Scientific Research Publishing

Open Journal of Anesthesiology, 2024, 14, 209-220
https://www.scirp.org/journal/ojanes
ISSN Online: 2164-5558
ISSN Print: 2164-5531

Incidence and Management of Early Postoperative Hypoxemia after Abdominal Surgery at Teaching Hospital

Nga Nomo Serge Vivier[1*], Mpeyou Sani Mohamed[2], Kuitchet Aristide[3], Binam Bikoi Charles[4], Maiwong Betila Venloah[5], Dominique Djomo Tamchom[6], Iroume Bifouna Cristella Raissa[7], Ngouatna Serge[7], Jemea Bonaventure[7], Metogo Mbengono Junette[8], Fidèle Binam[7]

[1]Department of Surgery and Specialties, Higher Institute of Medical Technology, Yaounde, Cameroon
[2]Department of Physiology, Faculty of Basic Medical Sciences, University of Calabar, Calabar, Nigeria
[3]Department of Surgery and Specialties, University of Garoua, Garoua, Cameroon
[4]Department of Surgery and Specialties, University of Ebolowa, Ebolowa, Cameroon
[5]Department of Anesthesia and Intensive Care, Catholic University of Central Africa, Yaounde, Cameroon
[6]Department of Surgery and Specialties, University of Buea, Buea, Cameroon
[7]Department of Surgery and Specialties, University of Yaounde I, Yaounde, Cameroon
[8]Department of Surgery and Specialties, University of Douala, Douala, Cameroon
Email: *serges771@gmail.com

How to cite this paper: Vivier, N.N.S., Mohamed, M.S., Aristide, K., Charles, B.B., Venloah, M.B., Tamchom, D.D., Raissa, I.B.C., Serge, N., Bonaventure, J., Junette, M.M., Binam, F. (2024) Incidence and Management of Early Postoperative Hypoxemia after Abdominal Surgery at Teaching Hospital. *Open Journal of Anesthesiology*, **14**, 209-220.
https://doi.org/10.4236/ojanes.2024.1410019

Received: May 28, 2024
Accepted: October 13, 2024
Published: October 16, 2024

Abstract

Background: Oxygen saturation refers to the quantity of oxygenated hemoglobin in the blood, that is to say the level of oxygen measurable in the red blood cells when they have passed through the lungs. The aim of this study was to describe the management of early postoperative hypoxemia after abdominal surgery at the Yaounde General Hospital (YGH). **Method**: This is a quantitative, observational study, with a descriptive aim, which took place in the anesthesiology department of the YGH, over a period of 2 months from August 1st to October 1st, 2023. The study included all the patients ≥18 years, of both sexes who had abdominal surgery under general anesthesia and were willing to participate during the time of data collection. The variables studied were the sociodemographic and clinical characteristics, risk factors for oxygen desaturation, postoperative variations in SPO^2 and therapeutic tools. **Results**: We collected 30 patients among whom 11 presented with early postoperative hypoxemia *i.e.* a frequency of 36.7%. The age of the patients ranged from 18 to 63 years and the mean was 42.47 ± 13.5 years on average. The sex ratio was 0.5. Hysterectomy was the most commonly performed surgery (23.3%). The most common comorbidity was high blood pressure (30%). Half of the patients had midline incision. Supra-umbilical surgery predominated (56.7%), intraoperative blood loss ≥500 ml in 46.7% of cases. Upper abdominal surgery

with, subcostal incision and blood loss ≥500 ml are statistically significant risk factors for the occurrence of early postoperative hypoxemia ($P < 0.05$). Regarding the treatment of hypoxemia, oxygen therapy was applied in 20% of cases, new tracheal intubation in 6.7% of cases. The outcome was favorable for all participants. **Conclusion**: Hypoxemia is the result of impaired respiratory function favored by the conditions encountered during the early postoperative period.

Keywords

Abdominal Surgery, Postoperative Hypoxemia, Incidence, Management

1. Introduction

The surgical approach to the abdominal cavity is generally accompanied by respiratory complications, which are one of the main causes of postoperative complications, including hypoxemia [1]-[3]. Postoperative hypoxemia was observed during transport of the patient from theater to the post anesthesia care unit (PACU), the PACU and later in the patient's room [2]. Hypoxemia is defined as inadequate oxygen level in the blood and can be caused by less oxygen content at the arterial level or inadequate blood flow to the tissues [1] [4]. It can be appreciated by low PaO2 level in the arterial blood less than 60 mmHg or with the aid of pulse oximetry SpO2 below 90% [1] [4]. The early postoperative period is a critical time for developing hypoxemia [1] [2]. The incidence of early postoperative hypoxemia ranges from 14 to 80% depending on the study, due to differences in the populations studied, the type of anesthesia as well as the type of surgery [3]-[7]. The outcome can be fatal in the event of inappropriate or late treatment. Mortality associated with postoperative respiratory complications ranges from 6 to 29% [7]. African data on early postoperative hypoxemia are scarce. With a view to reducing early postoperative mortality, we set out to measure the frequency of occurrence of early postoperative hypoxemia in abdominal surgery and to describe the management.

2. Material and Method

This is a quantitative study, with a descriptive aim and prospective data collection. It took place in the anesthesiology department of the Yaounde General Hospital (YGH) over a period of two months from August 1 to October 1, 2023. All adult patients (age ≥ 18 years) undergoing abdominal surgery, under general anesthesia, during the elicited period were included in the study. The exclusion concerned all patients who voluntarily chose not to participate in the study, those unable to communicate in French or English. The outcome variable of the study was early post-operative hypoxemia which was assessed with life box pulse oximetry. The variables studied were sociodemographic data (age, gender, ASA class, body mass

index), clinical and pharmacological data (anesthesia drugs, type of anesthesia, type of surgery, site of incision, past medical history, intraoperative blood loss and SpO2). Early postoperative hypoxemia is defined as a pulse oximetry reading of SpO2 less than 90% for at least 30 seconds during transport from the operating room to the PACU, or in the PACU within 20 minutes of extubation [5].

2.1. Sample Size Determination

The sample size was estimated by taking the prevalence of postoperative desaturation in abdominal surgery (12.1%) from a study done in USA [5] with the assumption of single population proportion at 5% margin of error, and at 95% confidence level (P = 12% was taken). P = 0.121, 1 − P = 0.88, d = 5%, Z = 1.96.

The sample size was calculated using the Lorenz formula of:

$$n = \frac{Z^2 P(1-P)}{d^2} = \frac{(1.96)^2 \times 0.121 \times (1-0.121)}{0.0025} = 43$$

where:

n is the desired sample size;

Z is standard normal distribution usually set as 1.96 (corresponds to 95% confidence level);

P is prevalence of the early postoperative hypoxemia in abdominal surgery;

d is degree of accuracy desired (marginal error is 5% (0.05)).

Then the sample size is 43 participants.

2.2. Procedure of Data Collection

Data were collected by nurse anesthetists who underwent 48 hours of training on the collection procedure, the use of collection tools and obtaining informed consent from study participants. A pretest to validate the collection tool was carried out on 5 patients undergoing elective abdominal surgery at the Essos hospital center (Cameroon) before the recruitment period. The data was collected through document review, direct patient observation, and measurement of oxygen saturation by pulse oximetry (Lifebox Pulse Oximeter). A patient received general anesthesia reversal of muscle blockage was done with neostigmine at 0.05 $mg{\cdot}kg^{-1}$ and atropine at 0.01 $mg{\cdot}kg^{-1}$ intravenously and patients were extubated when they respond to command after the completion of the surgery, there was no peripheral nerve stimulator in the study area. Peripheral arterial oxygen saturation measurement was started immediately when the patient was transferred to the post anesthesia care unit then measured continuously within the first hour. The quality was maintained by checking the consistency, clarity, and completeness of the anesthetic sheet, registration books, individual chart. The data were collected by an employed structured questionnaire. Data was collected post-operatively by reviewing the charts with a structured questionnaire which includes age, gender, physical status, type of surgery, history of co-morbidities, and their post-operative events and outcomes will be recorded carefully. The data was entered by using Epi info 7 and analyzed by SPSS 29.00 version statistical software. The incidence of

hypoxemia was expressed as descriptive statistics and logistic regression was used to adjust or control the possible confounding factors and to identify associated factors for postoperative hypoxemia. The cut point for Statistical significance was $P < 0.05$.

2.3. Ethical Considerations

Ethical authorization was requested and obtained from the ethical approval committee of the Catholic University of Central Africa. Verbal informed consent was obtained from participants before conducting the study. Participants were informed that participation is voluntary and that they can withdraw from the study at any time if they wish, without any penalty. Participant confidentiality was maintained at all levels of the study. Any hypoxemia detected during the data collection period was reported to the anesthetists and the means of management listed by the anesthesiologists collecting the data.

3. Results

A total of 30 patients met the inclusion criteria, among whom 36.7% (n = 11) experienced early postoperative hypoxemia, *i.e.* a frequency of 36.6%. The age of the patients ranged from 18 to 63 years and the mean was 42.47 ± 13.5 years on average. Most patients (43.3%) were aged between 45 and 60 years. The sex ratio was 0.5. Almost all patients belonged to ASA classes I and II (96.7%). The characteristics of the study population are presented in Table 1.

Hysterectomy was the most commonly performed surgery (23.3%), followed by appendectomy (20%), distal small bowel resection (20%), colectomy (13%) cholecystectomy (10%) and gastrectomy (7%). The most common comorbidity was high blood pressure (30%) and diabetes mellitus (23.3%). Half of those operated on had a median incision above and below the umbilical. The McBurny incision was performed in 20% of cases, the pfannenstiel incision in 16.7% of cases and the subcostal incision in 10% of cases. laparoscopy was rarely practiced and represented 3.3% of cases. In more than half of the cases, it involved supra-umbilical surgery (56.7%). The average duration of surgery was 226 ± 128 minutes, with extremes ranging from 495 to 67 minutes. Intraoperative blood loss was greater than 500 ml in 46.7% of cases. The mean was 438.67; the variance was 18301.61; the standard deviation was 135.28; the minimum blood loss was 200 ml and the maximum loss was 700 ml. Out of a total of 30 operated patients, 36.7% (n = 11/30) experienced early postoperative hypoxemia. In this population, hypoxemia was observed during transport to the PACU in 18.2% (n = 2/11) cases, at the PACU in 81.8% (n = 9/11) cases.

Referring to sociodemographic data, early postoperative hypoxemia was significantly correlated with body mass index, type of surgical procedure, past medical history and ASA class ($P < 0.05$). Cholecystectomy, hypertension, diabetes, HIV, ASA classes II and III represent isolated risk factors for the occurrence of early postoperative hypoxemia.

Table 1. Characteristics of the study population.

Sociodemographic characteristic		Early postoperative hypoxemia		OR (IC)	*P*
		YES	NO		
		N (%)	N (%)		
Gender	Female	8 (40)	12 (60)	1.53 (0.29 - 9.24)	0.598
	Male	3 (30)	7 (70)		0.598
Age group	[18 - 30[	2 (33.3)	4 (66.7)	0.83 (0.09 - 5.74)	0.852
	[30 - 45[	2 (25)	6 (75)	0.49 (0.5 - 2.95)	0.431
	[45 - 60[	5 (38.5)	8 (61.5)	1.14 (0.23 - 5.36)	0.860
	≥60	2 (66.7)	1 (33.3)	3.80 (0.26 - 123.93)	0.263
Body mass index	[18 - 25[	2 (40)	3 (60)	1.17 (0.12 - 9.37)	0.867
	[25 - 30[	5 (26.3)	14 (73.7)	0.31 (0.05 - 1.52)	0.128
	[30 - 35[	1 (50)	1 (50)	2.17 (0.05 - 92.25)	0.581
	≥35	3 (75)	1 (25)	6.29 (−0.58 - 186.49)	0.093
Surgical intervention	Hernioraphy	0 (0)	1 (100)	0 (0 - 32.81)	0.446
	Gastrectomy	1 (50)	1 (50)	1.76 (0.04 - 73.84)	0.690
	Appendectomy	0 (0)	6 (100)	0 (0 - 0.95)	**0.040**
	Bowel resection	4 (66.7)	2 (33.3)	4.57 (0.66 - 42.80)	0.093
	Cholecystectomy	3 (100)	0 (0)	1 (1.12 - 1)	**0.040**
	Colectomy	2 (50)	2 (50)	1.84 (0.16 - 20.29)	0.558
	Splenectomy	0 (0)	1 (100)	0 (0 - 32.81)	0.446
	Hysterectomy	1 (14.3)	6 (85.7)	0.22 (0.01 - 1.87)	0.167
Background	HTN*	6 (66.7)	3 (33.3)	5.94 (1.08 - 39.27)	**0.028**
	DM**	5 (71.4)	2 (28.6)	6.55 (1.01 - 60.02)	**0.032**
	History of smoking	2 (50)	2 (50)	1.84 (0.16 - 20.29)	0.558
	HIV***	2 (100)	0 (0)	1 (0.51 - 1)	0.058
ASA classification	I	2 (12.5)	14 (87.5)	0.08 (0.01 - 0.51)	**0.004**
	II	8 (61.5)	5 (38.5)	6.89 (1.33 - 44.12)	**0.015**
	III	1 (100)	0 (0)	1 (0.09 - 1)	0.188

Legend: HTN* = high blood pressure, DM** = diabetes mellitus, HIV*** = Human immunodeficiency virus (HIV).

According to Table 2, upper and lower abdominal surgeries are of equal proportions. Compared with lower abdominal surgery, only upper abdominal surgery exposes to early postoperative hypoxemia (n = 11/17, 64.7%, P = 0.06). The type of surgical incision most involved in the occurrence of early postoperative hypoxemia is the subcostal incision (n = 3/3, 100%), followed by the midline incision (n = 8/15, 53%). The last significant risk factor for the occurrence of early postoperative hypoxemia is represented by intraoperative blood loss of more than 500 ml (n = 10/11, 90.9%; p < 0.01).

Table 2. Surgical data.

Surgical data		Early postoperative hypoxemia		OR (IC)	*P*
		YES	NO		
		N (%)	N (%)		
Type of abdominal surgery	Upper abdominal	11 (64.7)	6 (35.3)	1 (4.76 - 1)	**<0.001**
	Lower abdominal	0 (0)	13 (100)	-	**<0.001**
Type of incision	Midline	8 (53.3)	7 (46.7)	4.33 (0.87 - 26.25)	0.062
	Pfannenstiel	0 (0)	5 (100)	0 (0 - 1.28)	0.066
	Subcostal	3 (100)	0 (0)	1 (1.11 - 2)	**0.040**
	McBurney	0 (0)	6 (100)	0 (0 - 0.95)	0.061
	Laparoscopy	0 (0)	1 (100)	0 (0 - 22.45)	0.357
Surgery duration (hours)	<2	0 (0)	8 (100)	0 (0 - 0.59)	**0.013**
	[2 - 4[	0 (0)	5 (100)	0 (0 - 1.28)	0.066
	[4 - 6[	7 (58.3)	5 (41.7)	4.61 (0.93 - 25.86)	0.062
	≥6	4 (80)	1 (20)	9.42 (0.99 - 266.84)	0.090
Blood loss	<500	1 (6.3)	15 (93.8)	0.03 (0 - 0.25)	<0.001
	≥500	10 (71.4)	4 (28.6)	0.00 (0.00)	**<0.001**
Maximum time spent in the recovery room (hour)	<1	1 (10)	9 (90)	0.11 (0 - 0.92)	0.081
	>1	10 (50)	10 (50)	6	0.081

Table 3. Incidence of early postoperative hypoxemia on different time of measurement.

		Incidence of early postoperative hypoxemia on different time of measurement									
		During transfer to PACU		5 min		10 min		15 min		20 min	
Oxygen saturation status		n	%	n	%	n	%	n	%	n	%
	Hypoxemia	6	20	11	36.66	7	23.33	3	10	2	6.66
	Normal	24	80	19	63.33	23	76.66	27	90	28	93.33

In Table 3, early postoperative hypoxemia varied over time, occurring mainly on admission to the PACU, *i.e.* 5 minutes after extubation (n = 11, 36.6%). A progressive regression of its incidence was observed from the 15th postoperative minute (10%). Concerning the management of early postoperative hypoxemia in our study, it used pharmacological and non-pharmacological means. Regarding non-pharmacological measures, they concerned the installation of the patient in a half-sitting position (fowlers position) in all cases (100%), the aspiration of oral and pharyngeal secretions (45.5%), the use of the Guedel cannula (18.2%). Therapy with oxygen was applied in 54.6% (n = 6/11) of cases, new tracheal intubation in 18.2% (n = 2/11) of cases. Other therapies are represented by muscle relaxant antagonists 18.2% (n = 2/11), corticosteroids 9.1% (n = 1/11), inhaled bronchodilators 9.1% (n = 1/11). The outcome was favorable for all participants; there were

no deaths attributable to early postoperative hypoxemia in our study.

4. Discussion

Postoperative hypoxemia is common in clinical practice and contributes to increased perioperative morbidity [8] [9]. It involves factors related to the patient (comorbidities), surgery, and anesthesia. There is no consensus definition of postoperative hypoxemia, which explains the variability of its frequency in the literature. In the absence of oxygen therapy, the majority of studies agree to observe an SpO2 less than or equal to 90% on arrival in the recovery room [8]. Our study population was mainly made up of young adults, with balanced comorbidities for those who had them. The female predominance in the sample could be explained by the participation of gynecological interventions.

The frequency of occurrence of hypoxemia must be related to the observation conditions and the period studied. We found a relatively high frequency of early postoperative hypoxemia (36.7%) at the Yaounde general hospital. Amar *et al*. [5] in a retrospective study on incidence and associated factors of postoperative hypoxemia among adult elective surgical patients at Dessie Comprehensive Specialized Hospital, found a frequency of early postoperative hypoxemia of 24.5% (95% of Confidence Interval 19.34, 30.62) among 298 postoperative patients. Walker M. [10] found an even lower frequency than the previous one in a work on Risk factors for oxygen desaturation on arrival in the post anesthesia care unit. In the retrospective cohort study conducted by Bang Y [11], which focused on Frequency and risk factors for failed weaning from supplemental oxygen therapy after general anesthesia at a post anesthesia care unit: a retrospective cohort study, the latter described major abdominal surgery as a risk factor for failure of postoperative oxygen therapy with the immediate consequence of increasing the frequency of early postoperative hypoxemia. Walde *et al*. [12] state in their series a frequency of early postoperative hypoxemia of 22.7%. Indeed, among sampled 238 elective surgical patient's 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). African data on early postoperative hypoxemia are scarce. The frequency of occurrence of the early postoperative hypoxemia event in our study remains high overall, compared to the results reported by many authors [5] [10]-[12]. This difference could be explained by the absence of systematic oxygen supplementation during the transport of patients from the operating room to the PACU in our research work. The choice of abdominal surgery and probably the insufficient management of postoperative pain could be additional reasons justifying this high frequency. After abdominal surgery, hypoxemia occurs in 30 to 50% of patients; this is generally reversible after treatment combining oxygen therapy and physiotherapy, but in 10% of patients, mechanical ventilation is necessary and is associated with an increase in morbidity, mortality and

length of stay in intensive care and with the hospital [13]. Hypoxemia can occur as soon as the patient is extubated in the operating room and during transport from the operating room to the recovery room. During their transition to the recovery room, almost half of patients have hypoxemia [14]. Clinical warning signs are most often non-specific, such as bradypnea, sometimes absent or inconsistent [6] [14]. The absence of SpO_2 monitoring during transport from the operating room to the PACU inevitably leads to hypoxemic situations being ignored. Pulse oximetry has revolutionized detection and allowed a better understanding of the frequency of early postoperative hypoxemia.

Early postoperative hypoxemia was significantly correlated with body mass index, type of surgical procedure, history and ASA class ($P < 0.05$) in our research work. The same applies to the following surgical variables: upper abdominal surgery, subcostal incision and significant blood loss ≥500 ml. Wolde G *et al*. [12] demonstrate that 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). According to Debas Yaregal M *et al*. [14], the risk factors of early post-operative hypoxemia were preoperative oxygen saturation. In the work of Andualem A *et al*. [5], associated factors with postoperative hypoxemia were age greater than 55 years, preoperative saturation below 95%, type of anesthesia, postoperative pain score, and postoperative muscular strength. The patient age below 55 years had 84% less likely to develop hypoxemic episodes postoperatively when we compare age above 55-year-old [5]. A patient who received general anesthesia had a chance of developing hypoxia eight times than those who received regional anesthesia [5]. A patient who can keep a grip for 15 seconds had 60% less likely to develop hypoxemia than those who can keep a grip for 15 seconds postoperatively [5]. Risk factors associated with the occurrence of early postoperative hypoxemia depend on the variables studied, the prospective or retrospective nature of the study and the sample size. This also explains the variability of the significance threshold of each risk factor. On the pathophysiological level, anesthesia, surgery and postoperative pain induce per and postoperative changes in respiratory function. These changes include the appearance of a restrictive syndrome with reduced vital capacity, reduced functional residual capacity and diaphragmatic dysfunction. The induction of general anesthesia results in cephalic displacement of the dependent part of the diaphragm which immediately generates a reduction in pulmonary compliance and functional residual capacity [15]. This situation is aggravated by the supine position. When the functional residual capacity falls below the closing volume, the alveoli close [15]-[17]. The immediate consequence is the appearance of atelectasis responsible for a shunt effect, an inadequacy of gas exchange with a ventilation/perfusion ratio <1. There are areas in which perfusion is normal but ventilation is impaired. These modifications are increased in obese people [18]. In the early postoperative period, the residual effects of anesthesia agents on respiratory function are then observed.

Concerning the management of early postoperative hypoxemia in our study, we note that the management used pharmacological and non-pharmacological means invariably. There was no algorithm that guided the particular use of one of these means. Oxygen therapy was not systematic postoperative abdominal surgery at Yaounde general hospital. Oxygen was administered to half of the patients with early postoperative hypoxemia. Oxygen therapy was probably guided by the depth of hypoxemia. Since 1994, it has been mandatory to continuously monitor the SpO_2 of all patients in the operating room and recovery room [19]. Clinical monitoring and prevention of early postoperative hypoxemia in the PACU are responsible for the reduction in postoperative respiratory depression, a significant cause of mortality attributable to anesthesia [9] [20].

Recent literature data show that most surgical patients routinely receive supplemental oxygen therapy in the postoperative period to prevent postoperative hypoxemia due to incomplete lung reexpansion, reduced thoracic expansion and diaphragmatic movements caused by chest pain. Surgical site, the consequences of hemodynamic impairment and the residual effects of anesthetic drugs (most notably residual neuromuscular blockade) which can lead to atelectasis, inadequate ventilation/perfusion ratio, alveolar hypoventilation and altered airway patency upper respiratory tract [5] [21]-[23]. Many devices can be used to deliver oxygen postoperatively, including a simple face mask or a low-flow nasal cannula. In recent years, oxygen administration via high-flow nasal cannula or continuous positive airway pressure (CPAP) is increasingly indicated. High-flow oxygen therapy and non-invasive ventilation are respiratory supports that improve oxygenation, reduce the work of breathing, and the risk of further intubation in certain patients. Post-operatively, standard oxygen is sufficient even after major planned surgery (risk of intubation < 5%), but should be replaced by high-flow oxygen therapy in the event of hypoxemia (risk of intubation 10% - 15%), and by non-invasive ventilation in case of respiratory failure with signs of distress (risk of intubation 50%) [24]-[26].

5. Conclusion

Early postoperative hypoxemia is a therapeutic challenge for anesthesiologists in sub-Saharan Africa. There are multiple etiologies in the postoperative time. It must be prevented and detected early to avoid potentially serious or lethal complications. Its incidence is considerable, and fortunately remains without dramatic consequences in abdominal surgery at the Yaounde general hospital. ASA class II and III patients, obesity, subcostal incision, upper abdominal surgery, intraoperative blood loss > 500 ml are recognized as the main risk factors that expose to early postoperative hypoxemia in patients retained in abdominal surgery at YGH. It probably reflects hypoventilation in ambient air which unfortunately remains the rule during transport between the operating room and the PACU. The choice of oxygen therapy and the postoperative administration methods must be adapted to the specific needs of each patient. Oxygen therapies such as high-flow oxygen

therapy and continuous positive airway pressure have gained prominence, showing improvement in oxygenation, and reducing the risk of reintubation.

Declarations

Limitations of the Study

The small sample size and the single-center nature of the study. Large cohort studies deserve to be carried out to consolidate our results.

Author Contribution

This work was carried out in collaboration among all authors. Serge Vivier Nga Nomo and Maiwong Betila contributed to the conception and design of the study, acquired, analyzed and interepted the data drafted and revised the manuscript. Mpeyou Sani Mohamed, Serge Vivier Nga Nomo, Charles Binam Bikoi, Aristide Kuitchet participate in reviewing the design and methods of data collection, interpretation and preparation of the manuscript. All authors participate in preparation and critical review of the manuscripts. Finally, all authors read and approved the manuscript.

Acknowledgements

We thank the staff of the department of anesthesia and intensive care of the Yaounde General Hospital for providing all the necessary material we needed for this study. We also thank the management and staff of the department of surgery of the Yaounde General Hospital for approving this study protocol and making available all the necessary materials needed for the study.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Sarkar, M., Niranjan, N. and Banyal, P. (2017) Mechanisms of Hypoxemia. *Lung India*, **34**, 47-60. https://doi.org/10.4103/0970-2113.197116

[2] Gülsen, A., Kilinc, O., Tertemiz, K.C., Ekice, T. and Günay, T. (2020) Comparison of Postoperative Pulmonary Complication Indices in Elective Abdominal Surgery Patients. *Tanaffos*, **19**, 20-30.

[3] Garg, S., Govindaraj, V., Dwivedi, D.P., Raja, K. and Theerthar, E.P. (2024) Postoperative Pulmonary Complications in Patients Undergoing Upper Abdominal Surgery: Risk Factors and Predictive Models. *Monaldi Archives for Chest Disease*. https://doi.org/10.4081/monaldi.2024.2915

[4] Gebeyehu, G., Eshetu, A. and Aweke, S. (2022) Incidence and Associated Factors of Postoperative Pulmonary Complications after Abdominal Surgery in the Public Hospital, Addis Ababa, Ethiopia. *Anesthesiology Research and Practice*, **2022**, Article ID: 8223903. https://doi.org/10.1155/2022/8223903

[5] Andualem, A.A. and Yesuf, K.A. (2022) Incidence and Associated Factors of Postoperative Hypoxemia among Adult Elective Surgical Patients at Dessie Comprehensive

Specialized Hospital: An Observational Study. *Annals of Medicine & Surgery*, **78**, Article ID: 103747. https://doi.org/10.1016/j.amsu.2022.103747

[6] Dooley, F.C. and Fahy, B.G. (2024) Early Postoperative Desaturation: A Measurable Educational Warning Sign in Anesthesiology Residency Training. *Journal of Clinical Anesthesia*, **92**, Article ID: 111265. https://doi.org/10.1016/j.jclinane.2023.111265

[7] Jaber, S., Delay, J., Chanques, G., Sebbane, M., Jacquet, E., Souche, B., *et al*. (2005) Outcomes of Patients with Acute Respiratory Failure after Abdominal Surgery Treated with Noninvasive Positive Pressure Ventilation. *Chest*, **128**, 2688-2695. https://doi.org/10.1378/chest.128.4.2688

[8] Baillard, C. (2011) Oxygénothérapie postopératoire: Quand estce utile et comment faire ? *Le Praticien en Anesthésie Réanimation*, **15**, 310-314. https://doi.org/10.1016/j.pratan.2011.08.013

[9] Liu, K., Scott, J.B., Jing, G. and Li, J. (2021) Management of Postoperative Hypoxemia. *Respiratory Care*, **66**, 1136-1149. https://doi.org/10.4187/respcare.08929

[10] Walker, M., Farmer, R.G. and Schelew, B. (2015) Risk Factors for Oxygen Desaturation on Arrival in the Postanesthesia Care Unit. *Canadian Journal of Anesthesia/Journal canadien d'anesthésie*, **62**, 1019-1020. https://doi.org/10.1007/s12630-015-0371-6

[11] Bang, Y.J., Park, I.H. and Jeong, H. (2023) Frequency and Risk Factors for Failed Weaning from Supplemental Oxygen Therapy after General Anesthesia at a Postanesthesia Care Unit: A Retrospective Cohort Study. *BMC Anesthesiology*, **23**, Article No. 231. https://doi.org/10.1186/s12871-023-02192-z

[12] Wolde, G.D., Awol, M.A., Suleiman Obsa, M., Wesene, N.G., Gemechu, A.D. and Tadesse, E.N. (2018) Magnitude and Associated Factors of Immediate Postoperative Hypoxemia among Elective Surgical Procedures at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia. *Journal of Anesthesia & Clinical Research*, **9**, Article 5. https://doi.org/10.4172/2155-6148.1000821

[13] Jabaudon, M., Audard, J., Charvin, M., Godet, T. and Futier, E. (2019) Ventilation non invasive en postopératoire. *Le Praticien en Anesthésie Réanimation*, **23**, 132-138. https://doi.org/10.1016/j.pratan.2019.04.005

[14] Melesse, D.Y., Denu, Z.A., Kassahun, H.G. and Agegnehu, A.F. (2020) The Incidence of Early Post-Operative Hypoxemia and Its Contributing Factors among Patients Underwent Operation under Anesthesia at University of Gondar Comprehensive and Specialized Referral Hospital, Gondar, North West Ethiopia, 2018. A Prospective Observational Study. *International Journal of Surgery Open*, **22**, 38-46. https://doi.org/10.1016/j.ijso.2019.11.011

[15] Jahromi, B. and Jani, J. (2024) Hypoventilation, Alveolar. Differential Diagnosis of Postoperative Arterial Hypoxemia. *Basic Anesthesia Review*, **161**, 404-406.

[16] Pham, M.Q., Bui, H.M., Tran, T.T.P. and Nguyen, T.H. (2022) Early Postoperative Arterial Hypoxemia Can Predict Postoperative Pulmonary Complications. *Anaesthesia, Pain & Intensive Care*, **26**, 137-142. https://doi.org/10.35975/apic.v26i2.1819

[17] Sun, Z., Sessler, D.I., Dalton, J.E., Devereaux, P., Shahinyan, A., Naylor, A.J., *et al*. (2015) Postoperative Hypoxemia Is Common and Persistent: A Prospective Blinded Observational Study. *Anesthesia & Analgesia*, **121**, 709-715. https://doi.org/10.1213/ane.0000000000000836

[18] Kaw, R., Wong, J. and Mokhlesi, B. (2021) Obesity and Obesity Hypoventilation, Sleep Hypoventilation, and Postoperative Respiratory Failure. *Anesthesia & Analgesia*, **132**, 1265-1273. https://doi.org/10.1213/ane.0000000000005352

[19] The French Society of Anaesthesia, Critical Care and Perioperative Medecine (SFAR) (2024) Decree No. 94-1050 of December 5, 1994 Relating to the Technical Operating Conditions of Health Establishments with Regard to the Practice of Anesthesia and Modifying the Public Health Code (Third Part: Decrees). https://sfar.org/decret-securite-8121994/

[20] Zorrilla-Vaca, A., Grant, M.C., Rehman, M., Sarin, P., Varelmann, D. and Urman, R.D. (2023) Postoperative Hypoxemia after Dual-Controlled vs Volume-Controlled Ventilation in Lung Surgery. *The Annals of Thoracic Surgery*, **116**, 173-179. https://doi.org/10.1016/j.athoracsur.2022.12.029

[21] Liao, P., Wong, J., Singh, M., Wong, D.T., Islam, S., Andrawes, M., *et al*. (2017) Postoperative Oxygen Therapy in Patients with OSA: A Randomized Controlled Trial. *Chest*, **151**, 597-611. https://doi.org/10.1016/j.chest.2016.12.005

[22] Young, P.J. and Frei, D. (2021) Oxygen Therapy for Critically Ill and Post-Operative Patients. *Journal of Anesthesia*, **35**, 928-938. https://doi.org/10.1007/s00540-021-02996-8

[23] Suzuki, S. (2020) Oxygen Administration for Postoperative Surgical Patients: A Narrative Review. *Journal of Intensive Care*, **8**, Article No. 79. https://doi.org/10.1186/s40560-020-00498-5

[24] Futier, E., Paugam-Burtz, C., Godet, T., Khoy-Ear, L., Rozencwajg, S., Delay, J., *et al*. (2016) Effect of Early Postextubation High-Flow Nasal Cannula vs Conventional Oxygen Therapy on Hypoxaemia in Patients after Major Abdominal Surgery: A French Multicentre Randomised Controlled Trial (Opera). *Intensive Care Medicine*, **42**, 1888-1898. https://doi.org/10.1007/s00134-016-4594-y

[25] Chaudhuri, D., Granton, D., Wang, D.X., Burns, K.E.A., Helviz, Y., Einav, S., *et al*. (2020) High-Flow Nasal Cannula in the Immediate Postoperative Period: A Systematic Review and Meta-Analysis. *Chest*, **158**, 1934-1946. https://doi.org/10.1016/j.chest.2020.06.038

[26] Oczkowski, S., Ergan, B., Bos, L., Chatwin, M., Ferrer, M., Gregoretti, C., *et al*. (2021) ERS Clinical Practice Guidelines: High-Flow Nasal Cannula in Acute Respiratory Failure. *European Respiratory Journal*, **59**, Article ID: 2101574. https://doi.org/10.1183/13993003.01574-2021