

## Postoperative Pulmonary Complications and Associated Factors among Surgical Patients

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### Abstract

**Introduction:** Postoperative complications, although other complications may occur, involving the respiratory tract is the most frequent one that contribute to the greatest peri operative morbidity and mortality. The occurrence of postoperative pulmonary complications varies depending on the clinical treatment setting, the kind of surgery and the definition used.

**Objective:** The aim of this study was to determine morbidity and mortality rate from postoperative pulmonary complications and factors associated among surgical patients that were operated in Gondar University Hospital from January to April 30, 2013.

**Methods:** Observational prospective study was conducted to assess postoperative pulmonary complications (PPC) among surgical patients in Gondar University Hospital. 405 patients were included in this study using systematic sampling technique. Pre, intra-operative and post-operative data were collected using checklist prepared based on variables of interest. A step wise logistic regression was used to identify independent predictors of PPC. P values and 95% CI were used to see for significance of associations.

**Results:** 405 patients were participated in this study with response rate of 100%. The incidence of PPC in this study was 21.7%. Use of General anesthesia (AOR=8.72 (2.01; 37.73), intra operative blood loss (AOR=2.02 (1.18; 3.46), poor post-operative pain control (AOR=2.00 (1.17; 3.43) and prolonged surgery (AOR=2.12; (1.18; 3.84) were independently associated with PPC.

**Conclusion and recommendation:** The burden of postoperative pulmonary complication in university of Gondar hospital was high and the commonest complication was postoperative pneumonia. Postoperative analgesia should be considered as part of anesthetic management for all surgical patients.

**Keywords:** Pneumonia; Gondar; Ethiopia

### Introduction

Postoperative complications, involving respiratory tract are the most frequent cause of morbidity and mortality [1]. Though there is no standard definition for postoperative pulmonary complications, different scholars define it as the occurrence of pneumonia which is characterized by fever above 38°C and evidence of pulmonary infiltration. Most pneumonia cases are seen during the first five days of post-operative time [2], atelectasis is the other post-operative pulmonary complication which is defined as increased work of breathing and hypoxemia). The onset of hypoxemia due to atelectasis occurs after the patient leaves post anesthesia care unit, particularly during the second post-operative night [3,4], respiratory failure defined as inability to be extubated within 48 hours of surgery [5], Acute respiratory distress syndrome (ARDS) and/or bronchospasm which is common during early post-operative time and diagnosed when there is dyspnea, wheezing, chest tightness, tachypnea, small tidal volumes, a prolonged expiratory time, and hypercapnia are seen

[6]. In facilities where there is routine radiographic screening during the postoperative period, atelectasis is the most prevalent complication [1]. However, pneumonia is the major cause of mortality on surgical wards [2].

The factors affecting the development of PPC are related to the prior health status of the patient and the effects of anesthesia and surgical trauma [7]. The synergy between these factors determines risk [8]. Usually risk factors are procedure, anesthesia and patient related. For all of these reasons, incidence rates vary dramatically, ranging from 5% to 80% [9].

Based on literatures, advanced age, obesity, cigarette smokers, American Society of Anesthesiologist (ASA) physical status of >II, chronic obstructive pulmonary disease (COPD), low albumin level, upper abdominal and thoracic surgery, prolonged surgical and anesthesia time [10,11], general anesthesia with long acting muscle relaxant [12] and type of endotracheal tube [13] are the identified risk factors for postoperative pulmonary complications.

Although the causal effect of the various factors was not studied, the limited regional and local data also indicate a high rate of postoperative pulmonary complications among surgical patients. A study conducted in Tanzania revealed that postoperative pulmonary complications accounted for 8.3% of morbidity and mortality [14]. In Ethiopia, a retrospective study conducted in Addis Ababa and Gondar showed pulmonary complications were the leading complications in postoperative period [15,16].

Postoperative pulmonary complications (PPC), though their risk factor is poorly studied as compared to cardiovascular risk factors, remain to be important cause of morbidity and mortality related to surgery and anesthesia [17,18]. Knowledge about PPC and factors predicting PPC in our local setup is lacking. This study was conducted to see the incidence and predictors of PPC in our setting and to devise strategies for their prevention. We anticipated that above would lead to reduction in morbidity and mortality associated with PPC and would eventually reduce the financial health care burden.

## Methods

Observational prospective study was conducted among surgical patients in Gondar University Hospital in 2013 after approval by University of Gondar ethical review committee. Based on 2013 annual report of the Hospital 6000 patients are operated.

Using single population formula (P as 50%, 95% CI and 5% non-response rate) 405 patients were included. The study subjects were selected using systematic sampling technique and every third elective or emergency patient were included.

Anesthesia was administered as routine by assigned anesthetists. Bupivacaine 0.5% was used for spinal anesthesia while for general anesthesia Ketamine, Thiopentone and Propofol were used as induction agents and Halothane as maintenance. Patients were also relaxed with suxamethonium and Pancuronium as induction and maintenance respectively. All patients were monitored with integrated (BP, pulseoximetry, capnography and temperature) monitor throughout the operation. There is no neuromuscular block monitoring device in the department. All patients given pancuronium were reversed by neostigmine 0.05mg/kg.

Socio-demographic, preoperative and intra-operative data and postoperative pulmonary complications were extracted from medical record. Criteria for diagnosis of postoperative pulmonary complications were in the reference articles [2-6]. All patients who have the complications were treated based on the hospital management protocol.

Data were coded, entered, cleaned and analyzed using SPSS version 20. A step wise logistic regression was used to identify predictors of PPC. Each variable was entered to bivariate analysis with the dependent variable; then variables with P values of <0.2 were considered for multivariate analysis. Odds ratio, 95% confidence interval and a P-value of <0.05 were used to identify associated factors.

## Results

### Socio-demographic, surgical and anesthetic characteristics

Data were collected and analyzed from 405 patients during the study period. The mean age was 33.2 years with standard deviation of 16.8 years. Of all, 208 (51.4%), were female and the rest were male).

Variables	Frequency	Percentage
Age (years)		
≤ 10	52	12.8
11-50	292	72.1
>50	61	15.1
Sex		
Male/Female	208/197	51.4/48.6
Residence		
Rural/Urban	240/165	59.3/40.7
BMI (kg/m <sup>2</sup> )		
<18.5	128	31.6
18.5-24.5	237	58.5
25-30	34	8.4
>30	6	1.4
ASA status		
ASA I/II/III	335/65/5	82.7/16.0/1.2
Intra-operative blood loss		
≤ 500 ml	277	68.4
>500 ml	128	31.6
Type of anesthesia		
GA/SA	339/66	83.7/16.3
Type of surgery		
Elective/Emergency	178/227	44.0/56.0
Postoperative analgesia		
Yes/No	190/215	47.0/53.0
Antibiotic Prophylaxis administration		
Yes/No	337/68	83.3/16.7
Duration of Surgery		
≤ 1 hr/>1 hr	139/266	34.3/65.7
Site of surgery		
Head and neck	84	20.7
Upper abdominal	44	10.9
Lower abdominal	240	59.3
Thoracic	6	1.5
Extremity	31	7.6

**Table 1:** Sociodemographic characteristics of surgical patients operated in Gondar University Hospital, January 1, to April 30, 2013 (N=405).

Majority of participants (82.7%) were ASA I. In this study only 0.7% of participants were smokers. With regard to BMI, 58.5% had normal BMI (18.5-25), and the proportion of underweight was one in three.

From all patients, (83.7%) were operated under general anesthesia and 56% were emergency cases. With regard to intra operative analgesia; Diclofenac (1mg/kg) was used for 44 (16%) of the cases, opioids (mainly fentanyl) was used for 29 (10.6%) of the cases and peripheral nerve block was used for 79 (28.7%) of the cases intra operatively. For peripheral nerve block bupivacaine with a maximum safe dose of 2 mg/kg was used by making the concentration 0.25% by diluting with normal saline solution.

Postoperative analgesia was utilized only in 53% of the cases. Fifty eight percent of the operations were lower abdominal procedures, Table 1.

### Percentage of post-operative complications by type of procedure

Out of 84 patients that underwent head and neck procedures, 20 developed post-operative pulmonary complications (23.8%). From 44 lower abdominal cases 11 developed post-operative pulmonary complications (25%). With regard to lower abdominal procedures, out of 240 cases 56 developed PPC (23.3%) (Table 2).

Type of procedures	Post-operative pulmonary complications	
	Yes	No
Head and neck procedures	20 (22.7%)	64 (77.3%)
Upper abdominal	11 (25%)	33 (75%)
Lower abdominal	56 (23.3%)	184 (76.7%)
Thoracic	1 (16.7%)	5 (83.3%)
Extrimity	1 (3.22%)	30 (96.8%)

**Table 2:** Distribution of post-operative complication by procedure type, among patients operated at Gondar University Hospital from January 1, 2013 to April 30, 2013; n=88.

### Postoperative pulmonary complications

Patients who developed postoperative pulmonary complications were 88 (21.7%). Of which 60.2% were emergency patients. Among the postoperative pulmonary complications evaluated, majority were postoperative pneumonia 75 (85.2%) followed by Bronchitis 10 (11.4%), respiratory failure 1 (1.1%) laryngeal edema 1 (1.1%) and heamothorax 1 (1.1%) (Table 3).

### Factors associated with postoperative complications

Type of anesthesia, intra-operative blood loss, postoperative analgesic use and duration of surgery were found to be significantly associated with postoperative pulmonary complications. Accordingly, the use of general anesthesia increased the occurrence of postoperative pulmonary complications 8 times as compared to Spinal Anesthesia. (AOR=8.72, CI, 2.01; 37.73). The incidence of postoperative pulmonary complication among patients with intra-operative blood loss of greater than 500 ml was twice as compared to those patients whose intra-operative blood loss was less or equal to 500 ml

(AOR=2.02, CI, 1.18; 3.46). Failure to use postoperative analgesics and surgical duration of greater than one hour were also 2 times risky than their counterparts (AOR=2.00, CI; 1.17; 3.43 and AOR=2.12, CI; 1.18; 3.84 respectively).

Variables	Postoperative complications		COR (Crude odds ratio) (95% CI)	AOR(Adjusted odds ratio) (95% CI)
	Yes	No		
Anesthesia type				
GA	86 (25.3%)	253 (74.7%)	10.87 (2.60; 45.35)**	8.72 (2.01; 37.73)**
SA	2 (3.1%)	64 (96.9%)	1.00	1.00
Intra-operative Blood loss				
≤ 500 ml	53 (1.13%)	224 (98.7%)	1.00	1.00
>500ml	35 (27.3%)	93 (73.6%)	1.59 (0.97; 2.59)*	2.02 (1.18; 3.46)*
Postoperative analgesia administered				
No	60 (28.0%)	155 (72.0%)	2.24 (1.35; 3.69)**	2.00 (1.17; 3.43)*
Yes	28 (14.7%)	162 (85.3%)	1.00	1.00
Duration of surgery				
≤ 1hour	19 (13.7%)	120 (84.3%)	1.00	1.00
>1 hour	69 (26.0%)	197 (74.0%)	2.21 (1.26; 3.85)**	2.12 (1.18; 3.83)*

**Table 3:** Factors that has shown association with post-operative pulmonary complications among patients operated in Gondar University teaching Hospital, from January 1, 2013 to April 30, 2013.

### Discussion

Postoperative pulmonary complications are as prevalent as cardiac complications and contribute significantly to morbidity, mortality and length of hospital stay. Pulmonary complications may even be more likely than cardiac complications to predict long-term mortality after surgery [19]. Determination of frequency and clinical impact of PPC in modern practice is limited because of lack of a uniform definition of PPC in the literature [8]. Likewise knowledge about factors predicting PPC is also imperfect and a lot of variation is seen in studies of non-cardiothoracic surgery [20]. The occurrence of postoperative pulmonary complications is between 5-80% with variation attributed to set-up, preoperative and intra-operative risk factors [9].

Our study has shown PPC rate of 21.7% following non-cardiothoracic surgery which means that PPC are common in our setup. This rate is higher than the reported rates by Toori et al. and Finlay et al. [20,21] which was 8% and 5% respectively. However, compared to Medeiros et al., Fisher et al. and Kanat et al. [22-24] (PPC rates of 33.9%, 37% and 58.3% respectively), our reported rate of PPC was quite less. The above mentioned statistics clearly depict a wide

range of PPC incidence because of difference in patient population and criteria used to define the PPC in different populations [9,25].

Postoperative pulmonary complications are the major source of morbidity and mortality associated with surgery and anesthesia. Postoperative pneumonia is the most serious postoperative complication occurred in 9% to 40% of patients after surgery. It ranks as the third most common postoperative infection, behind urinary tract and wound infection in hospitals [26]. Accordingly, in this study postoperative pneumonia was the most common postoperative pulmonary complication (85.2%). This is consistent with study conducted by Kanat et al. [24], Gerard et al. [27] and Brooks [26] where pneumonia was the leading postoperative pulmonary complication in their study. But it was higher comparable to study conducted by Toori et al., Modell et al. and Medeiros [21-23] which was 16%, 45% and 37.2% respectively. The possible explanation why there is increased incidence of post-operative pneumonia in our setting could be related to poor sterility of air way equipment such as endo tracheal tubes and laryngoscopes. As one of third world country we re- use endotracheal tubes several times and often we don't use filters on breathing systems, because of shortage.

Pulmonary adverse events after surgery are the commonest one. Managing these pulmonary complications requires much resource in terms of human resource and material, therefore risk identification is by far cost effective. In order to predict the occurrence of PPC in patients undergoing non-cardiothoracic surgery, all possible risk factors should be evaluated so as to devise preventive strategies leading to reduction in the associated morbidity and mortality [28,29]. This study showed that use of general anesthesia, absence of postoperative pain management, blood loss of 0.5L and long surgical time were significant predictors of PPC.

Based on literature review, the relation of postoperative pulmonary complication to the type of anesthesia was demonstrated in prospective randomized blinded study [28]. Similarly in this study, those patients operated under general anesthesia were more likely to have postoperative pulmonary complications. This is in line with systematic review of 7 studies on preoperative risk factors on postoperative pulmonary complications. On these studies general anesthesia was consistently found to be predictor of postoperative pulmonary complication [30]. This could be explained by the fact that most of general anesthesia cases require endotracheal intubation which bypasses the mucociliary function of the respiratory system.

Similarly absence of postoperative analgesic use was a predictor of postoperative pulmonary complication. This is also consistent with study conducted by Daniel et al. [30] where use of epidural analgesia has brought significant reduction in postoperative pneumonia as compared to those patients who were not given epidural analgesia in patients undergoing thoracic and abdominal surgeries [31]. This could be explained by impairment of effective breathing and coughing reflexes due to pain especially in procedures done on upper abdomen and intra thorax, thereby leading to hypoventilation and sputum retention; which intern lead to postoperative pulmonary complications as hypoxia, atelectasis and pneumonia.

Another factor that showed association with postoperative pulmonary complications was intra operative blood loss. This finding is consistent with study conducted by Kumar et al. [31] in which intra-operative blood loss showed significant association with postoperative pulmonary complications. The possible explanation for this could be because of increased risk of transfusion which decreases immunity.

In our study out of 128 patients who has lost blood volume of more than 500 ml, 62 were transfused perioperatively. The more the patient losses blood the more likely they will be anemic, that will in turn reduces tissue oxygen tension, thereby increase risk of infection by affecting the immune system. Besides anemic patients will be lethargic with very poor respiratory effort and less effort to cough and expectorate, thereby will have sputum retention that increases post-operative pulmonary complications.

Similarly, prolonged surgery was also identified as significant predictors of PPCs and it is well supported by literature review [1,32]. In fact, multivariate analyses have found prolonged surgery, ranging from 3 to 4 hours, to be an independent predictor of postoperative pulmonary complications.

Postoperative pulmonary complications are associated with substantial morbidity and mortality. It has been estimated that nearly one fourth of deaths occurring within 6 days of surgery are related to postoperative pulmonary complications [26]. The current study showed a mortality rate of 11.4%.

## Conclusion and Recommendations

The burden of postoperative pulmonary complication in university of Gondar hospital was high and the commonest complication was postoperative pneumonia. PPCs are often life threatening, as shown by PPC-associated mortality rates that can be as high as 11%. General anesthesia, absence of postoperative pain management, blood loss of greater or equal to 0.5 L and long surgical time were associated factor for the development of postoperative pulmonary complications. The ability to anticipate and prevent modifiable adverse clinical events such as postoperative pulmonary complications has become a principal measure of the quality and safety of hospital care. Postoperative analgesia should be considered as part of anesthetic management for all surgical patients.

## Limitations of the Study

As with many observational studied, this study might have been affected by many biases including information bias. The proportion of patients with co-existing diseases in this study was 10%, based on information we collected from patients' records, while the actual figure could be higher as patient screening for every medical disease is not done routinely before surgery in our Hospital.

## Competing Interests

The authors declare that they have no competing interests.

## Authors' Contributions

Zewditu Abdissa Denu initiated the research idea, designed the study, performed the statistical analysis and drafted the manuscript. Mensur Osman, Tadesse belayneh, and Alhazar Berhe participated in the study design, implementation of the study, statistical analysis and contributed to the draft manuscript. All authors contributed to the data analysis, read and approved the final manuscript.

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