeries and early postoperative hypoxia. In our study, the incidence of hypoxia among patients who were operated for more than 120 minutes was 19.1%. We could not demonstrate a significant correlation between surgical duration and early postoperative hypoxia. In accordance with our study, reports by Amare Agmas *et al* [17], Moges *et al* [18], Getahun Dendir *et al* [21], and Arunatoi Sirussawakul *et al* [23], also showed no statistical significance between duration of surgery and early postoperative hypoxia. However, Debas Yaregal *et al* [19], showed a statistical significance between surgical duration and early postoperative hypoxia. The possible reason might be the intraoperative use of longer acting drugs such as pancuronium and morphine in their study.

CONCLUSION

Our study recommends that patients aged ≥ 50 years, OSA patients, patients with a preoperative saturation level < 95%, patients undergoing surgery under general anaesthesia, laparoscopic surgeries and patients requiring opioids post-extubation are at high risk of hypoxia, hence requiring vigilant PACU monitoring and oxygen supplementation.

List of abbreviations

FiO_2: Fraction of Inspired Oxygen
PACU: Post Anaesthesia Care Unit
$EtCO_2$: End tidal Carbon dioxide
ASA: American Society of Anaesthesiology
MAC: Minimum Alveolar Concentration
TOFR: Train Of Four Ratio
POSS: Passero Opioid - induced Sedation Scale
LAMAC: Local Anaesthesia with Monitored Anaesthesia Care
EPH: Early Postoperative Hypoxia
VAS: Visual Analog Scale
FEV_1: Forced Expiratory Volume in 1 second

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Author's contribution

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Dr Suryakala. The first draft of the manuscript was written by Dr Suryakala under the guidance of Dr Lynda Franklin and Dr Kandha Giri Vasan. All authors read and approved of the final manuscript.

Conflict of interest

No conflicts of interest

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