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Original Research Article

STUDY ON POSTOPERATIVE PULMONARY COMPLICATION IN PATIENTS UNDERWENT UPPER ABDOMINAL SURGERY

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Abstract

Background: Patients who experience pulmonary complications during the postoperative period are at an increased risk of morbidity and mortality. The incidence of postoperative pulmonary complications ranges from 5% to 80%, depending on the patient population and the type of complication. There are several risk factors that contribute to the development of postoperative pulmonary complications. Patients over the age of 65 with an ASA > III are at an increased risk. Other risk factors include upper respiratory tract infection, anesthesia use, smoking, low socioeconomic status, low serum albumin levels, intraoperative bleeding, prolonged surgery, intraoperative blood loss, postoperative mechanical ventilation, cardiac surgery, and use of neuromuscular blocking drugs. Early ambulation is also important in reducing the risk of postoperative pulmonary complications. The development of postoperative pulmonary complications leads to increased healthcare costs due to prolonged hospital stays. In fact, patients with respiratory failure experience a 41% to 47% increase in healthcare costs. This highlights the importance of identifying and managing risk factors to prevent the occurrence of postoperative pulmonary complications and reduce healthcare costs. **Materials and Methods:** The study conducted prospective cohort on 70 patients and all significant elective abdominal surgeries was collected from our hospital. The postoperative pulmonary complications (PPC) at 7 days primary outcome measure were applied. At day 30, demographic, intraoperative, and postoperative data were gathered. The follow up complications were evaluated and peri-operative factors were statistically analyzed between the groups of patients with PPC and without PPC. **Result:** The most common complications were atelectasis, lung infiltration, and pulmonary effusion, which were reported in 12.8%, 10%, and 10% of the patients, respectively. Other complications that were observed included severe hypoxia, pulmonary infection, aspiration pneumonitis, syndrome of acute respiratory distress, and pulmonary edema. These complications were less common and were reported in less than 10% of the patients. The age of the patients, gender, BMI, and ASA physical status classification did not show a significant impact on the occurrence of PPC. However, cancer operation was found to be significantly associated with PPC (p=0.029). Among the types of operations, colorectal had the highest incidence of PPC (35%). Bowel resection was found to have a higher incidence of PPC (15%) compared to other procedures. The type of intubation and perioperative antibiotics did not show a significant impact on PPC. However, the length of the procedure was found to have a significant impact on PPC (p<0.001). **Conclusion:** The study concluded that PPC is associated with significant morbid conditions which can get worse within 7 days.

INTRODUCTION

Pulmonary complication leads to an increased rate of morbidity and mortality among patients during the postoperative phase. Nearly 5% to 80% of cases of postoperative pulmonary complication" has been recorded based on patient population and complication.[1] The incidence rate of affected patients varies among hospitals. Atelectasis, pneumonia, exacerbation of chronic lung disease,

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and bronchospasm defines as "postoperative pulmonary complication (PPC)". Adverse changes within the respiratory tract after surgery affect the clinical course of the affected individual and lead to "postoperative pulmonary complication". Preoperative test for risk identification, diverse population, and criteria considered for diagnosis contributes to a broad range of "postoperative pulmonary complication". Studies conducted on the Nigerian population reported the occurrence rate of "postoperative pulmonary complication" to be 52% while the rate has been reported to be 42.4% in Zimbabwe and 21.7% in Ethiopia.[2,3] Further investigation in the context of pulmonary complications highlights more than 230 million operations occurring globally. The incidence rate of PPC in the case of surgery ranges from 1 to 23%. Several studies further highlight pulmonary complications and "postoperative respiratory failure" is more prevalent than cardiac complications. Mortality rate enhances in case of both long as well as short term among patients who developed PPC. Nearly 14 to 30% of patients having PPC die within a month after operation in comparison to individuals who do not have PPC. PPC also enhances the morbidity rate.

Application of general anaesthesia (GA) leads to adverse respiratory impact after the loss of consciousness by patients. Depression in the Central respiratory drive leads to apnoea followed by spontaneous ventilation. A reduced dose of an anaesthetic drug also impairs ventilator response in the context of hypoxia and hypercapnia. After induction, changes within respiratory muscles occur. Obstruction in airway passage, enhanced spine curvature, displacement of cephalad diaphragm, and diminished cross-sectional area of the chest also occurs. Changes within "end-expiratory muscle tone" can be seen among patients who have not received "neuromuscular blocking drug (NMBD)", reducing "functional residual capacity" by 15 to 20%.[2] Diminished FRC, and abnormal ventilation distribution further result in an "altered ventilation-perfusion (V/Q) relationship". A high V/Q ratio leads to alveolar dead space and impairment of CO2 elimination while a low V/Q ratio leads to oxygenation impairment. Diminished lung volume in the context of PPC leads to atelectasis development. Lung tissue compression for example displaced diaphragm, closure of the airway, and increased gas absorption from alveoli lead to atelectasis formation.

Several risk factors lead to "postoperative pulmonary complications" among patients. ASA > III in patients above 65 years of age faces the risk of developing "postoperative pulmonary complications". Other identified risks include infection in the upper respiratory tract, usage of anaesthesia, smoking, poor socioeconomic status, low serum albumin level, intraoperative bleeding, prolonged surgery, "intraoperative blood surgery", "postoperative mechanical ventilation", cardiac surgery, usage of drugs blocking neuromuscular and early ambulation. PPC development enhances healthcare costs specifically due to increased stay within hospitals. Several instances further highlight the increase in cost by 41% to 47% in patients due to respiratory failure.[4-6] A recent study on evaluation of additional expenditure indicates an increase of $25 498 cost after gastrointestinal surgery". Surgeons are therefore required to be much more aware of the risk involved and accordingly adopt postoperative measures that might diminish surgical cost, morbidity, and mortality.

MATERIALS AND METHODS

Study Design

The study conducted prospective cohort on 70 patients from April, 2022 to March, 2023. Throughout a 2-week period, information on any and all significant elective abdominal surgeries was collected from our hospital. The postoperative pulmonary complications (PPC) at 7 days primary outcome measure was applied. To learn more about the relationships between various variables and PPC and the impact of these problems, univariate and multivariate analyses were carried out. At day 30, demographic, intraoperative, and postoperative data were gathered. The follow up complications were evaluated and peri-operative factors were statistically analyzed between the groups of patients with PPC and without PPC.

Inclusion and Exclusion Criteria

Included are individuals who visited our hospital's outpatient division and gave informed consent for the study. All individuals over 40 years old having major elective surgery during the study period were included in the study. Included in this study were consecutive individuals who had surgical resection of their stomach, abdominal aorta, pancreas, liver, bladder, small bowel, biliary tree, rectum, colon, and kidneys for benign and cancerous conditions.

Emergency procedures and organ transplants were not included. Cholecystectomy was also disregarded because most are done as day cases. Patients who do not provide informed consent are also not included. The patients who had chronic pulmonary conditions were also excluded.

Statistical Analysis

The study used SPSS software for effective analysis. Data entry and statistical analysis were done using ANOVA. The continuous data were expressed as mean values and standard deviations while discrete data were expressed as frequency and respective percentage. The level of significance was found to be $P<0.05$.

Ethical Approval

The authors gave the patients a full explanation of the study. The patients' consent has been obtained. The study's methodology has been approved by the ethical committee of the involved hospital.

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RESULTS

[Table 1] presents the demographic characteristics of the sample of 70 patients included in a study. The table provides information about various parameters related to the patients, such as age, sex, body mass index (BMI), physical status classification, smoking status, medical history, surgical procedure details, and analgesia approach.

The median age of the patients was 59 years, and the interquartile range (IQR) was not reported. Out of the total sample, 62.8% were male. The median BMI was 25.6 kg/m^2, and the IQR was not reported. The American Society of Anesthesiologists' physical status classification system was used to classify the patients into four categories based on their health status. The majority of the patients (52.8%) were classified as category 3, followed by category 2 (42.8%), category 1 (10%), and category 4 (7.1%). The physical status classification was unknown for 12 patients (17.1%).

A total of 11 patients (15.7%) were current smokers, and 7 patients (10%) had a history of pulmonary illness with chronic obstruction, while 14 patients (20%) had a history of stroke-related head trauma. The median level of urea was 6.2 milligrams per deciliter, and the IQR was 3.5-7.6 milligrams per deciliter. About one-third of the patients (32.8%) were on proton pump blockers, while 13 patients (7.1%) were on steroids. Additionally, 23 patients (32.8%) had undergone cancer surgery.The surgical procedures were categorized into different types based on the area of operation. Colorectal surgery was the most common type of surgery (24.2%), followed by vascular surgery (25.7%) and urological surgery (21.4%). Laparoscopic surgery was performed in 20 patients (28.6%), while 50 patients (71.4%) underwent open surgery. The median length of the procedure was 72 minutes, and the IQR was 61-83 minutes.Perioperative antibiotics were given to 60 patients (85.7%), and the intubation technique used for anesthesia was reported for 74 patients. Of these, 55 patients (78.6%) were intubated with an endotracheal tube, while 18 patients (25.7%) were intubated with a mask airway for the larynx.The analgesia approach used in the first 24 hours after surgery was reported for all patients. About 70% of the patients received only oral analgesia, while 10 patients (14.3%) received anesthetic-based analgesia, and 13 patients (18.6%) received pharmacological pain management. One patient (1.4%) received wound catheter analgesia, and two patients (2.8%) received an unidentified analgesia approach. Additionally, the analgesia approach was altered for 58 patients (82.8%) within the first 24 hours. Only one patient (1.4%) used a motivating spirometer.

[Table 2] provides the results of the outcomes after 7 days of the surgical intervention. The table contains information on the number of patients who experienced various complications following the surgery. The most common complications were atelectasis, lung infiltration, and pulmonary effusion, which were reported in 12.8%, 10%, and 10% of the patients, respectively. Other complications that were observed included severe hypoxia, pulmonary infection, aspiration pneumonitis, syndrome of acute respiratory distress, and pulmonary edema. These complications were less common and were reported in less than 10% of the patients.

Additionally, the table presents the number of patients who required readmission to the intensive care unit or reintubation. Four patients (5.7%) required both readmission to the intensive care unit and reintubation. Furthermore, the table also presents the duration of hospitalization, which was five days.After thirty days, fourteen patients (20%) attended accidents and emergencies, and another fourteen patients (20%) required readmission to the hospital. The death rate was reported as 2.8%, with two patients passing away within 30 days following the surgery.Overall, the results of Table 2 indicate that a considerable number of patients experienced pulmonary complications after the surgery. Atelectasis was the most common complication, followed by lung infiltration and pulmonary effusion. The findings suggest that patients who undergo major surgery may require close monitoring and management to prevent pulmonary complications. The readmission and attendance at accidents and emergencies highlight the need for postoperative follow-up care and the importance of monitoring patients after discharge from the hospital. The death rate observed in this study was low, which may be indicative of the effectiveness of the perioperative care provided to the patients.

A diagnosis of chronic obstructive lung disease, having undergone surgery for just a malignancy, and having a postoperative nasogastric tube were major risk factor for PPC by day 7. Moreover, the length of the procedure as well as the intraoperative analgesic strategy and a modification to this approach within the first 24 hours of the operation were linked to PPC at day 7. Age, gender, body mass index, other comorbidities, smoking, or the kind or technique of procedure were not linked to PPC (open vs. laparoscopic) [Table 3]. [Table 3] presents the impact of perioperative factors on postoperative pulmonary complications (PPC). The [Table 3] compares 50 patients without PPC and 20 patients with PPC, and reports the percentage of patients in each group for various parameters, along with the p-value to indicate the statistical significance of the results.

The age of the patients, gender, BMI, and ASA physical status classification did not show a significant impact on the occurrence of PPC. However, cancer operation was found to be significantly associated with PPC (p=0.029). Among the types of operations, colorectal had the highest incidence of PPC (35%). Bowel resection was found to have a higher incidence of PPC (15%) compared

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to other procedures. The type of intubation and perioperative antibiotics did not show a significant impact on PPC. However, the length of the procedure was found to have a significant impact on PPC ($p<0.001$), with patients who developed PPC having a longer duration of surgery (210 minutes, IQR 179-290) than patients without PPC (98 minutes, IQR 52-175).

The results of this study suggest that certain perioperative factors may increase the risk of PPC, particularly cancer operation, colorectal surgery, and longer duration of surgery. These factors may need to be considered in the preoperative assessment and planning to prevent or minimize the occurrence of PPC.

Table 1: Demographic characteristics of the sample

Parameter	Number of patients (%)
n	70
Age (IQR, years)	59
Sex - Male	44 (62.8)
Body mass index (kilogrammes per square metre, IQR)	25.6
Classification system for physical status used by the American Society of Anesthesiologists	
1	7 (10)
2	30 (42.8)
3	37 (52.8)
4	5 (7.1)
Unknown	12 (17.1)
Current smoker	11 (15.7)
pulmonary illness with chronic obstruction	7 (10)
previous stroke-related head trauma	14 (20)
Urea (milligrammes per decilitre, IQR)	6.2 (3.5-7.6)
Proton pump blocker	23 (32.8)
Steroids	13 (7.1)
cancer surgery	23 (32.8)
Kind of activity	
Gastro intestinal	7 (10)
Hepatocellular	5 (7.1)
Small bowel	4 (5.7)
Colorectal	17 (24.2)
Urological	15 (21.4)
Vascular	18 (25.7)
Other	5 (7.1)
Perioperative antibiotics	60 (85.7)
Intubation technique	
Mask airway for the larynx	18 (25.7)
Endotracheal tube with or without a cuff	55 (78.6)
Unexplained	1 (1.4)
Operation strategy	
Laparoscopic	20 (28.6)
laparoscopic - Assisted	3 (4.3)
converted from laparoscopic to open	4 (5.7)
open	50 (71.4)
Endovascular	4 (5.7)
Bowel surgery	19 (27.1)
the nasogastric tube	5 (7.1)
length of the procedure (minutes, IQR)	72 (61-83)
Admission for elective critical care	13 (18.6)
First 24 hours of analgesia use	
Anaesthetic	10 (14.3)
pharmacological pain management	13 (18.6)
wound catheter	1 (1.4)
only oral analgesia	49 (70)
Unidentified	2 (2.8)
In the first 24 hours, the analgesia approach was altered	58 (82.8)
Motivating spirometer	1 (1.4)

Table 2: Results of outcomes after 7 days

Complication	Number of patients
Severe hypoxia	4 (5.7)
Bronchospasm	1 (1.4)
pulmonary infection that may be present	6 (8.6)
lung infiltration	7 (10)
Aspiration pneumonitis	2 (2.8)
syndrome of acute respiratory distress	2 (2.8)
Atelectasis	9 (12.8)
lung effusion	7 (10)
Pulmonary oedema	5 (7.1)

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potential pulmonary issues following surgery	10 (14.3)
a readmission to intensive care	4 (5.7)
Reintubation	4 (5.7)
Duration of hospitalisation (days, IQR)	5
At thirty days	
Attendance at accidents and emergencies	14 (20)
Readmittance	14 (20)
All complications	16 (22.8)
Non- pulmonary complications	9 (12.8)
Death rate	2 (2.8)

Table 3: Results of impact of peri-operative factors on PPC

Parameters	PPC NO (%)	PPC YES (%)	P-value
n	50	20	
Age (years, IQR)	65	61	0.412
Gender			0.651
Male	28	12	
Female	22	8	
Body mass index (IQR: kilos per square metre)	26.2	23.4	
Classification system for physical status used by the American Society of Anesthesiologists			0.23
1	12 (24)	2 (10)	
2	25 (50)	8 (40)	
3	11 (22)	7 (35)	
4	2 (4)	1 (5)	
Unknown	1 (2)	1 (5)	
previous stroke-related head trauma	4 (8)	2 (10)	0.592
Urea (milligrammes per decilitre, IQR) (milligrams per decilitre, IQR)	5.8 (4.7 – 7.9)	5.2 (4.3 – 9.8)	0.798
Cancer operation	14 (28)	9 (45)	0.029
Type of operation			0.291
Gastric	5 (10)	2 (10)	
Hepatobiliary/pancreatic	4 (8)	1 (5)	
Colorectal	15 (30)	7 (35)	
Urological	12 (24)	1 (5)	
Vascular	11 (22)	6 (30)	
Other	2 (4)	2 (10)	
Perioperative antibiotics	44 (88)	16 (80)	0.871
Type of intubation			0.932
Mask airway for the larynx	34 (68)	3 (15)	
Endotracheal tube with or without a cuff	12 (22)	16 (80)	
Unidentified	1 (2)	0 (0)	
Operation strategy			0.794
Laparoscopy	17 (34)	3 (15)	
Laparoscopy assisted	1 (2)	1 (5)	
converted from laparoscopic to open	2 (4)	1 (5)	
Open	15 (30)	15 (75)	
Endovascular	2 (4)	0 (0)	
Bowel resection	14 (28)	3 (15)	0.065
length of the procedure (minutes, IQR)	98 (52-175)	210 (179-290)	<0.001

DISCUSSION

In the early days, an increased incidence of pulmonary complications in the upper portion of the abdomen was prevalent. The incidence rate has been reported to be the same even after improvement in the anaesthetic process and postoperative care. However, complications do not lead to an increased mortality rate rather it increases the hospital stay of the patients. Early atelectasis development is considered a major cause of PPC. Application of anesthesia leads to "diffuse alveolar collapse" due to lower "constant tidal ventilation" and "functional residual capacity" after surgery within the upper abdomen. Several studies in the context of PPC highlight the observation of patients undergoing upper abdominal surgery for 3 years. The investigation was carried out on 417 patients belonging to the age group 17 to 84. 287 patients went through choledocholithotomy (subcostal incision) while 98 patients (midline incision) went through vagotomy through a midline incision.[5,6] 34 patients went through malignancy operations. Patients were then grouped randomly that received intercostal block in combination with "centrally-acting analgesics. The majority of the patients who went through midline incisions were male while female patients underwent subcoastal incisions. Premedication with atropine and diazepam and neurolept anaesthesia was further administered. Breathing instructions were provided to patients by physiotherapists before and after the operation. Intercostal nerves at T5 to T11 were blocked.[6,7] ICB was received unilaterally among patients that went through a subcostal incision while patients who received ICB bilaterally went through a midline incision. The second blocks were received by patients that went through cholecystectomy after 8

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hours of receivable of the first block. Etidocaine (1%) was used with adrenaline for blocks while pentazocine (30 to 45mg) was used as an analgesic. The requirement for analgesic was recorded and measurement of "peak expiratory flow" was taken for 2 days after the operation. The incidence rate of PPC after choledocholithotomy through subcostal incision has been reported to be 5.5 in ICB while it has been reported to be 10% in the control group.[8-10] Pulmonary complications were not observed in patients who received ICB twice. In comparison to biliary surgery, the PPC incidence rate was higher among patients who went through midline incision surgery. Results further highlighted that after vagotomy was cured, the PPC rate has been reported to be 12% in the control group and 21% in ICB.[9,11] PPC rate was much more common in male than in female patients who went through the subcostal incision without any ICB treatment. Choledocholithotomy resulted in atelectasis as a major pulmonary complication while atelectasis was much more prevalent among patients who went through a midline incision. According to study results, PPC development was much more common among smokers and individuals suffering from concomitant disorders. Surgical complications like wound infection were much more prevalent among patients suffering from PPC than among individuals without PPC. Variation in the PPC rate is partly attributed to the varied investigation method implemented. Physical symptoms of respiratory disorders like reduced pulmonary volumes, hypoxemia, transpulmonary shunting, and tachypnoea were common among patients who underwent surgery in the upper abdomen.[12,13] Ventilation patterns along with pulmonary function disorder are considered major causes of changes. Atelectasis has been considered to be a prevalent form of PPC that developed after biliary surgery. ICB usage after cholecystectomy prevented hypoxemia and enhanced pulmonary ventilatory volume.[14] Thus it can be assumed that reduced PPC frequency after ICB was due to improved ventilator function during the early period of postoperation. However, patients who went through midline incisions were reported to have less pain and felt much more comfortable after ICB application while no improvement in respiratory function was observed. "Postoperative pulmonary ventilation rate" is largely influenced by analgesics dose, anaesthesia duration and type of surgery. Several other factors like obesity, smoking, age, sex, and postoperative surgical complication positively lead to PPC development.[15]

CONCLUSION

The study concluded that PPC is associated with significant morbid conditions which can get worse within 7 days. The study also highlighted the frequency of PPC which would be beneficial for the clinicians to manage properly. The complication discussed in this papers are the most common occurrence as PPC which would help keep the clinicians and the institute aware of PPC in a patient. The authors suggest that the management of PPC should be standardised and guidelines should be made and updated to keep PPC under check. The authors also suggest that similar studies should be conducted to bring more broader results which would be helpful in understanding PPC on broader aspect.

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