

Determination of Factors Affecting Oxygen Saturation During Transfer From the Operating Room to the Post-Anesthesia Care Unit

Emine Arıcı Parlak¹ , Neslihan İlkaz¹ , Hatice Ayhan¹ , Emine İyigün¹ 

¹Department of Surgical Diseases Nursing, Gülhane Faculty of Nursing, University of Health Sciences Türkiye, Ankara, Türkiye

ABSTRACT

Objectives: This study aimed to determine the incidence of desaturation ($\text{SpO}_2 \leq 94\%$) during the transfer of postoperative patients from the operating room to the post-anesthesia care unit (PACU) without oxygen support and to identify factors associated with desaturation.

Methods: This prospective cross-sectional study was conducted between July 2023 and July 2024 in the operating room and PACU of a training and research hospital. The sample consisted of 164 patients. Data were collected using the Oxygen Saturation Assessment Form. Post-extubation oxygen saturation levels were continuously monitored with a pulse oximeter during transfer to the PACU and until discharge.

Results: During transfer from the operating room to the PACU, 43.3% of patients had $\text{SpO}_2 \leq 94\%$, and 8.4% of these patients had $\text{SpO}_2 < 90\%$. Patients who developed desaturation had significantly higher mean age and body mass index (BMI) and lower preoperative SpO_2 values ($P < 0.001$). Desaturation was significantly associated with female sex and the presence of chronic disease ($P = 0.032$), whereas no significant association was found with smoking history or ASA score ($P > 0.05$). In addition, desaturation was associated with general surgical procedures, the supine position, upper abdominal and thyroid surgeries, and the use of neuromuscular blocking agents ($P < 0.05$).

Conclusions: Approximately half of postoperative patients experienced $\text{SpO}_2 \leq 94\%$ in the early postoperative period. Advanced age, higher BMI, lower preoperative SpO_2 values, comorbidities, upper abdominal and thyroid surgical incisions, and the use of respiratory-depressant neuromuscular agents were identified as key factors negatively affecting postoperative oxygen saturation.

Keywords: Oxygen Saturation, Patient Transfer, Perioperative Nursing, Post-Anesthesia Care Unit, Postoperative Desaturation, Risk Factors

The early postoperative period is characterized by the persistence of physiological effects of anesthesia, one of which is hypoxemia [1, 2]. A decrease in oxygen saturation measured by pulse oximetry is the earliest and primary indicator of hypoxemia. Hypoxemia is a critical oxygen deficiency that may develop depending on the type of surgery or anesthesia and typically becomes evident within the first 20 minutes after extubation [3, 4]. It has been reported that a substantial proportion of desaturated

Received: December 25, 2025 **Accepted:** January 26, 2026 **Available Online:** January 28, 2026 **Published:** March 1, 2026

How to cite this article: Arıcı Parlak E, İlkaz N, Ayhan H, İyigün E. Determination of Factors Affecting Oxygen Saturation During Transfer From the Operating Room to the Post-Anesthesia Care Unit. Eur Res J. 2026;12(3):347-357. doi: 10.18621/eurj.1849232

Corresponding author: Emine Arıcı Parlak, RN, PhD., Assist. Prof., E-mail: emine.ariciparlak@sbu.edu.tr

This is an **open-access** article distributed under the terms of a Creative Commons [Attribution-NonCommercial-NoDerivatives 4.0 International](https://creativecommons.org/licenses/by-nc-nd/4.0/) License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it.

Available Online at <https://dergipark.org.tr/en/pub/eurj>



patients experience hypoxemia particularly during the initial minutes of transfer [4-6]. Therefore, administering supplemental oxygen via an oxygen mask or nasal cannula to all patients during transfer from the operating room to the post-anesthesia care unit (PACU) and in the early post-anesthesia period may reduce the development or severity of hypoxemia [4, 7, 8]. In this regard, the transfer to the PACU represents a critical period for nurses and anesthesiologists in terms of mitigating hypoxemia risk [2].

Postoperative hypoxemia may lead to cardiac and neurological complications, prolong hospital stay, and result in additional costs [5]. Normal postoperative oxygen saturation during anesthesia and emergence from anesthesia is expected to range between 95% and 100%; values of 94% and below are considered desaturation, while levels below 90% are regarded as a clinical emergency [9, 10-12]. Furthermore, guidelines for the prevention of surgical site infections recommend the administration of a high fraction of inspired oxygen in the postoperative period and maintaining oxygen saturation above 95% [13, 14]. In the literature, reported rates of desaturation during transfer from the operating room to the PACU or in the early postoperative period range from 13% to 35% [2, 4, 6], while hypoxemia rates range from 14% to 45% [9, 15, 16]. It is observed that the factors affecting oxygen saturation during transfer from the operating room to the PACU have not been clearly established and that desaturation incidence varies widely. One factor whose impact on oxygen saturation at initial PACU admission remains controversial is the provision of supplemental oxygen during transfer. The literature indicates that while some anesthesiologists transfer patients from the operating room to the PACU with supplemental oxygen [17, 18], others do not consider it necessary [19, 20]. This suggests that oxygen administration practices during transfer vary across institutions. Such variability may stem from the absence of clear, high-level, and binding recommendations regarding the transfer process in existing guidelines, as well as from inconsistencies in the available evidence. Within this context, the aim of the present study is to determine the incidence of desaturation ($\text{SpO}_2 \leq 94\%$) during transfer of postoperative patients from the operating room to the PACU without supplemental oxygen and to examine

the factors affecting desaturation. It is anticipated that the findings of this study will enhance the quality of patient care and make a significant contribution to clinical practice.

METHODS

The study was designed as a prospective cross-sectional investigation and was conducted between July 2023 and July 2024 in the operating room and PACU affiliated with the Department of Anesthesiology and Reanimation of a training and research hospital in Ankara. The operating suite consists of a total of 14 operating rooms. Following surgery, patients are transferred to the PACU, which is located approximately 150 meters from the operating rooms, on a stretcher and under the supervision of an anesthesiologist. This transfer process takes an average of approximately 100 seconds, and due to the short distance, supplemental oxygen is not administered during transfer. The PACU is equipped to provide early postoperative monitoring and care for up to eight patients simultaneously. After completion of postoperative monitoring, patients who meet the PACU discharge criteria are transferred to their respective inpatient wards.

Study Population and Sample Size

The study population consisted of all elective surgical cases scheduled between July 2023 and July 2024. The total number of surgeries performed during the previous year was 22,459. The study sample comprised 164 cases, as determined using the Raosoft Sample Size Calculator, with a confidence level of 80% and a margin of error of 5% [21].

The inclusion criteria were as follows: willingness to participate in the study, age 18 years or older, and an American Society of Anesthesiologists (ASA) physical status classification of I, II, or III. The exclusion criteria included a preoperative oxygen saturation of $\leq 94\%$ and the presence of anemia, defined as a hemoglobin level of <12 g/dL in women and <13 g/dL in men. Patients classified as ASA IV were excluded due to their higher baseline risk of hypoxemia and increased perioperative physiological instability, which could

have affected postoperative oxygen saturation measurements. Additionally, patients who developed intraoperative hypothermia (body temperature < 36.0°C) or who could not be extubated postoperatively were excluded from the study.

Oxygen Saturation Assessment Form

In this study, data were collected using a structured form developed by the researchers based on the relevant literature [4–6]. The form includes variables related to patients' sociodemographic and clinical characteristics, such as age, sex, height, weight, presence of chronic disease, history of smoking, and ASA score. In addition, it contains data describing surgical and anesthetic characteristics, including the type of surgical clinic, surgical position, incision site, type of anesthesia, use of neuromuscular blocking agents, sedation status, duration of anesthesia, and transfer time.

Operational Definitions

Early postoperative desaturation was defined as an peripheral oxygen saturation (SpO₂) value below 94%, measured by pulse oximetry, persisting for at least 30 seconds during the transfer from the operating room to the PACU and within the first 20 minutes of the postoperative period in the recovery unit [4, 9, 10].

Sedation score was defined as follows: 0 = awake; 1 = drowsy, arousable by verbal stimulation; 2 = drowsy, arousable by tactile stimulation; 3 = unarousable [4].

Data Collection Procedure

Patients who met the inclusion criteria were informed about the study by the researchers, and written and verbal informed consent was obtained. Study data were collected using a structured data collection form through face-to-face interviews conducted in the operating room prior to surgery, as well as from patient medical records, and were subsequently recorded. Patients' oxygen saturation levels were measured using a pulse oximeter. The study was conducted in two phases.

In the first phase, the first ten items of the researcher-developed data collection form were used to assess patients' demographic and baseline clinical characteristics, including age, sex, height, weight,

presence of chronic disease, ASA score, history of smoking, and oxygen saturation. These data were collected and recorded through face-to-face interviews. Following surgery, the same data collection form was used to systematically record information related to the surgical procedure and anesthesia administered to the patients.

The second phase of the study involved monitoring and evaluating the oxygen saturation levels of postoperative extubated patients from the time of extubation through transfer to the PACU and until discharge from the PACU, using a pulse oximeter (Finger Clip Pulse Oximeter, 2019). Immediately after extubation, the patients' initial oxygen saturation values were measured and recorded by the researchers. Oxygen saturation monitoring continued during the transfer to the PACU, with patients being transferred with the pulse oximeter attached to their finger. The lowest oxygen saturation value was recorded every 30 seconds. Pulse oximeter devices typically provide averaged signal readings every 6–8 seconds, and threshold alarms are generally set at an average of 90%, depending on the unit or institutional protocols [15]. No patients received supplemental oxygen during the transfer process. Finally, patients' initial oxygen saturation values upon arrival at the PACU and their oxygen saturation values at the time of PACU discharge were recorded. Patients were discharged from the PACU when an Aldrete score of ≥ 9 was achieved.

Statistical Analysis

Study data were analyzed using SPSS version 22.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize the data. Normality of distribution was assessed using the Kolmogorov–Smirnov test. For variables that showed a normal distribution, Chi-square tests and Student's t-tests were applied to compare selected demographic, surgical, and anesthetic characteristics between patients with and without desaturation. The relationships between selected demographic and perioperative variables and minimum and mean SpO₂ values were examined using Pearson correlation analysis. In all statistical analyses, a P-value < 0.05 was considered statistically significant.

RESULTS

Patients (n=32) who developed intraoperative hypothermia (body temperature <36°C) or those (n=13) who could not be extubated postoperatively were excluded from the analysis. According to the study findings, 43.3% (n=71) of patients experienced a decrease in oxygen saturation to $\leq 94\%$ during the transfer to the PACU. Additionally, 8.4% (n=6) of desaturated patients were found to have oxygen saturation levels below 90%.

The findings related to the comparison of patients' demographic and clinical characteristics according to desaturation status are presented in Table 1. The mean age of patients who developed desaturation was 51.95 ± 13.4 years, whereas it was 41.4 ± 16.6 years in those without desaturation, and the difference between the two groups was statistically significant ($P < 0.001$).

The mean body mass index (BMI) of desaturated patients was 28.3 ± 4.7 , compared with 25.2 ± 5.3 in non-desaturated patients, and this difference was also statistically significant ($P < 0.001$). It was determined that 73.2% (n=52) of desaturated patients were female and 59.2% (n=42) had at least one chronic disease. Statistically significant differences were observed between the groups with respect to sex and the presence of chronic disease ($P = 0.032$ and $P < 0.001$, respectively). In contrast, no statistically significant differences were found between desaturated and non-desaturated patients in terms of smoking history and ASA score ($P > 0.05$). Additionally, preoperative oxygen saturation levels were found to be significantly lower in desaturated patients compared with those without desaturation ($P < 0.001$).

The findings regarding the comparison of patients' surgical and anesthetic characteristics according to

TABLE 1. Comparison of Patients' Sociodemographic and Clinical Characteristics According to Postoperative Desaturation Status (n=164)

Variables	Postoperative SpO ₂		Test statistic	P-value
	Nondesaturation SpO ₂ >94 (n=93)	Desaturation SpO ₂ ≤ 94 (n=71)		
Age (year)	41.4 $\pm$ 16.6	51.95 $\pm$ 13.4	-4.367	<0.001^b
BMI (kg/m ²)	25.2 $\pm$ 5.3	28.3 $\pm$ 4.7	-3.829	<0.001^b
Gender				
Female	53 (57.0%)	52 (73.2%)	4.616	0.032^a
Male	40 (43.0%)	19 (26.8%)		
Chronic diseases				
Yes	19 (20.4%)	42 (59.2%)	25.846	<0.001^a
No	74 (79.6%)	29 (40.8%)		
ASA score				
I	27 (29.0%)	12 (16.9%)	3.271	0.195 ^a
II	58 (62.4%)	52 (73.2%)		
III	8 (8.6%)	7 (9.9%)		
History of smoking				
Yes	32 (34.4%)	25 (35.2%)	0.011	0.915 ^a
No	61 (65.6%)	46 (64.8%)		
Preoperative SpO ₂	97.7 $\pm$ 1.36	96.6 $\pm$ 1.5	4.941	<0.001^b

Data are shown as Mean $\pm$ standard deviation or n (%) where appropriate. BMI, body mass index; ASA, American Society of Anesthesiologists; SpO₂, peripheral oxygen saturation.

^aChi-square test. ^bIndependent samples *t*-test. Statistically significant P-values are shown in bold.

TABLE 2. Comparison of Surgical and anesthetic Characteristics According to Postoperative Desaturation Status (n=164)

Variables	Postoperative SpO ₂		Test Statistic	P-value
	Nondesaturation	Desaturation		
	SpO ₂ >94 (n=93)	SpO ₂ ≤94 (n=71)		
Type of surgical clinic				
General surgery	51 (54.8%)	52 (73.2%)	7.665	0.053 ^a
Thoracic surgery	18 (19.4%)	8 (11.3%)		
Neurosurgery	17 (18.3%)	5 (7.0%)		
Obstetrics and gynecology	7 (7.5%)	6 (8.5%)		
Surgical Position				
Supine	59 (63.4%)	37 (52.1%)	10.683	0.030 ^a
Reverse Trendelenburg	22 (23.7%)	22 (31.0%)		
Prone	6 (6.5%)	4 (5.6%)		
Lithotomy	6 (6.5%)	2 (2.8%)		
Lateral	0 (0.0%)	6 (8.5%)		
Incision site				
Upper abdominal region	25 (26.9%)	22 (31.0%)	22.741	<0.001 ^a
Lower abdominal region	15 (16.1%)	9 (12.7%)		
Sternotomy incision	18 (19.4%)	8 (11.3%)		
Breast surgery	18 (19.4%)	8 (11.3%)		
Thyroid surgery	3 (3.2%)	19 (26.8%)		
Lumbar region / lower back	14 (15.1%)	5 (7.0%)		
Anesthesia type				
General anesthesia	76 (81.7%)	64 (90.1%)	2.287	0.319 ^a
Laryngeal mask airway	12 (12.9%)	5 (7.0%)		
Spinal anesthesia	5 (5.4%)	2 (2.8%)		
Neuromuscular blocking agent				
Yes	52 (55.9%)	51 (71.8%)	4.367	0.037 ^a
No	41 (44.1%)	20 (28.2%)		
Sedation status, n (%)				
Awake	51 (54.8%)	37 (52.1%)	0.120	0.729 ^a
Drowsy, arousable to verbal stimulation	42 (45.2%)	34 (47.9%)		
Duration of anesthesia (min)	126.1±59.73	133.8±62.2	-0.803	0.423 ^b
Transfer time (seconds)	96.3±27.1	99.0±31.4	-0.610	0.543 ^b

Data are shown as Mean±standard deviation or n (%) where appropriate. BMI, body mass index; SpO₂, peripheral oxygen saturation.

^aChi-square test. ^bIndependent samples *t*-test. Statistically significant P-values are shown in bold.

desaturation status are presented in Table 2. As shown in Table 2, 73.2% (n=52) of desaturated patients underwent general surgical procedures, 52.1% (n=37) were operated on in the supine position, 31.0% (n=22) underwent upper abdominal surgery, 26.8% (n=19) underwent thyroid surgery, and 71.8% (n=51) received neuromuscular blocking agents. Statistically significant differences were observed between desaturated and non-desaturated patients with respect to these variables ($P<0.05$).

It was also observed that 90.1% (n=64) of desaturated patients received general anesthesia and 52.1% (n=37) were awake during the transfer process. However, no statistically significant differences were found between the groups in terms of type of anesthesia and sedation status ($P>0.05$). Similarly, when patients were compared according to duration of anesthesia and transfer time, no statistically significant differences were identified ($P=0.423$ and $P=0.543$, respectively).

The relationships between minimum and mean SpO₂ values and selected demographic and perioperative variables are presented in Table 3. According to the findings, age and mean BMI were moderately, negatively, and statistically significantly correlated with both minimum and mean SpO₂ values ($P<0.05$). In contrast, preoperative SpO₂ levels and the first oxygen saturation values measured after extubation showed a strong positive and statistically significant correlation with both minimum and mean SpO₂ values ($P<0.001$). However, no statistically

significant correlations were identified between duration of anesthesia or transfer time and minimum or mean SpO₂ values ($P>0.05$).

Changes in patients' mean SpO₂ levels monitored from the preoperative period until discharge from the PACU are presented in Figure 1. Accordingly, the mean SpO₂, which was 97.3% in the preoperative period, gradually decreased during the first three measurements following extubation, reaching approximately 94.0%. The lowest mean SpO₂ value was observed at initial admission to the PACU (93.5%). Subsequently, patients' mean SpO₂ levels in the PACU increased to approximately 96.5%.

DISCUSSION

In this study, the incidence of desaturation (SpO₂ $\leq 94\%$) observed during the transfer of patients from the operating room to the PACU, as well as the factors affecting oxygen saturation, were comprehensively examined. It is recommended that patients' SpO₂ levels be maintained above 95% in the PACU [15]. In addition, oxygen saturation is expected to remain between 95% and 100% during anesthesia and the emergence period, with SpO₂ values of $\leq 94\%$ considered desaturation and values below 90% regarded as a clinical emergency [10, 11, 22]. In the our study, 43.3% of patients experienced desaturation during transfer from the operating room to the PACU, and 8.4% of the desaturated patients had oxygen

TABLE 3. Relationship Between Patient and Procedure-Related Factors and Minimum/Mean Peripheral Oxygen Saturation*

Variables	Postoperative SpO ₂			
	Minimum SpO ₂		Mean SpO ₂	
	r	P-value	r	P-value
Age (year)	-0.344	<0.001	-0.310	<0.001
BMI (kg/m ²)	-0.287	0.001	-0.292	<0.001
Duration of anesthesia (min)	-0.043	0.581	-0.019	0.805
Transfer time (seconds)	-0.110	0.162	-0.128	0.104
Preoperative SpO ₂	0.436	<0.001	0.398	<0.001
First SpO ₂ after extubation	0.779	<0.001	0.908	<0.001

SpO₂, peripheral oxygen saturation; BMI, body mass index.

*Pearson correlation. Statistically significant P-values are shown in bold.

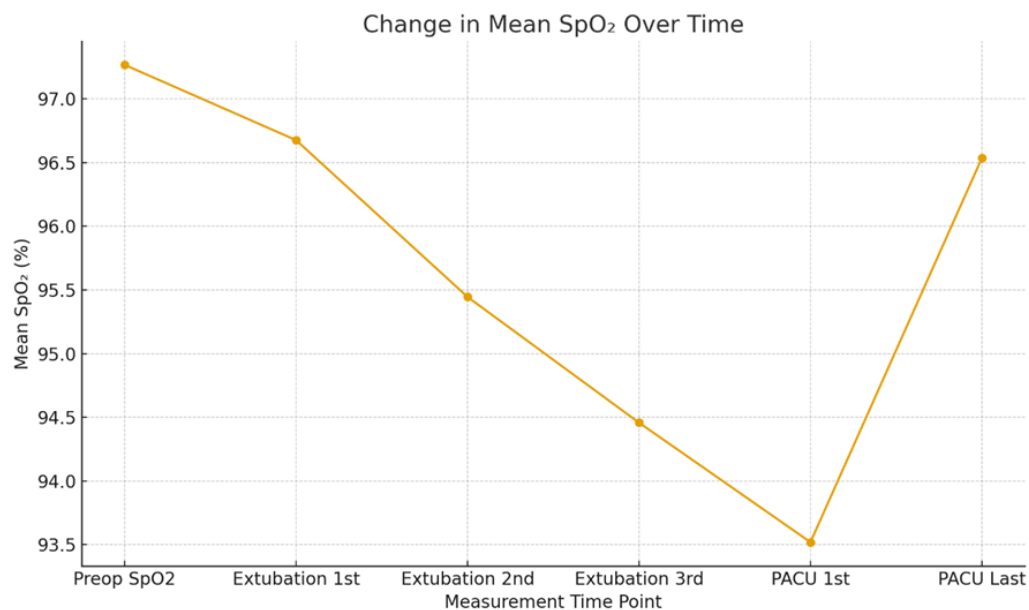


FIGURE 1. Mean oxygen saturation changes across six time points from the preoperative period to PACU transfer and discharge. SpO₂, peripheral oxygen saturation; PACU, post-anesthesia care unit.

saturation levels below 90%. In the literature, postoperative hypoxemia is most commonly defined using an SpO₂ threshold of <90%, with the reported incidence ranging between 13% and 35% [2, 4, 6,23]. Studies conducted in Ethiopia have reported hypoxemia rates ranging from 22.7% [24] to 26.7% [4], while earlier studies have indicated rates as high as 61.4% [25]. In the study, the relatively lower incidence of hypoxemia may be attributable to the short transfer duration. However, some studies define desaturation as SpO₂ ≤94% and report higher rates accordingly. Taye *et al.* [9] reported that 45.8% of patients experienced SpO₂ levels of ≤94% in the early postoperative period, while this rate was 14.5% in the study by Ramachandran *et al.* [15] and 13.5% in the study by Kaushal *et al.* [16]. In the study conducted by Taye *et al.* [9], hypoxemia was observed in patients who did not receive supplemental oxygen during transfer, whereas in the study by Kaushal *et al.* [16], oxygen saturation values were monitored while patients were breathing room air. In contrast, the study by Ramachandran *et al.* [15] did not provide information regarding supplemental oxygen use during transfer. Similar to the study by Taye *et al.* [9], our study found that 43.5% of patients had oxygen saturation levels of SpO₂ ≤94%. In addition, none of the aforementioned studies reported the distance

between the operating room and the PACU. In our study, however, the PACU is located close to the operating rooms; therefore, supplemental oxygen was not administered to patients during transfer. It is thought that these differences in the incidence of hypoxemia may be attributable to variations in practices during the transfer process from the operating room to the PACU after extubation, as well as institutional differences in hospital physical layouts. The literature identifies various factors influencing the incidence of hypoxemia during transfer from the operating room to the PACU or in the early postoperative period, with advanced age consistently reported as one of the most prominent risk factors. Numerous studies have demonstrated a significant increase in hypoxemia incidence among individuals aged 55 years and older [4, 16, 19, 26, 27]. Maity *et al.* [23] similarly reported that the rate of hypoxemia in elderly patients was nearly twice as high as that observed in younger patients (43.47% vs. 17.24%) [26]. Consistent with these findings, our study revealed that patients who developed desaturation had a higher mean age, and a strong, negative, and statistically significant correlation was identified between age and oxygen saturation levels. These results suggest that age-related physiological changes in the lungs may adversely affect postoperative

oxygenation.

The literature indicates that BMI is an important determinant of postoperative oxygenation. Kaushal *et al.* [16] demonstrated that the risk of hypoxemia increases in patients with a BMI greater than 25, with this risk becoming particularly pronounced in individuals with a BMI ≥ 30 kg/m². Similarly, Taye *et al.* [9] reported a higher frequency of hypoxemia in patients with BMI >25 kg/m², while Labeste *et al.* [6] found increased hypoxemia rates among patients with BMI >30 kg/m². Walker *et al.* [27] also reported a similar BMI threshold value of approximately 29.5. Consistent with these findings, our study identified a significant negative relationship between BMI and postoperative oxygen saturation, and the mean BMI of desaturated patients was above 25. This finding suggests that pathophysiological mechanisms observed in obese patients, such as reduced chest wall compliance, upper airway obstruction, and central apnea, may contribute to an increased risk of postoperative hypoxemia.

The literature indicates that patients' preoperative hemodynamic status, particularly preoperative SpO₂ levels, is closely associated with postoperative oxygenation. Anduallem and Yesuf [26] reported that the risk of postoperative hypoxemia was four times higher in patients with preoperative SpO₂ $<95\%$. Similarly, numerous studies have demonstrated that preoperative SpO₂ levels below 95% significantly increase the risk of hypoxemia [4, 6, 9]. In contrast, some studies have reported that preoperative oxygen saturation does not significantly affect the incidence of hypoxemia in the early postoperative period [4, 25]. In our study, however, consistent with the majority of the literature, preoperative SpO₂ levels were significantly lower in patients who developed desaturation. This finding highlights that identifying low oxygen saturation during the preoperative period and implementing appropriate preventive measures constitute a critical area of assessment for nurses, both in reducing the risk of hypoxemia and in planning safe postoperative care.

The literature has demonstrated through studies that smoking is an important risk factor for postoperative hypoxemia [9, 16, 28]. However, in our study, no statistically significant difference was found between desaturated and non-desaturated patients with respect to smoking status. This finding may be related

to the fact that desaturation observed in this study was predominantly mild in severity. In contrast, when comorbidity status was evaluated, the frequency of comorbid conditions was found to be higher in the desaturated group. Consistent with this result, the literature indicates that the risk of hypoxemia is significantly increased in individuals with chronic diseases [4, 9, 16]. This finding suggests that patients with respiratory, cardiovascular, and metabolic disorders require more careful monitoring of oxygenation during the postoperative period. The presence of comorbidities should therefore be thoroughly assessed during the preoperative evaluation as a critical risk factor. Such information facilitates the anticipation of potential postoperative oxygenation problems and supports the planning of individualized nursing interventions, including supplemental oxygen therapy, patient positioning, breathing exercises, and close monitoring. Consequently, these measures contribute to the early prevention of complications and the promotion of a safe postoperative care process.

When surgery-related factors were examined, the incidence of desaturation in this study was found to be higher in procedures performed in the supine or reverse Trendelenburg positions, as well as in surgeries involving upper abdominal and thyroid incisions. Although Kaushal *et al.* [16] reported that the type of surgical incision was not a determining risk factor for oxygen saturation, another study, consistent with our findings, demonstrated an association between subcostal incisions and early postoperative hypoxemia [4]. Regarding anesthesia-related and anesthetic risk factors, no significant difference was observed between the groups in terms of type of anesthesia in the present study. In contrast, the literature reports that general anesthesia increases the risk of postoperative hypoxemia [2, 4, 19, 26]. The lack of a significant difference in our study may be attributable to the fact that the vast majority of patients in both groups underwent surgery under general anesthesia. The literature presents inconsistent findings regarding the duration of anesthesia. Some studies have reported that an anesthesia duration longer than 120 minutes increases the risk of hypoxemia [4, 27]. In contrast, Kaushal *et al.* [16] indicated that anesthesia duration is not an independent risk factor, and similarly, the studies by

Maity *et al.* [23] and Taye *et al.* [9] found no significant association between duration and hypoxemia. Consistent with these findings, the present study also identified no significant relationship between anesthesia duration or transfer time and desaturation. The findings of Walker *et al.* [27], which suggest that transport duration is not a determining factor for hypoxemia, are likewise in agreement with the results of our study.

Strengths and Limitations

The assessment of oxygen saturation levels in patients transferred from the operating room to the PACU without oxygen support, under routine clinical conditions, using a prospective design and continuous pulse oximetry monitoring, constitutes a key strength of this study. The limitation of this study is that it was conducted in a single training and research hospital, which may restrict the generalizability of the findings to institutions with different infrastructure, transfer distances, and postoperative care practices.

CONCLUSION

The findings of this study demonstrate that, in the early postoperative period during which all patients were transferred without supplemental oxygen, nearly half of the patients had oxygen saturation levels of $\text{SpO}_2 \leq 94\%$. Advanced age, higher BMI, preoperative SpO_2 levels close to the lower limit of normal, presence of comorbidities, upper abdominal and thyroid surgical incisions, and the use of respiratory-depressant neuromuscular blocking agents during anesthesia were identified as factors that negatively affect postoperative oxygen saturation. Therefore, it is recommended that operating room nurses and the anesthesia team comprehensively assess patients for these risk factors during the preoperative period and identify patients at increased risk. In addition, continuous monitoring of SpO_2 levels during patient transfer and the provision of supplemental oxygen during transfer for high-risk patients are recommended. This approach, together with effective communication of patient status to the care team upon handover to the PACU, is considered a prophylactic, simple, and effective nursing intervention that

contributes to maintaining adequate oxygenation in the early postoperative period.

Ethics Approval and Consent to Participate

The study was approved by the Ankara Medipol University Non-Interventional Clinical Research Ethics Committee (Decision no.: 84, date: 11.07.2023). All procedures performed during data collection, review of patient records, and study implementation complied with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its subsequent amendments. Written informed consent was obtained from all individual participants included in the study. In addition, institutional permission was obtained from the relevant clinic and the hospital where the study was conducted.

Data Availability

All data generated or analyzed during this study are included in this published article. The data that support the findings of this study are available on request from the corresponding author, upon reasonable request.

Authors' Contribution

Study Conception: EAP, NI, HA; Study Design: EAP, NI, HA; Supervision: HA, Eİ; Funding: N/A; Materials: EAP; Data Collection and/or Processing: EAP, NI, HA; Statistical Analysis and/or Data Interpretation: EAP, NI, HA, Eİ; Literature Review: EAP, NI, HA; Manuscript Preparation: EAP, NI, HA; and Critical Review: EAP, NI, HA, Eİ.

Conflict of Interest

The author(s) disclosed no conflict of interest during the preparation or publication of this manuscript.

Financing

The author(s) disclosed that they did not receive any grant during the conduction or writing of this study.

Acknowledgment

The authors would like to thank the all participating patients involved.

Generative Artificial Intelligence Statement

The author(s) declare that artificial intelligence–

based tools were used in accordance with academic ethical standards during the preparation of this manuscript. ChatGPT (version 5.2) was utilized solely to assist with language editing, translation, and grammatical corrections. The authors maintained full responsibility for the content and ensured complete oversight and final control of the manuscript.

Editor's Note

All statements made in this article are solely those of the authors and do not represent the views of their affiliates or the publisher, editors, or reviewers. Any claims made by any product or manufacturer that may be evaluated in this article are not guaranteed or endorsed by the publisher.

REFERENCES

- Hines R, Barash PG, Watrous G, O'Connor T. Complications occurring in the postanesthesia care unit: a survey. *Anesth Analg*. 1992;74(4):503-509. doi: 10.1213/00000539-199204000-00006.
- Siddiqui N, Arzola C, Teresi J, Fox G, Guerina L, Friedman Z. Predictors of desaturation in the postoperative anesthesia care unit: an observational study. *J Clin Anesth*. 2013;25(8):612-617. doi: 10.1016/j.jclinane.2013.04.018.
- Jones JG, Sapsford DJ, Wheatley RG. Postoperative hypoxaemia: mechanisms and time course. *Anaesthesia*. 1990;45(7):566-573. doi: 10.1111/j.1365-2044.1990.tb14833.x.
- Melesse DY, Denu ZA, Kassahun HG, Agegnehu AF. 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, North West Ethiopia: a prospective observational study. *Int J Surg Open*. 2020;22:38-46. doi: 10.1016/j.ijso.2019.11.011.
- Habre W, Peták F. Perioperative use of oxygen: variabilities across age. *Br J Anaesth*. 2014;113 Suppl 2:ii26-36. doi: 10.1093/bja/aeu380.
- Labaste F, Silva S, Serin-Moulin L, et al. Predictors of desaturation during patient transport to the postoperative anesthesia care unit: an observational study. *J Clin Anesth*. 2016;35:210-214. doi: 10.1016/j.jclinane.2016.07.018.
- Ayhan H, Iyigun E, Tastan S, Orhan ME, Ozturk E. Comparison of two different oxygen delivery methods in the early postoperative period: randomized trial. *J Adv Nurs*. 2009;65(6):1237-1247. doi: 10.1111/j.1365-2648.2009.04984.x.
- Triyasunant N, Siriussawakul A, Nimmannit A, Kunawudhi A, Jirakulsawat A. Postoperative Supplemental Oxygen Is Unnecessary in Low-Risk Cesarean Delivery Parturients Under Spinal Anesthesia: An Observational Study. *AANA J*. 2016;84(5):358-361.
- Taye MG, Molla A, Teshome D, et al. Predictors of hypoxemia after general anesthesia in the early postoperative period in a hospital in Ethiopia: an observational study. *Multidiscip Respir Med*. 2021;16(1):782. doi: 10.4081/mrm.2021.782.
- World Health Organization. Pulse Oximetry Training Manual. Geneva: WHO; 2011.
- Herbst A, Goel S, Beane A, et al. Oxygen saturation targets for adults with acute hypoxemia in low and lower-middle income countries: a scoping review with analysis of contextual factors. *Front Med (Lausanne)*. 2023;10:1148334. doi: 10.3389/fmed.2023.1148334.
- Siemieniuk RAC, Chu DK, Kim LH, et al. Oxygen therapy for acutely ill medical patients: a clinical practice guideline. *BMJ*. 2018;363:k4169. doi: 10.1136/bmj.k4169.
- World Health Organization. WHO Guidelines on the Use of Pulse Oximetry. Geneva: WHO; 2016. Available from: <https://www.who.int/publications/i/item/9789241550475>.
- Berrios-Torres SI, Umscheid CA, Bratzler DW, et al; Healthcare Infection Control Practices Advisory Committee. Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection, 2017. *JAMA Surg*. 2017;152(8):784-791. doi: 10.1001/jamasurg.2017.0904.
- Ramachandran SK, Thompson A, Pandit JJ, Devine S, Shanks AM. Retrospective observational evaluation of postoperative oxygen saturation levels and associated postoperative respiratory complications and hospital resource utilization. *PLoS One*. 2017;12(5):e0175408. doi: 10.1371/journal.pone.0175408.
- Kaushal A, Goyal P, Dhiraaj S, Agarwal A, Singh PK. Identification of Various Perioperative Risk Factors Responsible for Development of Postoperative Hypoxaemia. *Turk J Anaesthesiol Reanim*. 2018;46(6):416-423. doi: 10.5152/TJAR.2018.82160.
- Tyler IL, Tantisira B, Winter PM, Motoyama EK. Continuous monitoring of arterial oxygen saturation during transfer to the recovery room. *Anesth Analg*. 1985;64(11):1108-1112.
- Blair I, Holland R, Lau W, McCarthy N, Chiah TS, Ledwidge D. Oxygen saturation during transfer from operating room to recovery after anaesthesia. *Anaesth Intensive Care*. 1987;15(2):147-150. doi: 10.1177/0310057X8701500205.
- Moller JT, Wittrop M, Johansen SH. Hypoxemia in the postanesthesia care unit: an observer study. *Anesthesiology*. 1990;73(5):890-895. doi: 10.1097/00000542-199011000-00016.
- Gift AG, Stanik J, Karpenick J, Whitmore K, Bolgiano CS. Oxygen saturation in postoperative patients at low risk for hypoxemia: is oxygen therapy needed? *Anesth Analg*. 1995;80(2):368-372. doi: 10.1097/00000539-199502000-00028.
- Raosoft Inc. Sample Size Calculator. Available from: <http://www.raosoft.com/samplesize.html>.
- O'Driscoll BR, Howard LS, Davison AG; British Thoracic Society. BTS guideline for emergency oxygen use in adult patients. *Thorax*. 2008;63 Suppl 6:vi1-68. doi: 10.1136/thx.2008.102947.
- Maity A, Saha D, Swaika S, Maulik SG, Choudhury B, Sutradhar M. Detection of hypoxia in the early postoperative period. *Anesth Essays Res*. 2012;6(1):34-37. doi: 10.4103/0259-1162.103369.
- Wolde GD, Awol MA, Obsa MS, Wesene NG, Gemechu AD. Magnitude and Associated Factors of Immediate Postoperative Hypoxemia among Elective Surgical Procedures at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia. *J Anesth*

- Clin Res 218;9(5):1000821. doi: 10.4172/2155-6148.1000821.
25. Meiklejohn BH, Smith G, Elling AE, Hindocha N. Arterial oxygen desaturation during postoperative transportation: the influence of operation site. *Anaesthesia*. 1987;42(12):1313-1315. doi: 10.1111/j.1365-2044.1987.tb05282.x.
26. Andualem AA, Yesuf KA. Incidence and associated factors of postoperative hypoxemia among adult elective surgical patients at Dessie Comprehensive Specialized Hospital: An observational study. *Ann Med Surg (Lond)*. 2022;78:103747. doi: 10.1016/j.amsu.2022.103747.
27. Walker M, Farmer RG, Schelew B. Risk factors for oxygen desaturation on arrival in the postanesthesia care unit. *Can J Anaesth*. 2015;62(9):1019-1020. doi: 10.1007/s12630-015-0371-6.
28. Scholes RL, Browning L, Sztendur EM, Denehy L. Duration of anaesthesia, type of surgery, respiratory co-morbidity, predicted VO₂max and smoking predict postoperative pulmonary complications after upper abdominal surgery: an observational study. *Aust J Physiother*. 2009;55(3):191-198. doi: 10.1016/s0004-9514(09)70081-9.