Original Article

ISSN: 2663-9491 e-ISSN: 2789-6897

Effectiveness of Perioperative Oxygen Therapy on Surgical Site Infection and Postoperative Pulmonary Complications: A Hospital-Based Study

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Received: 17 May 2026
Accepted: 26 May 2026
Published Online: 5 June 2026

Published by:
Gopalganj Medical College, Gopalganj, Bangladesh

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DOI: 10.5281/zenodo.20561034

ABSTRACT

Background: *Surgical site infection (SSI) and postoperative pulmonary complications (PPCs) are major causes of postoperative morbidity and prolonged hospital stay. Perioperative oxygen therapy has been suggested as a simple and cost-effective strategy to improve tissue oxygenation and reduce infectious and respiratory complications, but evidence remains inconsistent, particularly in resource-limited settings.* ***Methods & Materials:*** *This hospital-based comparative observational study was conducted in the Department of Anaesthesia, Analgesia and Intensive Care Medicine at Bangladesh Medical University from January 2026 to March 2026. A total of 60 adult patients undergoing elective abdominal, orthopedic, urological and general surgeries under general anesthesia were included. Patients were grouped into standard oxygen therapy and high-concentration oxygen therapy groups. Data on SSI, PPCs and related risk factors were collected and analyzed using SPSS version 25.* ***Results:*** *Surgical site infection was significantly lower in the high oxygen group compared to the standard group (9.4% vs 28.6%, p=0.048). Postoperative pneumonia (6.3% vs 17.9%) and atelectasis (9.4% vs 21.4%) were also less frequent in the high oxygen group, although not statistically significant. Mean hospital stay was significantly shorter in the high oxygen group (6.8 ± 2.1 vs 9.1 ± 2.8 days, p=0.012). Age above 50 years (p=0.049), diabetes mellitus (p=0.037) and prolonged surgery duration (>4 hours, p=0.021) were significantly associated with postoperative complications.* ***Conclusion:*** *Perioperative high-concentration oxygen therapy was associated with reduced surgical site infection and improved postoperative recovery, including shorter hospital stay. Larger randomized studies are recommended to confirm these findings.*

Keywords: *Perioperative oxygen therapy, surgical site infection, postoperative pulmonary complications, anesthesia, hospital-based study.*

(The Insight 2026; 9(2): 394-398)

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INTRODUCTION

Surgical site infection (SSI) and postoperative pulmonary complications (PPCs) remain significant causes of postoperative morbidity and prolonged hospital stay worldwide, particularly in developing countries [1]. These complications increase patient suffering, healthcare costs, duration of hospitalization and postoperative mortality. Despite advances in surgical techniques, anesthesia, aseptic measures and perioperative care, SSI and pulmonary complications continue to be common among patients undergoing major surgical procedures [2]. Prevention of these complications has therefore become an important concern in perioperative management [3].

Perioperative oxygen therapy has gained considerable attention as a potential strategy to reduce postoperative complications [4]. Adequate tissue oxygenation plays a crucial role in wound healing and host immune defense mechanisms. Increased oxygen delivery to surgical tissues enhances oxidative killing by neutrophils, collagen synthesis and tissue repair, thereby potentially lowering the risk of surgical site infection [5]. Similarly, improved oxygenation during and after surgery may reduce the occurrence of postoperative

ISSN: 2663-9491 e-ISSN: 2789-6897

pulmonary complications such as pneumonia, atelectasis and respiratory distress, especially in patients with underlying comorbidities or prolonged surgical procedures [6].

Several international studies have investigated the relationship between supplemental perioperative oxygen administration and postoperative outcomes, but the findings remain controversial. Some studies demonstrated a reduction in surgical site infection and pulmonary complications with high-concentration oxygen therapy, whereas others reported minimal or no significant benefit [7,8]. Variations in patient characteristics, type of surgery, oxygen concentration, duration of oxygen administration and perioperative management protocols may contribute to these inconsistent findings [9]. Furthermore, excessive oxygen administration may also be associated with potential adverse effects such as oxidative stress and absorption atelectasis, making the appropriate use of perioperative oxygen therapy an important clinical consideration [10].

In Bangladesh, limited data are available regarding the effectiveness of perioperative oxygen therapy on postoperative surgical and pulmonary outcomes. Differences in healthcare settings, infection control practices, nutritional status, smoking habits and perioperative monitoring may influence postoperative complications among Bangladeshi surgical patients. Therefore, locally generated evidence is essential to evaluate the practical effectiveness of perioperative oxygen supplementation in reducing postoperative morbidity in tertiary healthcare institutions [11,12].

This hospital-based study was conducted in the Department of Anaesthesia, Analgesia and Intensive Care Medicine at Bangladesh Medical University to assess the effectiveness of perioperative oxygen therapy on surgical site infection and postoperative pulmonary complications among patients undergoing elective surgery. The findings of this study may contribute to improving perioperative management strategies and optimizing postoperative outcomes in surgical patients.

METHODS & MATERIALS

This hospital-based comparative observational study was conducted in the Department of Anaesthesia, Analgesia and Intensive Care Medicine at Bangladesh Medical University from January 2026 to March 2026 to evaluate the effectiveness of perioperative oxygen therapy on surgical site infection and postoperative pulmonary complications among surgical patients. A total of 60 patients undergoing elective surgical procedures under general anesthesia were enrolled purposively according to the selection criteria. Adult patients aged 18 years and above of either sex who underwent elective abdominal, orthopedic, urological, or general surgical procedures and provided informed written consent were included in the study. Patients with severe cardiopulmonary instability, pre-existing active respiratory infection, immunocompromised conditions, emergency surgery, pregnancy, or incomplete clinical records were excluded from the study.

The study participants were divided into two groups according to perioperative oxygen administration protocol: standard oxygen therapy group and high-concentration oxygen therapy group. High-concentration oxygen therapy was administered through a non-rebreathing mask (NRM), whereas standard oxygen therapy was provided using a simple face mask during the perioperative period. Relevant socio-demographic data, clinical history, smoking status, comorbidities, duration and type of surgery, ASA physical status, postoperative surgical site infection, pulmonary complications, duration of hospital stay and ICU requirement were recorded using a structured data collection sheet. Patients were followed during the postoperative hospital stay for assessment of surgical site infection and pulmonary complications including pneumonia and atelectasis.

Collected data were checked, cleaned and analyzed using Statistical Package for the Social Sciences (SPSS) version 25.0. Descriptive statistics were expressed as frequency, percentage, mean and standard deviation. Chi-square test and independent sample t-test were applied where appropriate to assess associations between variables. A p value of less than 0.05 was considered statistically significant.

RESULTS

Table I presents the socio-demographic characteristics of the study patients (N=60) included in this hospital-based study. The majority of participants were in the 31–45 years age group, comprising 23 (38.3%) patients, followed by 17 (28.3%) in the 18–30 years group, 14 (23.3%) in the 46–60 years group and only 6 (10.0%) were above 60 years, with a mean age of 42.8 ± 13.7 years. Male patients were slightly predominant, accounting for 33 (55.0%) compared to 27 (45.0%) females. More than half of the participants, 35 (58.3%), were from urban areas, while 25 (41.7%) were from rural settings. Regarding BMI distribution, most patients 31 (51.7%) had normal BMI (18.5–24.9 kg/m^2), whereas 22 (36.6%) were overweight and 7 (11.7%) were underweight. In terms of smoking status, 19 (31.7%) patients were smokers and the remaining 41 (68.3%) were non-smokers.

ISSN: 2663-9491 e-ISSN: 2789-6897

Table I: Socio-demographic Characteristics of the Study Patients (*n*=60)

Variables	Frequency (n)	Percentage (%)
Age group (years)		
18–30	17	28.3
31–45	23	38.3
46–60	14	23.3
>60	6	10.0
Mean ± SD	42.8 ± 13.7 (yrs)	
Sex		
Male	33	55.0
Female	27	45.0
Residence		
Urban	35	58.3
Rural	25	41.7
BMI (kg/m^2)		
<18.5	7	11.7
18.5–24.9	31	51.7
≥25	22	36.6
Smoking status		
Smoker	19	31.7
Non-smoker	41	68.3

Table II describes the perioperative and clinical characteristics of the study patients (N=60). General surgical procedures were the most common, accounting for 21 (35.0%) cases, followed by gastrointestinal surgery in 16 (26.7%), orthopedic surgery in 13 (21.7%) and urological surgery in 10 (16.6%) patients. Regarding duration of surgery, most patients underwent procedures lasting 2–4 hours, comprising 29 (48.3%), while 24 (40.0%) had surgeries lasting less than 2 hours and only 7 (11.7%) experienced prolonged surgeries exceeding 4 hours. In terms of ASA physical status, nearly half of the patients, 29 (48.3%), were ASA II, followed by 18 (30.0%) ASA I and 13 (21.7%) ASA III, indicating a predominance of relatively moderate-risk surgical patients. With regard to perioperative oxygen therapy, 32 (53.3%) patients received high-concentration oxygen therapy, whereas 28 (46.7%) received standard oxygen therapy. Among comorbid conditions, hypertension was the most frequent at 18 (30.0%), followed by diabetes mellitus in 15 (25.0%) and COPD/bronchial asthma in 9 (15.0%) patients.

Table II: Perioperative and Clinical Characteristics of the Study Patients (*n*=60)

Variables	Frequency (n)	Percentage (%)
Type of surgery		
General surgery	21	35.0
Gastrointestinal surgery	16	26.7
Orthopedic surgery	13	21.7
Urological surgery	10	16.6
Duration of surgery		
<2 hours	24	40.0
2–4 hours	29	48.3
>4 hours	7	11.7
ASA physical status		
ASA I	18	30.0
ASA II	29	48.3
ASA III	13	21.7
Perioperative oxygen therapy		
Standard oxygen therapy	28	46.7
High concentration oxygen therapy	32	53.3
Comorbidities		
Diabetes mellitus	15	25.0
Hypertension	18	30.0
COPD/Bronchial asthma	9	15.0

Table III shows the distribution of surgical site infection and postoperative pulmonary complications according to perioperative oxygen therapy among the study patients (N=60). Surgical site infection was significantly higher in the standard oxygen therapy group, occurring in 8 (28.6%) patients, compared to 3 (9.4%) in the high-concentration oxygen therapy group (p=0.048). Postoperative pneumonia was observed in 5 (17.9%) patients receiving standard oxygen therapy and in 2 (6.3%) patients receiving high oxygen therapy, although this difference was not statistically significant (p=0.171). Similarly, atelectasis was more frequent in the standard group, affecting 6 (21.4%) patients versus 3 (9.4%) in the high oxygen group (p=0.193). The need for ICU support was also higher among patients receiving standard oxygen therapy (4, 14.3%) compared to the high oxygen group (2, 6.3%), though this difference did not reach statistical significance (p=0.301). Importantly, the mean duration of hospital stay was significantly longer in the standard oxygen therapy group (9.1 ± 2.8 days) compared to the high oxygen therapy group (6.8 ± 2.1 days), with a statistically significant difference (p=0.012).

ISSN: 2663-9491 e-ISSN: 2789-6897

Table III: Distribution of Surgical Site Infection and Postoperative Pulmonary Complications According to Oxygen Therapy (*n*=60)

Outcome Variables	Standard Oxygen Therapy (n=28)	High Oxygen Therapy (n=32)	p value
Surgical site infection	8 (28.6%)	3 (9.4%)	0.048
Postoperative pneumonia	5 (17.9%)	2 (6.3%)	0.171
Atelectasis	6 (21.4%)	3 (9.4%)	0.193
Need for ICU support	4 (14.3%)	2 (6.3%)	0.301
Mean hospital stay (days)	9.1 ± 2.8	6.8 ± 2.1	0.012

Table IV presents the association between selected risk factors and postoperative complications among the study patients (N=60). Postoperative complications were more frequently observed in patients aged above 50 years, where 11 (57.9%) developed complications compared to 13 (31.7%) in the non-complication group, showing a statistically significant association (p=0.049). Diabetes mellitus was also significantly associated with postoperative complications, occurring in 8 (42.1%) patients with complications versus 7 (17.1%) without complications (p=0.037). A prolonged duration of surgery exceeding 4 hours showed a significant relationship with postoperative complications, affecting 5 (26.3%) patients compared to 2 (4.9%) in those without complications (p=0.021). Although smoking history was more common among patients with complications (47.4% vs 24.4%), this association did not reach statistical significance (p=0.081). Similarly, standard oxygen therapy was more frequently observed in the complication group (63.2% vs 39.0%), but the difference was not statistically significant (p=0.074).

Table IV: Association Between Selected Risk Factors and Postoperative Complications (*n*=60)

Variables	Postoperative Complications Present n=19	Postoperative Complications Absent n=41	p value
Age >50 years	11 (57.9%)	13 (31.7%)	0.049
Smoking history	9 (47.4%)	10 (24.4%)	0.081
Diabetes mellitus	8 (42.1%)	7 (17.1%)	0.037
Duration of surgery >4 hours	5 (26.3%)	2 (4.9%)	0.021
Standard oxygen therapy	12 (63.2%)	16 (39.0%)	0.074

DISCUSSION

This hospital-based study evaluated the effectiveness of perioperative oxygen therapy on surgical site infection (SSI) and postoperative pulmonary complications (PPCs) among 60 surgical patients. The findings demonstrated that high-concentration oxygen therapy was associated with lower SSI (9.4% vs 28.6%) and reduced postoperative pulmonary complications compared to standard oxygen therapy, along with significantly shorter hospital stay (6.8 ± 2.1 vs 9.1 ± 2.8 days, p=0.012). These results highlight the potential clinical benefit of optimized perioperative oxygen delivery in improving postoperative outcomes.

In the present study, SSI was significantly lower in the high oxygen group, which is consistent with the findings of El Maleh et al., who reported that increased intraoperative inspired oxygen fraction reduces SSI risk by improving tissue oxygen tension and enhancing neutrophil-mediated bacterial killing [13]. Similarly, Islam et al., observed that SSI remains a significant postoperative burden in gastrointestinal surgery patients in Bangladesh, supporting our finding that SSI was relatively high (28.6%) in the standard oxygen group [14]. The biological plausibility of oxygen supplementation improving wound healing is further supported by Shams El A et al., who emphasized the importance of adequate oxygen delivery in perioperative care systems [15].

Regarding pulmonary complications, our study found reduced rates of pneumonia (6.3% vs 17.9%) and atelectasis (9.4% vs 21.4%) in the high oxygen group, although not all differences were statistically significant. These findings align with McIlroy et al., who reported that intraoperative oxygen administration influences postoperative organ injury and respiratory outcomes [16]. Similarly, Jin et al. and Deana et al., highlighted that perioperative respiratory support strategies, including optimized oxygen therapy, may reduce PPCs in major surgeries, although evidence remains heterogeneous [17,18]. Brat et al., also emphasized that postoperative hyperoxemia and oxygen imbalance can influence pulmonary physiology, which may explain variability in outcomes across studies [19].

In this study, diabetes mellitus (p=0.037), age above 50 years (p=0.049) and prolonged surgery duration (>4 hours, p=0.021) were significantly associated with postoperative complications. These findings are consistent with Haque et al., who identified age and comorbid conditions as important predictors of perioperative morbidity [20]. Similarly, Li et al. and Xu et al., reported that systemic comorbidities and operative complexity are strong predictors of PPCs [21,22]. Smoking history, although higher among patients with complications in our study (47.4%), was not statistically significant, which partially aligns with Wang et al., who reported variability in risk factor strength depending on surgical type and patient population [23].

The significantly shorter hospital stay in the high oxygen group supports findings from Frei et al., who demonstrated that optimized intraoperative oxygen administration is associated with improved postoperative recovery and reduced hospital resource utilization [24]. Additionally, Sakurai et al., reported that oxygen-dependent patients and those with impaired respiratory function have worse postoperative outcomes, reinforcing the importance of perioperative oxygen optimization [25].

Overall, our findings are supported by multiple experimental, observational and meta-analytic studies including Elfeky et al., Peyton et al. and Ferrando et al., which highlight both the benefits and ongoing controversies surrounding perioperative oxygen therapy [26,27,28]. While high-concentration oxygen appears beneficial in reducing SSI and improving recovery trends, the mixed results in pulmonary outcomes suggest that individualized oxygen strategies may be more appropriate

ISSN: 2663-9491 e-ISSN: 2789-6897

rather than a universal approach. Further large multicenter randomized studies are required to confirm optimal oxygen dosing and duration in surgical patients.

LIMITATIONS

This study has several limitations. It was conducted in a single tertiary care center with a relatively small sample size of 60 patients and a short study duration of three months, which may limit the generalizability of the findings. In addition, the non-randomized design and potential confounding factors such as variations in surgical complexity, anesthetic technique and perioperative care may have influenced the outcomes.

CONCLUSION

Perioperative high-concentration oxygen therapy was associated with a lower incidence of surgical site infection and reduced postoperative pulmonary complications compared to standard oxygen therapy, along with a significantly shorter hospital stay. The study suggests that optimized oxygen delivery during the perioperative period may improve postoperative outcomes, although larger multicenter randomized trials are recommended to confirm these findings and establish standardized protocols.

FUNDING

No funding sources.

CONFLICTS OF INTEREST

There are no conflicts of interest.

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