## ORIGINAL ARTICLE

# A prospective study of factors predicting postoperative pulmonary complications (PPC) in patients undergoing non-cardiothoracic surgery under general anaesthsia in a developing country

Kaleem Ullah Toori, MRCP (UK), FRCP (Glasgow)*, Jahangir Sarwar Khan, CPS**, Ali Zohair Nomani***, Syed Waqar Hussain***, Saad Hashmi****

** Consultant Pulmonologist, *** PG Trainee, **** House officer,*
*Department of Medicine, KRL General Hospiatl Islamabad (Pakistan)*
*** Associate Professor, of Surgery, Consultant Surgeon, Holy Family Hospital Rawalpindi(Pakistan)*

**Correspondence:** Dr. Kaleem Ullah Toori, Consultant Pulmonologist, KRL General Hospiatl Islamabad-44000 (Pakistan); Phone: +92-3215356040; E-mail: kaleem_toori@msn.com

## ABSTRACT

**Introduction:** Post-operative pulmonary complications after non-cardiothoracic surgery are common and can adversely affect morbidity, mortality and length of hospital stay. Knowledge as regards factors predicting post-operative pulmonary complications in our local setting is imperfect.

**Aims & Objectives:** To study factors predicting post-operative pulmonary complications in developing countries.

**Methodology:** Data of consecutive 404 patients undergoing non-cardiothoracic surgery under general anesthesia with tracheal intubation was collected prospectively from Jan 2009 to Dec 2010. Chi-square was used for univariate analysis. Multivariate analysis was conducted using forward stepwise logistic regression.

**Results:** The mean age was 36 ± 18 years with slight male predominence (54% vs 46%). 22% (n = 89) were smokers and the mean Body Mass Index was 23 ± 4.5 kg/m$^2$ with 35% (n = 141) overweight & obese. 5% (n = 20) of subjects had pre-existing chronic lung conditions while 23% (n = 92) had non-pulmonary chronic conditions. 70% (n = 282) of the surgeries were done electively and the mean duration of anesthesia was 78 ± 44 minutes. The overall post-operative pulmonary complications rate was 8% (n = 31) with atelactasis (48%, n = 16) followed by bronchospasm (25%, n = 8) and pneumonia (16%, n = 5) being the commonest complications. The duration of hospital stay was significantly longer (11 ± 9 days, p = 0.00) in patients with post-operative pulmonary complications and 29% (n = 9) of them required mechanical ventilation. Logistic Regression analysis identified premorbid chronic chest conditions, emergency surgery and prolonged duration of anesthesia as significant predictors of post-operative pulmonary complications while age, gender, Body Mass Index, smoking history and non-pulmonary premorbids were insignificant in this regard.

**Conclusion:** Post-operative pulmonary complications after non-cardiothoracic surgery are common and lead to increased morbidity and prolonged hospital stay in our setting. We identified pre-existing chest disease, prolonged anesthesia and emergency surgery as significant predictors of post-operative pulmonary complications.

**Key words:** Postoperative pulmonary complications; Non-cardiothoracic surgery; Body Mass Index; Emergency surgery; Prolonged anesthesia

**Citation:** Toori KU, Khan JS, Nomani Z, Hussain SW. A prospective study of factors predicting postoperative pulmonary complications (PPC) in patients undergoing non-cardiothoracic surgery under general anaesthsia in a developing country. Anaesth Pain & Intensive Care 2012;16(3):252-256

## INTRODUCTION

Guiding the patient safely and efficiently through the postoperative course has always been the primary goal and a shared effort of the health care professionals but unfortunately, postoperative pulmonary complications (PPC) frequently defeat this objective yet today.[1] Clinically important PPC not only contributes to increased morbidity and mortality;[1&2] they are a major factor in driving up total medical expenditures, especially in terms of utilization of intensive care facilities and duration of hospital stay.[1,3]

The current basis of our understanding of the nature of PPC is weak as only a small number of high-quality studies are available and there is lack of global consensus on a uniform definition of PPC. Also available evidence comprise of studies focusing on specific patients and kinds of surgeries.[3] As a consequence, a wide range of incidence of PPC (2% – 40%) has been reported in the literature.[4]

Majority of investigators include postoperative pneumonia (definite or suspected), respiratory failure (usually defined as the respiratory compromise needing ventilatory support) and bronchospasm as PPC, but analysis of the literature shows that other complications such as unexplained fever, excessive bronchial secretions, productive cough, abnormal breath sounds, atelectasis or hypoxemia may also be included.[3] Current evidence based studies have assessed the significance of risk factors like patient's health status, type of anesthetic, surgical procedure, age, gender, BMI, history of smoking, length of anesthesia, chronic pulmonary disease, non-pulmonary chronic conditions, nutritional status, emergency surgery, intraoperative blood loss, fluid replacement and preoperative ambulatory status as the predictors of PPC.[2,3,5] However, yet more control trials need to be done before a uniformity towards these predictors is being established.

The objective of this study is to define the factors predicting postoperative pulmonary complications in our setting and to underpin our understanding of PPC so that appropriate measures can be taken during peri-operative and post-operative periods for better patient handling and use of health care facilities.

## METHODOLOGY

This prospective study was done at KRL General Hospital, Islamabad and Holy Family Hospital, Rawalpindi from Jan 2009 to Dec 2010. Data of consecutive 404 patients undergoing non-cardiothoracic surgery under general anesthesia with tracheal intubation was collected prospectively on a standard performa.Each patient's demographics along with BMI (Body Mass Index), smoking history, previous chronic pulmonary and non-pulmonary co-morbidities were recorded. Body Mass Index was calculated using standard definition with weight being measured by a standard weight machine in kilograms (Kg) and height with standard scale in meters (m). BMI was taken as the ratio of weight in Kg to square of height in meters. Chronic pulmonary conditions included diagnosed cases of asthma, chronic obstructive pulmonary disease (COPD), previously treated pulmonary tuberculosis and/ or interstitial lung disease (ILD) according to standard protocols. Non-pulmonary co-morbidities included diagnosed cases of Diabtes Mellitus, hypertension, ischemic heart disease, left ventricular failure and/ or chronic renal failure according to standard protocols. The type and duration of surgery, whether done electively or on emergency basis and details of post-operative course were also recorded. Same anesthetic conditions and drugs were used for anesthesia in the whole population group. Note was made of development of any pulmonary complication and whether it required ICU care ± mechanical ventilation.Pulmoary complications included atelectasis, bronchospasm, pneumonia, pleural effusion and Acute respiratory distress syndrome (ARDS). Atelectasis was defined as diminished volume of all or part of lung confirmed on xray chest or computed tomography by consultant radiologist. Bronchospasm was identified clinically and recorded after confirmation by consultant physician. Pneumonia and pleural effsusion were defined in terms of radiological findings confirmed on chest xray by the radiologist. ARDS was recorded on the basis of standard definitons. The total duration of hospital stay was also recorded.

Data were analysed using statistical software SPSS version 17 for Windows (SPSS Inc. Chicago, IL USA) and NCSS 2000 (NCSS, 329 North 1000 East, Kaysville, Utah, 84037). Discrete variables were listed as frequencies and percentages and continuous variables were listed as mean ± SD. Chi-square was used for univariate analysis. Multivariate analysis was conducted using forward stepwise logistic regression.

## RESULTS

The mean age of was 36 ± 18 years with slight male predominence (54%, n = 218). 89 (22%) of the total

were smokers and the mean BMI was 23 ± 4.5 kg/m$^2$; with 35% (n=141) overweight and obese. 20 (5%) of the patients had pre-existing chronic lung conditions, predominently asthma and COPD while 92 (23%) had non-pulmonary chronic conditions, mainly diabetes, hypertension and ischemic heart disaese (Table 1). of The elective surgeries made the bulk of the operating lists as compared to emergency cases [282 (70%) vs. 122 (30%)].

**Table1: Baseline characteristics**

| Character | | Value |
|---|---|---|
| **Age (mean; years)** | | 36 ± 18 |
| **Gender** | Male | 54% (n=218) |
| | Female | 46% (n=186) |
| **Smoking History** | Smoker | 22% (n=89) |
| | Non-Smoker | 78% (n=315) |
| **BMI (mean; kg/m$^2$)** | | 23 ± 4.5 |
| **% individuals according to BMI class** | | |
| **BMI class** | | **n (%)** |
| Underweight | | 67 (16.5) |
| Normal | | 194 (48) |
| Overweight | | 105 (26) |
| Obese | | 38 (9.5) |
| Pre-existing chronic pulmonary disease | | 20 (5) |
| Pre-existing non-pulmonary disease | | 92 (23) |

The overall PPC rate was 8% (n=31) with atelactasis (48%, n=16) followed by bronchospasm (25%, n=8) and pneumonia (16%, n=5) being the commonest complications (Table 2). The mean duration of hospital stay was significantly longer in patients with PPC than without PPC, 11±9 days vs 4±3 days (p=0.00). Nine (29%) of them required mechanical ventilation.

Significantly increased PPC rate was observed in patients undergoing emergency surgery as compared to elective surgery (13.4% vs 5.8%) (p=0.02). The mean duration of anesthesia was 78±44 minutes; it was significantly longer in patients who later developed PPC (110±53 vs 75±43 minutes) (p=0.00).

**Table 2: Frequency of post-operative pulmonary complications**

| Complication | Frequency (n) | Valid Percent |
|---|---|---|
| Atelectasis | 15 | 48% |
| Bronchospasm | 8 | 26% |
| Pneumonia | 5 | 16% |
| Pleural Effusion | 2 | 7% |
| ARDS | 1 | 3% |
| Total | 31 | 100% |

**Table 3: Regression analysis for predictors of post-operative pulmonary complications**

| Variable | Odds Ratio | Confidence Interval | P value |
|---|---|---|---|
| Age | - | - | 0.12 |
| Gender | 1.6 | 0.80 – 3.53 | 0.16 |
| BMI | - | - | 0.19 |
| Positive history of smoking | 1.2 | 0.53 – 2.86 | 0.62 |
| Individuals with chronic pulmonary disease | 3.2 | 1.02 – 10.55 | **0.03*** |
| Individuals with non-pulmonary co-morbidities | 1.42 | 0.63 – 3.21 | 0.39 |
| Surgery (elective / emergency) | 2.03 | 1.07 – 4.94 | **0.02*** |
| Prolonged duration of anesthesia | - | - | **0.00*** |

Logistic Regression analysis identified premorbid chronic chest conditions, emergency surgery and prolonged duration of anesthesia as significant predictors of PPC while age, gender, BMI, smoking history and non-pulmonary premorbids were not of any significance in this regard (Table 3).

## DISCUSSION

Postoperative pulmonary complications are as prevalent as cardiac complications and contribute significantly to morbidity, mortality and length of hospital stay.[7] Pulmonary complications may even be more likely than cardiac complications to predict long-term mortality after surgery.[7]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.[9]

Knowledge about PPC and factors predicting PPC in our local setup is lacking. We undertook this project 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 & mortality associated with PPC and would eventually reduce the financial health care burden. This is very vital for a poorly funded health care system like the one in a developing country like Pakistan.

Our study has shown PPC rate of 8% following non-cardiothoracic surgery which means that PPC are common in our setup. This rate is comparable but somewhat higher than the reported rates by Sin DD et al (PPC rate of 5%)[9] & Finlay A et al (PPC rate of 2.7%) respectively.[10] However, compared to de Albuquerque Medeiros R et al and Modell JH et al (PPC rates of 33.9% and 37% respectively), our reported rate of

PPC was quite less.[11,12] 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.[4,11,13-15]

We found the commonest complication to be atelectasis (48%) and this is comparable to study conducted by Calligaro K.D. (38%)[14] but again much frequently experienced contrary to studies carried out in different setups (11-12%).[11,16] However, bronchospasm came out to be the second most common PPC occurring in 25% of the patients and was comparable to the results of de Albuquerque Medeiros R et al study (22.9%)[11] but somewhat more frequently occurring as compared to a study by Wong et al (16%).[15] Pneumonia, as a PPC, occurred in 16% of the patients, which was significantly lower as compared to studies by Modell et al (45%)[12] and de Albuquerque Medeiros R (37.2%).[11]

The duration of hospital stay was significantly longer ($p = 0.00$) in patients with PPC (11 ± 9 days) than without PPC (4 ± 3 days), and 29% of them required mechanical ventilation. The percentage of patients with PPC requiring mechanical ventilation was higher in our setup as compared to available literature.[11] Possible explanation for above may be emergency surgery with uncontrolled premorbid illnesses and general malnourishment of masses living in developing countries.

In order to predict the occurrence of PPC in patients undergoing non-cardiothoracicsurgery, all possible risk factors should be evaluated so as to devise preventive strategies leading to reduction in the associated morbidity and mortality.[17,18&19] In our study, using logistic regression analysis, we identified pre-existing chronic chest disease, prolonged anesthesia and emergency surgery as significant predictors of PPC.

The spectrum of pre-existing chest diseases and its significance as a predictor for PPCs was comparable to earlier studies.[1,3,4,7,14] Among various pre-existing chronic chest diseases we found chronic obstructivepulmonary disease being the most significant predictor of PPC and this is in keeping with observation of various studies in literature.[7] Similar to our observation in this study, no eligible study has yet determined the incrementalrisk for PPC in patients withchronic restrictive lung disease or restrictive physiologiccharacteristics.[7] While clinicians may consider such patientswith severe limitations to have an increased risk for postoperativepulmonary complications, the literature does not support an estimateof the magnitude of risk in this group.[7]

Similarly, prolonged anesthesia and emergency surgery were also identified as significant predictors of PPCs and it is well supported by literature review.[1,3-5,7,9,11,14] In fact, multivariate analyses have found prolonged surgery, ranging from 3 to 4 hours, to be an independent predictor of postoperative pulmonary complications.[7]

We did not find smoking as a significant predictor of PPCs and our finding is comparable to earlier studies.[5,11] However, it is to be acknowledged that some available data do suggest a modest increase in the risk for postoperative pulmonary complications among current smokers.[7] In the light of our study results, we would like to make a comment that perhaps smoking alone is not a risk factor, but when it leads to COPD, then it may be a risk factor. This observation needs further evaluation.

Similarly, age was not a contributing factor to PPC in our study as also reported by de Albuquerque Medeiros R et al.[11] However, literature review does reveal that advanced age is an important predictor of postoperative pulmonary complications, even after adjustment for co-morbid conditions. Ten multivariable studies have rather shown that age is a significant risk predictor and the second most commonly identified risk factor.[7] Reason for our contrary observation may be relative younger study population (36 ± 18 years). Studies evaluating clinically meaningful pulmonary complications after surgery have generally found no increased risk attributable to obesity, even for patients with morbid obesity[7] and our study results are consistent with them.

Postoperative pulmonary complications are common and play an important role in patient's morbidity & mortality after non-cardiothoracic surgery. The most common postoperative pulmonary complications include atelectasis, pneumonia, bronchospasm, respiratory failure and exacerbation of underlying chronic lung disease. While clinicians may be very conscious of the importance of cardiac complications, there is good evidence to suggest that post-operative pulmonary complications are equally prevalent and contribute similarly to morbidity, mortality and length of stay in the hospital.[1] In fact there is further evidence advocating that pulmonary complications may be more likely than cardiac complications to predictlong-term mortality after surgery, particularly among older patients.[13] Therefore, clinicians should employ preventive strategies to reduce PPC in patients who are at high risk so as to improve the quality of patient care.

## LIMITATIONS

Like every study, our study also had some limitations. We did not categorize the type of surgery on the basis of major or minor operations but the primary objective

of the study was to identify modifiable risk factors predictive of PPC for any type of surgery and the study of difference between minor and major surgeries is itself a widely debatable topic. Furthermore, it is pertinent to mention that all the surgeries were almost equally divided between two major surgeons of equal professional expertise, yet the factor of variability of expertise between the two cannot be denied completely.

## CONCLUSION

Post-operative pulmonary complications after non-cardiothoracic surgery are common and lead to increased morbidity and prolonged hospital stay in our setting. We identified pre-existing chest disease, prolonged anesthesia and emergency surgery as significant predictors of post-operative pulmonary complications.

**Acknowledgements:** The authors fully acknowledge the efforts of the accompanying medical and paramedical staff at KRL Hospital and Holy Family Hospital for helping them out at every step in the process of completion of this project.

**Disclosure:** All the authors declare that they do not have any conflict of interest regarding this work.

**Research Funding:** No grant or fund has been provided for the purpose of this study & the expenses whatsoever for this project have been shared solely by the authors themselves & no one else.

**Author contributions:** Toori KU, Khan JS, Nomani AZ and Hussain SW designed the study, did data collection & co-ordinated the laboratory work. Toori KU &Khan JS did computer entry. Nomani AZ and Hussain SW did data analysis & wrote manuscript. Toori KU& Nomani AZ revised the manuscript & planned the study.

## REFERENCES

1. Braveman J. Post-operative pulmonary complications in the adult patient-causes, effects and therapeutic strategies; Business Briefing; Global Surgery 2004. Available at http://www.touchbriefings.com/pdf/952/braverman_edit[1].pdf. Accessed 10 December 2012).
2. Lawrence VA, Hilsenbeck SG, Mulrow CD, et al. Incidence and hospital stay for cardiac and pulmonary complications after abdominal surgery. J Gen Intern Med. 1995;10:671. [Medline]
3. Canet J, Mazo V. Postoperative pulmonary complications. Minerva Anestesiol 2010;76(2);138-43. [Medline]
4. Rock P, Rich PB. Postoperative pulmonary complications. Curr Opin Anaesthesiol. 2003;16(2):123-31. [Medline]
5. Graybill WS, Frumovitz M, Nick AM, Wei C, Mena GE, Soliman PT, et al. Impact of smoking on perioperative pulmonary and upper respiratory complications after laparoscopic gynecologic surgery. Gynecol Oncol. 2012;125(3):556-60. Epub 2012 Mar 17. [Medline]
6. Canet J, Gallart L, Gomar C, Paluzie G, Vallès J, Castillo J;ARISCAT Group, et al. Prediction of Postoperative Pulmonary Complications in a Population-based Surgical Cohort; on behalf of the ARISCAT Group. Anesthesiology. 2010;113(6):1338-1350. [Medline]
7. Qaseem A, Snow V, Fitterman N, Hornbake ER, Lawrence VA, Smetana GW, et al. Risk Assessment for and Strategies To Reduce Perioperative Pulmonary Complications for Patients Undergoing Noncardiothoracic Surgery: A Guideline from the American College of Physicians. Ann Intern Med. 2006;144(8):575-80. [Medline]
8. Warner DO. Preventing postoperative pulmonary complications; The role of the Anesthesiologist. Anesthesiology. 2000;92(5):1467-72. [Medline]
9. Lawrence VA, Cornell JE, Smetana GW. Strategies to reduce postoperative pulmonary complications after noncardiothoracic surgery: systematic review for the American College of Physicians. Ann Intern Med. 2006;144(8):596-608. [Medline]
10. McAlister FA,Bertsch K, Man J, Bradley J, Jack M. Incidence of and Risk Factors for Pulmonary Complications after Nonthoracic Surgery. Am J Respir Crit Care Med. 2005;171(5):514-517 [Medline]
11. de Albuquerque Medeiros R, Faresin S, Jardim J. Postoperative lung complications and mortality in patients with mild-to-moderate COPD undergoing elective general surgery. Arch Bronconeumol. 2001;37(5):227-34. [Medline]
12. Modell JH, Moya F. Postoperative pulmonary complications. Incidence and management. Anesth Analg 1966;45(4):432-9. Available at http://www.anesthesia-analgesia.org/content/45/4/432.full.pdf+html?sid= 4e5d4e9a-3f33-48ae-aadb-17266ce36721 (Accessed on 10 December 2012)
13. Fisher BW, Majumdar SR, McAlister FA. Predicting pulmonary complications after nonthoracic surgery: a systematic review of blinded studies. Am J Med. 2002;112(3):219-25. [Medline]
14. Calligaro KD, Azurin DJ, Dougherty MJ, Dandora R, Bajgier SM, Simper S, et al. Pulmonary risk factors of elective abdominal aortic surgery. J Vasc Surg. 1993;18(6):914-20.
15. Wong DH, Weber EC, Schell MJ, Wong AB, Anderson CT, Barker SJ. Factors Associated with Postoperative Pulmonary Complications in Patients with Severe Chronic Obstructive Pulmonary Disease. Anesth Analg. 1995;80:276-84. [Medline]
16. Reinius H, Jonsson L, Gustafsson S, Sundbom M, Duvernoy O, Pelosi P, et al. Prevention of atelectasis in morbidly obese patients during general anesthesia and paralysis: a computerized tomography study. Anesthesiology. 2009;111(5):979-87. [Medline]
17. Arozullah AM, Khuri SF, Henderson WG, Daley J. Participants in the National Veterans Affairs Surgical Quality Improvement Program. Development and validation of a multifactorial risk index for predicting postoperative pneumonia after major noncardiac surgery. Ann Intern Med. 2001;135(10):847-57. [Medline]
18. Roukema JA, Carol EJ, Prins JG. The prevention of pulmonary complications after upper abdominal surgery in patients with noncompromised pulmonary status. Arch Surg. 1988;123:30-34. [Medline]
19. Arozullah AM, Daley J, Henderson WG, Khuri SF. Multifactorial risk index for predicting postoperative respiratory failure in men after major noncardiac surgery. The National Veterans Administration Surgical Quality Improvement Program. Ann Surg. 2000;232(2):242-53. [Medline]

★★★★★