Factors Contributing to Pulmonary Complications Among Postoperative Open Heart Surgery Patients.

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Abstract

Background: *Open-heart surgery is critical for treating cardiovascular conditions like coronary artery disease, valve dysfunction, and congenital heart defects, but postoperative pulmonary complications (PPCs) remain a significant risk, leading to increased ICU stays and mortality rates. PPCs include complications such as atelectasis, pleural effusion, and pneumonia, influenced by preoperative, intraoperative, and postoperative factors.* ***Objective****: To identify factors contributing to pulmonary complications among postoperative open heart surgery patients.* ***Settings:*** *This study was carried out in the cardiothoracic intensive care unit at Alexandria Main University Hospital and Sharq El Madina Hospital, Egypt.* ***Subjects:*** *A convenience sample of 100 adult post-open heart surgery patients from both genders and their ages ranged from 18 to 65 years, who were newly admitted to the previously mentioned CICUs.* ***Tools:*** *Two tools were utilized for data collection in this study, namely "Perioperative Assessment of Patients Undergoing Open-Heart Surgery'' and "Postoperative Pulmonary Complications Assessment".* ***Results:*** *The study showed that key preoperative factors were chronic heart failure and low hemoglobin levels, identifying significant risk factors for postoperative pulmonary complications (PPCs). Intraoperative risks included prolonged surgery and higher anesthesia doses. Postoperative challenges involved prolonged immobility and extended ICU stays. Atelectasis was the most common PPC (84%), followed by pleural effusions (29%).* ***Conclusion:*** *Age, male gender, comorbidities, and smoking significantly influence postoperative pulmonary complications (PPCs), with key risk factors including chronic heart failure, high CRP levels, and prolonged immobility.* ***Recommendations:*** *Critical care nurses should focus on optimizing preoperative health and ensuring effective postoperative care, including early mobilization, vigilant infection control, and rehabilitation.*

Keywords:contributing factors, postoperative pulmonary complications, open heart surgery patients.

Introduction

Open-heart surgery is crucial for treating cardiovascular conditions like coronary artery disease, valve dysfunction, and congenital heart defects. Despite advancements, postoperative pulmonary complications (PPCs) remain a significant risk, leading to increased ICU stays, higher readmission rates, and long-term mortality. PPCs are prevalent and often lead to complications like bleeding, cardiac arrhythmias, wound infections, acute renal failure, myocardial infarction, stroke, and graft failure. (Georgi Bachvarov, 2024)(Sigona & Richman, 2023)

Postoperative pulmonary complications (PPCs), affecting 20% to 60% of patients, are a major cause of morbidity and mortality post-surgery. These complications, such as atelectasis, pleural effusion, pneumonia, pneumothorax, hemothorax, prolonged mechanical ventilation, phrenic nerve injury, and acute respiratory distress syndrome (ARDS), significantly impact patient recovery and healthcare costs. The development of PPCs is influenced by a range of preoperative, intraoperative, and postoperative factors, including patient characteristics, surgical techniques, and postoperative care practices. (Duan et al., 2024; Odor et al., 2020)

Preoperative factors like advanced age, gender, preexisting pulmonary disease, smoking history, and comorbidities such as COPD and congestive heart failure are significant predictors of PPCs. Intraoperative factors include the type of surgery, duration of the operation, and unexpected events like cardiac arrest and excessive bleeding. Postoperative factors involve pain management, the presence of chest tubes, immobility, blood transfusions, and pleural effusions. Critical care nurses are vital in managing these complications through optimal ventilation strategies, infection prevention, and patient education. (Tuna & Akgün, 2023)

The study aims to identify factors contributing to PPCs among open-heart surgery patients, addressing the types of complications and key predictors in the preoperative, intraoperative, and postoperative phases. Understanding these factors is crucial for effective prevention and management, ultimately improving patient outcomes. (Setlers et al., 2024)

The current study seeks to fill the gap in national studies on the early identification of risk factors and their impact on preventing PPCs in Egypt, providing valuable insights for clinical decision-making in cardiac surgery. Therefore, comprehensive assessment is essential to identify and mitigate these risk factors, preventing their occurrence.

Aims of the Study

This study aims to identify factors contributing to postoperative pulmonary complications among open-heart surgery patients.

Research question

What are the factors contributing to postoperative pulmonary complications among open heart surgery patients?

Materials and Method

Materials

Design: A descriptive research design was used to conduct the current study.

Settings: This study was conducted in the cardiothoracic intensive care unit at Alexandria Main University Hospital (AMUH), which includes eight beds, and the cardiothoracic intensive care unit at Sharq El Madina Hospital, which includes seven beds. These units receive immediate postoperative open-heart surgery for adult patients in which there is direct monitoring of physiological parameters.

Subjects: A convenience sample of 100 adult post-open heart surgery patients from both genders, their ages ranged from 18 to 65 years, who were newly admitted to the previously mentioned CICUs and who fulfilled the following criteria were included in this study. sample size was calculated using power analysis (Epi-info7) program based on the following parameters: population size = 134 over six consecutive months, expected frequency =55%, acceptance error =5%, confidence coefficient =95%. design effect=1and power=80%. All patients who underwent scheduled or emergency surgery were included in the study.

Tools: In order to collect the necessary data for the study, two tools were used:

Tool one: "Perioperative Assessment of Patients Undergoing Open-Heart Surgery" This tool was developed by the researcher after extensive reviewing of the related literature (Baar et al., 2022; Liu et al., 2024; Ryz et al., 2024;Tegegne et al., 2021;Wang et al., 2023;Salling et al., 2023;Wu et al., 2024). This tool was used to assess the preoperative, intraoperative, and postoperative factors contributing to Pulmonary Complications. **It consists of two parts:**

Part I: Patients' socio-demographic and clinical profile: Socio-demographic data included the age, gender, clinical data as date of admission, current diagnosis, past medical surgical history, smoking status, invasive devices attached to the patients, and length of stay, comorbidities, type of surgery, duration of mechanical ventilation, and Severity of illness by Sequential Organ Failure Assessment (SOFA) Score were obtained from patient and record.

Part II: Perioperative Assessment of Patients Undergoing Open-Heart Surgery: This part was used to assess **the preoperative, intraoperative, and postoperative factors** contributing to postoperative pulmonary Complications (PPCs).

I. Pre-operative risk factors that include advanced age, smoking history, family history, diabetes, preoperative ventricular ejection fraction>40%, pre-existing diseases such as COPD, and congestive heart failure, laboratory findings, and use of assistive cardiac devices such as intra-aortic balloon are vital preoperative risk factors.

II. The intraoperative surgery-related factors that predispose to the development of PPCs include the induction of opioids, the number of bypass grafts, damage to the phrenic nerve during surgery, on-the-pump and off-pump, cross-clamping time, and time consumed during the operation.

III. The postoperative risk factors that can lead to PPCs include length of stay, duration of mechanical ventilation, duration of chest tubes or drains >48 hours, use of cardiac assistive devices, restricted chest movement following median sternotomy, and immobility.

Tool two: "Postoperative Pulmonary Complications Assessment". This tool was developed by the researcher after an extensive review of the related literature (Fischer et al., 2022; Mali & Haghaninejad, 2019; Tanner & Colvin, 2020) to identify the pulmonary complications of postoperative open-heart surgery such as **atelectasis, pleural effusion, pneumonia, pneumothorax, hemothorax, prolonged mechanical ventilation>48 hours, acute respiratory distress syndrome (ARDS), and phrenic nerve injury**.

Method

Approval from the Research Ethics Committee (REC) of the Faculty of Nursing, Alexandria University, was obtained before conducting the study (permission no. AU-20-2-68, IRB00013620, (9/19/2025). Permission to

conduct the study was obtained from the administrative authorities of the previously mentioned settings after an explanation of the aim of the study. Informed written consent was obtained from patients or relatives in case of a disturbed level of consciousness, including the aim of the study, potential benefits, risks, discomforts from participation, and the right to refuse to participate in the study. The reliability of the tools was tested using Cronbach's Alpha test. The reliability coefficient was 0.85 for tool one and 0.85 for tool two which is acceptable. Data was collected by the researcher during the period from September 2023 to March 2024. The study tools were tested for content validity by 5 experts in the field of the study. The necessary modifications were done accordingly. A pilot study was carried out on 10% of the study sample to test the clarity and applicability of the research tools.

The study was conducted:

- The demographic and clinical data were obtained and recorded using part one of the tool one once on admission.
- Risk factors contributing to postoperative pulmonary complications (PPCs) were assessed by the researcher and recorded.
- **Phase I:** In the Preoperative assessment, the researcher checks the patient's characteristics such as age, and gender, and the clinical data such as past medical and surgical history, and smoking history. The researcher also checked preoperative medication, and the class of heart failure was obtained using the New York Heart Class.
- **Phase II:** Intraoperative assessment, all patients who were undergoing Scheduled or emergency open heart surgery in the study sample were carried through a midline sternotomy. The researcher checks the cross-climbing time, the time spent on the cardiopulmonary bypass machine, and the total operation time. Number of grafts in the case of coronary artery, type of valve repair or replacement in case of valvular procedure. In addition, the type of anesthesia and its duration. All patients were monitored for any disturbance in human dynamic States and if they need hemofiltration therapy.
- **Phase III:** postoperative assessment, in this phase, the researcher collected the data from post-operative parameters from the time of admission in the ICU using the developed tool part II, which was collected in three times intervals as the following: **The first time** was done in day one which was within the first 24hours from admission to the intensive care unit as a baseline data. **The second time** was done on day two which was after 24 hours post-operatively from admission in the ICU. **The third time** was done on day three which was 48 hours postoperatively from admission to the ICU.
- Furthermore, the following parameters were assessed over the previous three times intervals, time spent on the mechanical ventilator per hour, immobility time per hour, and length of stay per unit per day.
- In the same line, the following clinical outcomes were monitored, assessed, and recorded by using tool II. All patients were monitored to investigate the development of postoperative complications, from admission to the open-heart intensive care unit for three days postoperatively. According to diagnostic criteria after physicians' examination and supervision.
- On the other hand, all postoperative pulmonary complications of patients who were undergoing open heart surgery were monitored, recorded, and confirmed after discussion with the physician about the signs and symptoms to determine their occurrence.

Ethical considerations:

Written informed consent was obtained from the patient if they were conscious and Witness consent from the physician, or nurse

if the patient was not able to communicate after explaining the aim of the study, and the right to refuse to participate in the study and/ or withdraw at any time. The patient's privacy was respected. Data confidentiality was during the implementation of the study.

Statistical Analysis

Data were fed to the computer and analyzed using IBM SPSS software package version 26.0. Qualitative data were described using numbers and percentages. Quantitative data were described using range mean, and standard deviation. The significance of the obtained results was judged at the 5% level.

Results

Table 1 presents the distribution of studied patients according to socio-demographic and clinical data. One hundred patients were recruited in the current study. **Regarding the age,** shows that the sample's participants are between the ages of 27.0 and 64.0. The sample's central tendency is towards the older end of the age range, as indicated by the population's average age of 54.0 years. **Concerning gender,** Male patients (59%) are more likely to undergo open heart surgery than females (41%).

Table 2 represents the distribution of the studied patients who were undergoing open heart surgery according to pre-operative assessment. revealed that all patients (100%) had open heart **surgical diagnoses** which is the current study. A significant portion of the sample (76%) reported **previous hospitalizations**. As regards **smoking,** A considerable proportion of patients are smokers (41%), revealing a potential correlation between smoking status and postoperative pulmonary complications post open-heart surgery. **Preoperative medication** usage was high with antiplatelets being the most common (68%), followed by beta-blockers (64%). **The FOUR score** assessment indicated that all patients were fully conscious (scores ≥8) before surgery.

Table 3 represents the distribution of the studied patients who were undergoing open heart surgery according to Postoperative assessment. It was found that eighty percent of patients had a **postoperative hospital stay** exceeding four days, averaging 5.9 days. Most (75%) required 1-2 days of **mechanical ventilation**, with a small group (6%) needing more than 2 days (>48 hours), indicating that while most were quickly weaned off ventilation, some required extended support. post-surgery, **opioids,** and **Antiplatelet** were administered to 100% of patients, with beta-blockers used in 84%, emphasizing the need for cardiovascular care and pain management while Bronchodilators were given to 75% of patients. Concerning **invasive devices**, all studied patients (100%) have a urethral catheter, followed by an arterial line tube and a central venous catheter (100%).

Table 4 represents the distribution of the Preoperative Factors of Patients Undergoing Open-Heart Surgery. It can be noted that in this study, 97% of patients had this operation as **elective surgery** and 77% of patients were **classified as American Society of Anesthesiologists class II or III**, indicating moderate to severe systemic disease. Additionally, 60% had a significant **family history** of related Cardiovascular issues. Cardiovascular issues were prevalent, with 57% showing impaired left ventricular function, 52% experiencing chronic heart failure (NYHA >3), and 45% having elevated CRP levels (>3 mg/dl). furthermore, 3% had Emergency surgery, and 18% had a history of Previous surgery other than cardiac.

Table 5 represents the distribution of the different intraoperative-related factors of Patients Undergoing Open-Heart Surgery. It can be noted that in this cohort, 98% of patients remained in a **supine position** for over 2 hours due to the prolonged nature of cardiac surgeries. **High doses of anesthesia** and opioids were administered to 86% of patients, with 75% requiring anesthesia for

over 290 minutes, reflecting the complexity of the procedures. **Surgery duration** exceeded 250 minutes in 76% of cases, with coronary artery bypass grafting (CABG) performed in 71%, often involving **triple or quadruple vessel grafts**. The **internal mammary artery (IMA)** was used in 95% of CABG cases. **Cardiopulmonary bypass (CPB)** was used in 81% of surgeries, with extended CPB times in 72% of patients. Blood transfusions were necessary in 45% of cases. Valve surgeries were less common, performed in 14% (mitral) and 3% (aortic) of patients. These findings emphasize the high-risk nature of cardiac surgeries, requiring meticulous intraoperative management.

Table 6 represents the distribution of the different postoperative-related factors of Patients Undergoing Open-Heart Surgery. It can be noted that in this cohort, 92% of patients experienced **prolonged immobility (>8 hours),** and 87% **required extended ICU stays (>4 days)**. Post-extubation respiratory support was necessary in 81% of patients, with 76% requiring nasal high-flow oxygenation. Chest tubes were maintained in 78% of patients for over 48 hours, with 77% needing patency management. Less common but severe complications included sternal infections (15%), use of an intra-aortic balloon pump (4%), acute myocardial infarction (1%), and cerebrovascular accidents (1%). No cases of phrenic nerve injury were reported.

Table 7 represents the distribution of the different Postoperative Pulmonary Complications of Patients Undergoing Open-Heart Surgery. It can be noted that Atelectasis was the most common postoperative complication, affecting 84% of patients. **Pleural effusions** were present in 29% of cases, and **hemothorax** occurred in 18%, highlighting bleeding risks. **Pneumonia** was diagnosed in 8% of patients, indicating susceptibility to infections. **Prolonged mechanical ventilation >48 hours** was observed in 7% of patients, while **pneumothorax and ARDS** each impacted 4% of patients. Notably, no cases of **phrenic nerve injury** were reported.

Discussion

The current study revealed that the age distribution within the sample, which ranged from 27 to 64 years, with the majority falling between approximately 45.69 and 62.31 years, suggests that older adults are at a greater risk of needing open heart surgery. Furthermore, the study identified a gender imbalance, with males making up most of the patient population compared to females.

A gender imbalance is evident in the fact that men make up most patients receiving open heart surgery, according to current statistics according to Gaudino et al. (2023) and Grant & Ouzounian, (2022). Men are more affected due to earlier onset and faster progression of cardiovascular diseases, exacerbated by lower estrogen levels, higher smoking rates, and greater stress according to (Ndzie Noah et al. (2021). Men are more likely than women to receive CABG according to Qiu & Rubens, (2024) and Uchmanowicz & Boen, (2025).

Concerning **patient's pre-operative clinical data**, the current study revealed that a detailed overview of patients undergoing open heart surgery showed that all patients required surgical intervention, with many having concurrent medical conditions, highlighting their high-risk status. This complexity is further evidenced by a significant portion of patients with previous hospitalizations and past surgeries, indicating chronic health issues. Additionally, smoking habits were significantly linked to the necessity of open-heart surgery. The study indicated that a substantial portion of the patients were either current smokers or former smokers, while a smaller number were non-smokers.

According to Gaidhani, K. A., Harwalkar, M., Bhambere, D., & Nirgude, (2021), the carbon monoxide and nicotine in cigarettes

reduce oxygen levels and increase the risk of heart-related issues after surgery. Preoperative medication usage was high, with antiplatelet being the most common, followed by beta-blockers and bronchodilators. This reflects the need for meticulous management of cardiovascular and respiratory conditions to optimize surgical outcomes and minimize risks (Sahai et al., 2022) (Schwartz et al., 2020).

The current study revealed that concerning the **patient's postoperative clinical data**, the study's findings highlight the length of stay (LOS) following open heart surgery varies significantly among patients, with a notable proportion experiencing extended hospitalizations. Prolonged ICU stays significantly impact recovery outcomes(Rustenbach et al., 2024;Seese et al., 2020). They correlate with higher mortality rates and prolonged immobility, emphasizing the need for early mobilization and strategic ICU protocols to mitigate complications such as pleural effusions and atelectasis (Mohamed Elesawy et al., 2019) (Yang et al., 2024)

Regarding Mechanical ventilation data reveals that most patients were weaned off ventilation within one to two days, demonstrating effective respiratory management (H. Yang et al., 2024). However, a subset of patients required extended ventilatory support, highlighting the variability in recovery times and the need for tailored respiratory care strategies (Buonanno et al., 2023) (Rahimi et al., 2023)(Sankar et al., 2022)

The current study findings showed that regarding the **preoperative factors** of patients Undergoing Open-Heart Surgery, the study findings on preoperative factors in patients undergoing open-heart surgery are multifaceted, reflecting this population's complexity and high-risk nature. Key findings indicate that a considerable proportion of patients are classified as American Society of Anesthesiologists (ASA) class II or III, highlighting systemic disease severity. The prevalence of emergency surgeries and a notable family history of cardiovascular issues further complicate the surgical landscape.

A sizable percentage of patients fall into American Society of Anesthesiologists (ASA) class II or III, indicating moderate to severe systemic disease, which correlates with increased surgical risk (B. Wang et al., 2021) (Chandler et al., 2020). A substantial family history of cardiovascular issues points to a genetic predisposition, which may influence patient management strategies. Many patients demonstrate impaired left ventricular function and chronic heart failure, indicating advanced heart disease (Rudenko et al., 2020) (Sameed et al., 2021).

The current study showed that regarding the **intraoperative Factors** of Patients Undergoing Open-Heart Surgery, the study highlights the complexity and high-risk nature of open-heart surgery, with prolonged supine positioning and extended anesthesia times being key factors. The frequent use of high doses of anesthesia and opioids emphasizes the need for effective pain management strategies. The lengthy duration of surgeries, particularly those involving coronary artery bypass grafting (CABG) with multiple vessel grafts, highlights the technical challenges and the need for precise surgical skills.

Extended supine positioning is common, reflecting the intricate nature of cardiac surgeries(Kai et al., 2021). Anesthesia times often exceed three hours, correlating with increased complications and longer recovery (Richey et al., 2018) (Sigona & Richman, 2023).Cardiopulmonary bypass (CPB) duration significantly impacts recovery; longer times are associated with higher rates of complications (Liu et al., 2024)(Echeverria-Villalobos et al., 2019).

The current study showed that regarding the **postoperative Factors** of Patients Undergoing Open-Heart Surgery, the study reveals that patients undergoing open-

heart surgery face significant challenges and complexities in recovery. Prolonged immobility and extended ICU stays highlight the intensive nature of postoperative management required for these patients. Effective respiratory management is crucial to ensuring enough oxygenation and preventing problems like hypoxemia and respiratory failure.

Prolonged ICU stays significantly impact recovery outcomes. They correlate with higher mortality rates and prolonged immobility, emphasizing the need for early mobilization and strategic ICU protocols to mitigate complications such as pleural effusions and atelectasis(Thevathasan et al., 2022). Post-extubation respiratory support is critical; however, a study found no significant difference in major complications between extubation in the operating room versus the ICU (Y. C. Wang et al., 2023). Severe complications, including sternal infections and acute myocardial infarctions, are less frequent than anticipated, suggesting variability in patient outcomes (Curran et al., 2022) (Huang et al., 2023).

Concerning the postoperative pulmonary complications of patients undergoing open-heart Surgery, the current study revealed that Postoperative pulmonary complications in open-heart surgery patients highlight significant respiratory challenges during recovery. **Atelectasis** is the most common complication, due to prolonged immobility and anesthesia effects, which impair lung function(Churchill et al., 2023) (Lagier et al., 2022). **Pleural effusions** and hemothorax highlight bleeding risks and the need for vigilant monitoring(Brookes et al., 2021) (Xiao et al., 2020). **Pneumonia** diagnosis in some patients indicates heightened susceptibility to infections, necessitating stringent infection control measures and early intervention to mitigate respiratory infections(Bardia et al., 2019) (Fischer et al., 2022).

Prolonged mechanical ventilation and pneumothorax require comprehensive respiratory support to prevent severe respiratory distress. **Acute respiratory distress syndrome (ARDS)** in some patients requires intensive care and advanced support strategies. The absence of phrenic nerve injury suggests effective surgical techniques and careful intraoperative management. Initiative-taking and comprehensive postoperative respiratory care strategies are crucial for optimizing recovery and improving patient outcomes following open-heart surgery.

Furthermore, prolonged mechanical ventilation and the incidence of acute respiratory distress syndrome (ARDS) necessitate comprehensive respiratory support strategies to optimize recovery(Kacmarek, 2019) (Neto et al., 2018). Despite these challenges, the absence of phrenic nerve injury suggests effective surgical techniques, indicating that with proper management, outcomes can be improved. However, the high incidence of complications necessitates ongoing research and refinement of postoperative care protocols (Kogan et al., 2019)(Fayssoil et al., 2022) (Mali & Haghaninejad, 2019) (Nijbroek et al., 2019).

Conclusion

Based on the findings of the current study, it could be concluded that age, male gender, concurrent medical conditions, and smoking significantly influence postoperative pulmonary complications (PPCs) in open-heart surgery patients. Preoperative factors included reduced left ventricular function, chronic heart failure, and high CRP levels. Postoperative challenges involved prolonged hospital stays, mechanical ventilation, and complications like atelectasis, pleural effusions, and hemothorax. Significant risk factors for PPCs were chronic heart failure, internal mammary artery use, prolonged immobility, and sternal infections. Hemofiltration during surgery increased the risk of ARDS, while prolonged mechanical ventilation was influenced by intraoperative hemofiltration and postoperative re-operation

for bleeding.

Recommendations

In line with the findings of the study, the following recommendations are made:

- Critical care nurses (CCNs) should conduct a comprehensive assessment for Preoperative Evaluation and thoroughly assess risk factors like age, gender, smoking, and medical conditions, focusing on cardiovascular issues and left ventricular function.
- Critical care nurses (CCNs) should ensure effective postoperative care, including early mobilization, adequate respiratory support, effective pain management, and comprehensive follow-up and rehabilitation are essential strategies to reduce postoperative Pulmonary complications and support recovery in open-heart surgery patients.
- Implement training programs on early mobilization protocols to reduce immobility and related complications.
- Teach staff about providing adequate respiratory support post-extubation and monitoring for respiratory distress.

- ***Author contributions***

Ibrahim Hassan Ibrahim El Adham, demonstrator: played a significant role in data collection, analysis, and interpretation. Assisted in drafting and revising the dissertation and contributed to the methodology and statistical analysis.

Nadia Taha Mohamed Ahmed, Professor emeritus: supervised the research and provided expert guidance throughout the study. Contributed to the conceptualization, study design, and final dissertation review.

Bassem Adel Ramadan, Assistant Professor: offered critical revision and expertise in the interpretation of results. Provided insights into the critical application of the finding.

Haitham Mokhtar Mohamed Abdallah, Lecturer: contributed to the study design, data analysis, and interpretation, assisted in writing and revising the dissertation, and provided guidance.

Table (1): Sociodemographic data of patients undergoing open heart surgery (N=100):

patient's demographic data	No.	%
Demographic data		
Age		
Min.- Max.	27.0-64.0	
Mean ± SD	54.0±8.31	
Gender		
Male	59	59.0
Female	41	41.0

Table (2): Pre-operative assessment of patients undergoing open heart surgery (n=100):

Pre-operative Clinical data	No.	%
Current diagnosis		
Surgical (The current study)	100	100.0
Medical	80	80.0
Previous hospitalization		
Yes	76	76.0
No	24	24.0
Past surgical history		
Yes (cardiac and other than cardiac)	47	47.0
No	53	53.0
Smoking status		
Smoker	41	41.0
Nonsmoker	39	39.0
EX smoker	20	20.0
Preoperative medications*		
Antiplatelet	68	68.0
Beta-blocker	64	64.0
Bronchodilator	47	47.0
ACE inhibitor	44	44.0
Calcium channel blocker	21	21.0
Anticoagulant	12	12.0
FOUR score		
≥8 (fully conscious)	100	100.0

*: more than one medication in each patient.

Table (3): Postoperative assessment of patients undergoing open heart surgery (n=100):

Postoperative Clinical Data	No.	%
Length of stay		
<4 days	20	20.0
>4 days	80	80.0
Min. – Max.	2.0 – 14.0	
Mean ± SD	5.9±2.1	
Duration of mechanical ventilation (days)		
<1	19	19.0
1- 2	75	75.0
>2	6	6.0
Min. – Max.	8 hours – 11.0	
Mean ± SD	1.4 ± 2.0	
Total number of Invasive devices*	651	
Mean ± SD	6.5±1.3	
Postoperative medications*		
Narcotics and opioids	100	100.0
Antiplatelet	100	100.0
Beta-blocker	84	84.0
Bronchodilator	75	75.0
ACE inhibitor	51	51.0
Calcium channel blocker	35	35.0

Anticoagulant	12	12.0

*: more than one medication in each patient.

Table (4): Preoperative related factors of Patients Undergoing Open Heart Surgery n100:

Preoperative related factors*	No.	%
Elective surgery	97	97.0
Family history	60	60.0
Impaired left ventricular function	57	57.0
Chronic heart failure (NYHA >3)	52	52.0
CRP > 3 mg/dl	45	45.0
Hemoglobin level (mg/dl) 11.0±2.2	42	42.0
Repeated lung infections	31	31.0
Previous heart surgery	29	29.0
Previous surgery other than cardiac	18	18.0
Emergency surgery	3	3.0

*: more than one Preoperative-related factor in each patient.

Table (5): Intraoperative Related Factors of Patients Undergoing Open Heart Surgery

Intraoperative Related Factors*	No.	%
Surgical procedures		
Total Time of operation > 250 minutes	76	76.0
Type of operation:		
CABG	71	71.0
Valve	17	17.0
Aortic surgery	8	8.0
Congenital heart surgery	4	4.0
Number of CABG vessel grafts:		
Triple	30	30.0
Quadruple	23	23.0
Double	14	14.0
Single	4	4.0
Type of CABG Vessels grafts:		
Use of the internal mammary artery (IMA)	67	67.0
Use of the saphenous vein	71	71.0
Types of Valve Replacement		
Mitral valve replacement (MVR)	14	14.0
Aortic valve replacement (AVR)	3	3.0
Transfusion of blood or its products	45	45.0
Hemofiltration	6	6.0
Anesthesia procedure		
a supine position for more than 2 h	98	98.0
higher doses of anesthesia drugs	86	86.0
use of opioids such as morphine during anesthesia	86	86.0
Prolonged time of anesthesia >290 minutes	75	75.0
Cardiopulmonary bypass pump		
On-pump	81	81.0
Increased cardiopulmonary bypass time>180 (min)	72	72.0
Duration of ischemic time ACC:(aortic cross-clamping time) >	9	9.0

120 (min) Off-pump	19	19.0

*: more than one Intraoperative Related Factor in each patient.

Table (6): Postoperative Related Factors of Patients Undergoing Open Heart Surgery

Postoperative Related Factors*	No.	%
Prolonged immobility time >8hr	92	92.0
Prolonged length of open-heart intensive care unit stays >4 days	87	87.0
Non-invasive ventilation after extubating	81	81.0
Time of chest tube removal after surgery>48hrs	78	78.0
Nasal high-flow oxygenation after tracheal extubating	76	76.0
Bleeding	31	31.0
Pleural effusion	30	30.0
Acute kidney injury	29	29.0
Anemia	26	26.0
New onset of atrial fibrillation	21	21.0
Re-operation for bleeding	15	15.0
Sternal infection	15	15.0
Arrhythmia	12	12.0
Cardiac tamponade	5	5.0
Use of IABP intra-aortic balloon pump	4	4.0
Mediastinitis	3	3.0
AMI, acute myocardial infarction.	1	3.0
Cerebral vascular accident	1	2.0
Phrenic nerve injury	0	0.0

. *: more than one postoperative-related factor in each patient.

Table (7): Postoperative Pulmonary Complications Assessment of Patients Undergoing Open Heart Surgery (n=100):

Pulmonary complications*	No.	%
Atelectasis	84	84.0
Pleural effusions	29	29.0
Hemothorax	18	18.0
Pneumonia	8	8.0
Prolonged mechanical ventilation >48 hours	7	7.0
Pneumothorax	4	4.0
ARDS	4	4.0
Phrenic nerve injury	0	0.0

*: more than one Pulmonary complication in each patient

Contributing Factors, Postoperative Pulmonary Complications, Open Heart Surgery Patients.

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