Effect of incentive spirometry on postoperative pulmonary complications and oxygenation following open heart surgery

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Abstract
Background: Patients receiving cardiac surgeries present high risk of developing postoperative complications. Incentive spirometry (IS) is used for the prevention and treatment of postoperative pulmonary complications in patients undergoing cardiac surgeries. **Aim**: Evaluate the effect of incentive spirometry on oxygenation and postoperative pulmonary complications after open heart surgery. **Setting:** The study was carried out in Cardiothoracic Department and open heart Intensive Care Unit at Sohag University Hospital. **Subjects:** A purposive sample of 60 adult patients undergoing open heart surgery they were reviewed for potential enrollment in the study.(30 study group) received routine hospital care in addition to incentive spirometer every 2 hours while the (30 control group) received routine hospital care only. **Tools:** Two tools were utilized to collect data **Tool I:-**Patient assessment sheet. **Tool II:** physiological Assessment sheet. **Methods:** Patients in the intervention group received bihourly use incentive spirometer for 72 hours. **Results:** Patients in the study group had a significantly lower mean number of hypoxic events with shorter duration and shorter length of stay in the hospital and the ICU. **Conclusion:** use of the incentive spirometer reduces the risk of pulmonary complications and hospital length of stay after cardiac surgery. **Recommendations:** Offer a training program to refresh critical care nurses' knowledge about new deep breathing techniques, and teaching the patient how to perform incentive spirometry before surgery.

Key words: Incentive spirometry, oxygenation, postoperative pulmonary complications and open heart surgery

Introduction
Postoperative pulmonary complications (PPCs) are common after abdominal, thoracic, and cardiac operations. They are a major contributor to morbidity, compromise oxygenation, extend hospitalization, and raise death, with an incidence of between 30 and 60%. (**Toor, Kashyap&Yau2022).**

Following heart surgery, variety of postoperative pulmonary problems, such as hypoxemia, pleural effusion, pneumothorax, bronchiectasis, respiratory distress, respiratory infections, pulmonary edema and pleural effusion may be developed. (**Gilaniet al., 2022).**

After being discharged from the hospital, patients who have heart surgery may experience physical and mental challenges. Following discharge, they frequently need assistance and follow-up. Before and after cardiac surgery, patients' knowledge of the risks and self-care procedures can be improved by using educational techniques or methods. (**Shahmoradi, Rezaei&Rezayi, 2022**).

Any surgical procedure involving the heart or blood veins that supply the heart with blood, is referred to "open heart surgery". These procedures are frequently used in patients who have cardiac disease, have experienced a heart attack, strokes, or blood clotting, as well as in those who are at high risk of experiencing any of these health issues. A heart operation can take many different forms which listed by the National Heart, Lung, and Blood Institute and include Coronary Artery Bypass Grafting (CABG), heart valve substitute or replace damage, pacemaker or Implantable Cardioverter-Defibrillator (ICD) implantation, maze surgery, aneurysm repair, heart transplant, and the implantation of Ventricular Assist Device (VAD) or Total Artificial Heart (TAH) **(Shahet al., 2020).**

Incentive spirometry (IS) raises oxygen saturation, expands breathing volume, and strengthens respiratory muscles. With the aid of visual feedback from an incentive spirometer, patients can learn and are motivated to practice breathing. Spirometry with incentives is similarly inexpensive and simple to use. Due to these numerous benefits, incentive spirometry is applied in clinical settings all over the world for patients slated for open heart surgery. **(Zeranget al., 2022).**

Incentives spirometers are used to treat or prevent atelectasis, soften respiratory discharge, prevent the accumulation of mucus and fluid in the lungs, protect against pneumonia and other dangerous lung infections, Keep lungs healthy if patient's bedridden by managing the symptoms of lung diseases, particularly thoracic and abdominal surgery. They measure the amount of air that is inhaled through the mouthpiece and help increase pulmonary ventilation. Through encouraging the

patient to breathe deeply and slowly, incentive spirometry simulates the natural sighing movement. **(Zeranget al., 2022).**

Nursing personnel are responsible for monitoring, instructing, and educating the patient how to use the IS. PPC incidence might be decreased with respiratory therapy that incorporates periods of IS each day along with deep breathing exercises, guided coughing, early mobilization, and pain management. Additionally, incentive spirometry may help patients who have undergone open heart surgery avoid PPCs. (**feizi et al., 2020).**

Important steps are taken to reduce PPCs, despite the fact that clinical evidence supporting PPC prophylaxis is frequently ambiguous. These include carefully tailored methods for reducing atelectasis and aspiration of oral secretions, improving the patient's capability for movement, expectorating secretions, and regaining functional residual capacity. Additionally, numerous preventative strategies are used, including early ambulation, positive airway pressure, that IS, deep breathing exercises, and other methods **(Zarbocket al., 2020).**

Critical care nurse's involvement is crucial in helping the patient recover from open heart surgery, promoting healing, and avoiding complications. During the assessment, the nurse gathered information that was crucial in determining the patient's respiratory condition and planning their care. The nurse evaluates arterial blood gases, lung function tests, breathing rate and depth, blood oxygen, breath sounds, and diagnostic chest X-ray. These findings are beneficial in anticipating postoperative pulmonary function and lowering the occurrence of postoperative pulmonary problems. Additionally, the nurse should evaluate the patient's tolerance while delivering care. **(feizi et al., 2020)**.

Significance of the study

Cardiothoracic surgery patients frequently experience postoperative pulmonary problems (Decreased oxyhaemoglobin saturation level, etelactasis, and pneumonia, ect...)which can occur in up to one-fifth of cases and are caused by general anaesthesia, ischemia with consequences for the extracorporeal circulation, sternotomy, and extended hypothermia.(Tanner & Colvin 2020)

Therefore the study was conducted to evaluate effect of incentive spirometry on prevention of pulmonary complications among cardiac surgery patients

Aim of this study

The study's aim is to evaluate the effects of incentive spirometry on oxygenation and postoperative pulmonary complications after open heart surgery

Research hypotheses

To fulfill the aim of the study following research hypothesis were formulated:

- Post-operative open heart surgery patients practicing routine breathing and coughing exercise have expressing high incidence of pulmonary secretion than whom use incentive spirometry plus routine breathing and coughing exercise.
- Post-operative open heart surgery patients using incentive spirometry plus routine breathing and coughing exercise will expressing moderate pulmonary secretion and improved oxygenation.

Subjects and Methods

Research Design: In this work, a quasi-experimental research approach was used. This empirical study design is used to calculate the causal effect of an intervention on the population it is intended to reach, without using randomization **(Handley et al 2018).**

Variables

- Independent variable: is incentive spirometer.
- Dependent variables: are patient's oxygenation and postoperative complications.

Setting: This study was carried out at the Sohag University Hospital's Cardiothoracic Department and Open Heart Intensive Care Unit.

Subjects: A sample of 60 adult patients undergoing open heart surgery was selected for the study and was randomly divided into two equal groups

Inclusion criteria

- All adult (18-65 yrs.) patients admitted in cardiothoracic for open heart surgery
- Hemodynamically stability
- The patient must remain in the intensive care unit for at least 72 hours.

Exclusion criteria

The study was excluding those whom have a history of mental disorders.

Sample size

According to Epi Info 2000, the sample size was determined. With a precision of (2%), a sample size was chosen using a custom calculation based on illness prevalence at a 95% confidence level. To address issues with non-responses and dates that were missed, the sample size was raised by 10%. 85% of the study's power**.**

Tools for Data Collection

According to the following, two instruments were used to get the data:

Tool I: Patient assessment questionnaire: - The researcher created an assessment sheet, and the tools' contents were decided after conducting a thorough literature analysis and pilot study. **(Christalle et al 2019).**

.It includes the following main items:-

A-personal data include: - age, sex, marital status and level of education.

B- Medical and clinical relevant data: history of present illness, history of previous illnesses, date of admission, clinical diagnosis, number of hours or days spent on a mechanical ventilator and duration of stay in the intensive care unit.

Tool II: Physiological Evaluation Application form: The researcher created this tool after studying the pertinent literature **(Christalle et al 2019). Which include:**

Hemodynamic evaluation variables such as: temperatures, cardiac variables (heart rate, blood pressure, and mean arterial pressure, CVP, and spo2)

Laboratory study: arterial blood gases, full blood analysis.

Pulmonary assessment: During the post-operative period, the respiratory system is evaluated for breathing rate, breathing discomfort, wheezing, dyspnea, coughing, sputum production, and hemoptysis**.**

Post-operative complications: Complications occur postoperative period as pulmonary complications, wound infection, atelectasis, pneumonia, hemorrhage, dysrhythmia & gastrointestinal complications.

Pulmonary function test: (preoperative and in fourth day postoperative open heart patient)Several metrics, including forced vital capacity (FVC), forced exhalation volumes on one second (FEV1), and vital capacity(VC), may appear on patient report following spirometry

Methods

The study was conducted throughout three main phases, which are preparatory phase, implementation and evaluation phase

Preparatory phase

- Developing instruments for data collecting entails examining pertinent literature, gaining theoretical understanding of various study-related topics, and using books, papers, the internet, journals, and magazines.
- In order to get their cooperation, the study's goal was presented to the director of the cardiothoracic surgery department and the post-operative ICU before receiving their formal consent and administrative authority to gather the required data.
- Protection of human rights: After explaining the study's goals and the confidentiality of the patient's data for research purposes, informed consent was acquired from every patient.

- **Content validity:** A jury of five experts from the fields of thoracic surgery (two professors, one assistant professor), critical nursing staff, and other disciplines examined the tools for the validity of the research's content (2 assistant professor).
- **Pilot research:** To assess the viability and application of the tools, a pilot study involving 6 patients was conducted. The analysis of the results of the study showed that only minor revisions are needed. The subjects were taken out of the study and these necessary alterations were made.
- The researcher interviewed each patient individually to gather the essential data throughout the course of a nine-month period beginning in March 2022 and ending in October 2022.

Implementation and evaluation phase

Study group:

- In the second, third, and fourth postoperative days, the patient received an incentive spirometer to be used 5 to 10 times daily every 2 hours.
- Patient takes a slow, deep breath into the incentive spirometer while holding their breath for two to three seconds.
- Watch the ball rise to keep track of the patient's progress.
- Then, exhale into the mouthpiece while continuing to breathe normally for several breaths.
- Following this procedure, the patient performed a deep coughing exercise to remove secretions.
- Repeat this approach with the patient throughout the day.

Control group: -was received usual routine hospital care (breathing and coughing exercise)

For both groups

- Identify the arterial blood gas ABG (arterial blood gas), six times every four hours in the first two days (before and after extubation), and three times every eight hours in the third and fourth postoperative days after extubation and after having completed deep breathing maneuver's within 30 minutes, then take the average of each day.
- Every two hours, check vital indicators.
- A evaluate the likelihood of respiratory problems on the fourth day.
-A lung function test is performed on the first evaluation day prior to surgery and on the fourth postoperative day (2nd assessment).
- Measure postoperative pain on a numerical scale and assess it: (Pain at rest, Pain while taking deep breath, Pain while coughing, Pain at pulmonary function test)

Evaluation phase

- Assess the occurrence of post-operative pulmonary problems in both groups of open heart surgery patients (using auscultation, chest x-ray, pulmonary function testing, and blood gas), including atelectasis, pneumonia, bronchitis, fever, and cough with sputum or blood.

Analysis of data

SPSS version 19 was used to collect data through computer programmers. Information given as "mean standard deviation," "number," or "percentage." To determine whether a numeric variable is significant, use T test. To evaluate whether a non-parametric variable is significant, use the Chi-square test. Utilizing the person's correlation for a numerical variable within the same group, n.s. P > 0.05 no significant, P 0.05 significant** P 0.01 moderately significant, *** P 0.001 highly significant

Results

Table (1): Shows that, there was no statistically significant difference between the study group and control group regarding to **Socio-demographic** characteristics as age, sex, marital status and educational level (1.000, 0.542, 0.689) receptively

Table (2): Showed that, there was no statistically significant difference between the study group and control group regarding to past history and type of surgery at (0.681, 0.920) receptively

Table (3): Showed that, there was highly statistically significant difference between the study group and control group regarding to temperature, heart rate and SpO_2 in second day and third day. Moreover, there was statistically significant difference between the study group and control group regarding to blood pressure in second day at (0.05, 0.01), While, there was no statistically significant difference in first and second day at (0.14, 0.037) (0.951, 0.84) .More ever, there was statistically significant difference between the study group and control group regarding to central venous pressure in the third day (0.01). While, there was no statistically significant difference in first and second day at (0.52, 0.029)

Table (4): Demonstrated that, in terms of arterial blood gases on the first day, there was no statistically significant difference between the study group and control group (p > 0.05). Additionally, the data demonstrates that there was a statistically significant difference between the study group and control group for PH, PaCO2, PaO2, and SaO2 on the second and third day (p= 0.05), but not for HCO3 and BE.

Table (5): Demonstrated that there was a significant difference between the research group and control group for the length of the MV at (0.000, 0.001) and the number of days spent in the ICU, respectively.

Table (6): Demonstrated that there was a statistically significant disparity between both group for wound infection, atelectasis pneumonia, and gastrointestinal complications, with respective P values of (0.035, 0.022, 0.006, and 0.024).

Table (7) : Postoperative pain using numerical scale, regarding to postoperative pain, it was noticed that (80% & 52%) of patients in group 1 & 2 respectively had mild pain, while coughing, while 80% of patients in group 2 had mild pain when done pulmonary function test with statistical significant difference was found between the two groups P(0.037).As regard pain while taking deep breath it was found (100%,&92%)of patients in group 1&2 respectively had mild pain while taking deep breath with non-significant difference was found between the two groups.

Table (8): Showed that, there was statistically significant difference between the study group and control group regarding to assessment of pain level in second and third day at (0.033, 0. 001) respectively

Table (1): Socio demographic characteristic for both study and control groups (n=60).

Socio demographic characteristic	Study (n= 30)		Control (n= 30)		P-value
	No.	%	No.	%	
Age (years)					0.766
Mean ± SD	36.67 ± 13.64		35.57 ± 14.85		
Sex:					1.000
Male	18	60.0	18	60.0	
Female	12	40.0	12	40.0	
Marital status:					0.542
Single	6	20.0	8	26.7	
Married	24	80.0	22	73.3	
Education:					0.689
Illiterate	18	60.0	15	50.0	
Basic education	4	13.3	4	13.3	
Secondary	8	26.7	11	36.7	

Chi-square test & Independent samples t-test P >0.05 non-significant *P<0.05 significant **P<0.01 moderate significant ***P<0.001 highly significant

Table (2): Medical and clinical assessment data for study & control groups (no= 60)

Chronic disease	Study (n= 30)		Control (n= 30)		P-value
	No.	%	No.	%	
Past history:					0.681
Ischemic heart disease	4	13.3	2	6.7	
Rheumatic heart disease	20	66.7	21	70.0	
No past history of disease	6	20.0	7	23.3	
Type of surgery:					0.920
Aortic valve replacement	2	6.7	3	10.0	
Coronary artery bypass	6	20.0	7	23.3	
Mitral valve replacement	22	73.3	20	66.7	

Chi-square test & Independent samples t-test P >0.05 non-significant *P<0.05 significant **P<0.01 moderate significant ***P<0.001 highly significant

Table (3) Comparison between study &control groups regarding Vital signs and hemodynamic parameters of three days post-operative (no= 60)

Hemodynamic parameters		study group (n= 30)	control group (n= 30)	P value
Temperature	1st day 2nd day 3rd day	36.3± 0.9 37.5± .7 37.3 ± .5	36.5± .9 38.5± .8 39.8± 1.3	0.253 **0.05*** **034***
Heart rate (beat/min)	1st day 2nd day 3rd day	103.3± 23.7 96.71±11.39 93.16±12.79	105.8± 12.84 110.64±11.14 91.07±7.0	0.313 **0.001**** **0.01***
Systolic BP (mm .Hg)	1st day 2nd day 3rd day	120.30±12.76 100.44±10.22 123.87±15.8	122.47±20.55 127.15±9.87 127.75±12.97	0.14 **0.05*** 0.037
Diastolic BP (mm. Hg)	1st day 2nd day 3rd day	68.54±7.24 65.96±17.15 77.45±5.64	66.03±7.19 71.86±23.40 76.04±11.05	0.951 **0.01*** 0.84

Hemodynamic parameters		**study group (n= 30)**	**control group (n= 30)**	**P value**
C.V.P	1st day 2nd day 3rd day	3.56±2.45 7.06±1.9 10.45±1.8	4.21±3.19 7.94±2.9 7.10±2.5	0.52 0.029 **0.01***
SPO_2	1st day 2nd day 3rd day	97.58±1.7 97.65±2.09 98.79±2.10	98.35±1.19 96.47±1.8 95.31±3.6	0.065 **0.001*** **0.003****

Chi-square test & Independent samples t-test P >0.05 non-significant *P<0.05 significant **P<0.01 moderate significant ***P<0.001 highly significant C.V.P= central venous pressure SpO2= peripheral capillary oxygen saturation.

Table (4): Comparison between study &control groups regarding Arterial blood gases in first, second & third day post- operative (no= 60)

ABG	**DAYS**	**Study (n= 30)**	**Control (n= 30)**	**P-value**
		Mean ± SD	**Mean ± SD**	
PH	1st day 2nd day 3rd day	7.35 ± 0.10 7.37 ± 0.08 7.39 ± 0.07	7.34 ± 0.09 7.42 ± 0.06 7.45 ± 0.06	0.593 **0.02*** **0.018***
$PaCO_2$	1st day 2nd day 3rd day	35.85 ± 9.47 36.12 ± 6.29 37.31 ± 4.08	36.72 ± 10.86 42.93 ± 4.23 41.74 ± 4.98	0.740 **0.001**** **0.023***
PaO_2	1st day 2nd day 3rd day	140.87 ± 37.20 161.87 ± 30.19 166.99 ± 15.41	133.20 ± 38.80 126.97 ± 32.98 135.58 ± 17.99	0.566 **0.001**** **0.041***
HCO_3	1st day 2nd day 3rd day	20.27 ± 4.98 20.00 ± 2.97 23.20 ± 5.03	19.50 ± 4.75 19.57 ± 3.01 22.33 ± 4.20	0.544 0.577 0.472
SaO_2	1st day 2nd day 3-rd day	96.93 ± 2.36 97.80 ± 0.92 97.87 ± 0.97	96.87 ± 2.50 95.77 ± 0.94 94.87 ± 0.94	0.916 **0.011*** **0.001****
BE	1st day 2nd day 3rd day	-5.01 ± 5.36 -3.71 ± 4.79 -2.25 ± 4.37	-5.81 ± 4.53 -4.63 ± 4.30 3.09 ± 3.63	0.531 0.437 0.424

Chi-square test & Independent samples t-test P >0.05 non-significant *P<0.05 significant **P<0.01 moderate significant ***P<0.001 highly significant ABG: arterial blood gasPao2: partial pressure of arterial oxygen paco2:-partial pressure of arterial carbon dioxide

Table (5): Comparison between study group &control group regarding (ICU Stay, Duration of MV) (n=60).

ICU stay (days)	**Study Group (n= 30)**		**Control Group (n= 30)**		**P- value**
Mean ± SD	4.07 ± 1.01		5.30 ± 1.29		**0.000*****
Range	3.0 – 7.0		4.0 – 8.0		
Duration of MV:					**0.001****
3 hrs.	24	80.0	11	36.7	
6 hrs.	6	20.0	19	63.3	

Chi-square test & Independent samples t-test P >0.05 non-significant *P<0.05 significant **P<0.01 moderate significant ***P<0.001 highly significant

Table (6): Comparison between the study & control groups regarding to post-operative complications (n=60)

Complications	Study Group (n= 30)		Control Group (n= 30)		P-value
	No.	%	No.	%	
Wound infection	4	13.3	9	30.0	**0.035***
Atelectasis	2	6.6	7	23.3	**0.022***
Pneumonia	3	10.0	11	36.6	**0.006***
Hemorrhage	0	0.0	1	3.3	0.635
Dysrhythmia	1	3.3	1	3.3	0.765
Gastrointestinal complication	4	13.3	11	36.3	**0.024***

Chi-square test & Independent samples t-test P >0.05 non-significant *P<0.05 significant **P<0.01 moderate significant ***P<0.001 highly significant

Table (7): Distribution of sample according to Postoperative pain using numerical scale.

Pain	Study (n= 25)		Control (n= 25)		P-value
	No.	%	No.	%	
Pain at rest					0.508
None(0)	20	80.0	18	72.0	
Mild(1-3)	5	20.0	7	28.0	
Pain while taking deep breath					0.470
Mild(1-3)	25	100.0	23	92.0	
Moderate(4-6)	0	0.0	2	8.0	
Pain while coughing					0.037*
Mild(1-3)	20	80.0	13	52.0	
Moderate(4-6)	5	20.0	12	48.0	
Pain when done pulmonary function test					0.037*
Mild(1-3)	13	52.0	20	80.0	
Moderate(4-6)	12	48.0	5	20.0	

Group 1*; incentive spirometer method* ***Group 2****: conservative method*

Table (8): Comparison between study group &control group regarding Assessment of pain level (n=60).

Assessment of pain level	Study (n= 30)		Control (n= 30)		P-value
	No.	%	No.	%	
First day:					0.064
Moderate	18	60.0	20	66.7	
Severe	12	40.0	10	33.3	
Second day:					0.033*
Moderate	23	76.6	17	56.7	
Severe	7	23.4	13	43.3	
Third day:					0. 001*
Mild	18	60.0	8	26.6	
Moderate	7	23.4	10	33.0	
Sever	5	1.6	12	40.0	

Chi-square test & Independent samples t-test P >0.05 non-significant *P<0.05 significant **P<0.01 moderate significant ***P<0.001 highly significant

Discussion

Heart procedures still result in high incidence and mortality despite technological advancements in surgical methods and improvements in preoperative and postoperative care. In patients undergoing open coronary surgery, respiratory dysfunction, including as atelectasis, restrictive ventilator malfunction, and hypoxemia, are common **(Yazdannik, etal. 2019).**

Coronary artery disease's (CAD) Patients who are refractory to medical treatment must frequently contemplate cardiac surgery because is one of the top causes of morbidity and mortality in both developing and industrialized countries. (**Kandaswamy& Zuo.2018**). In preparation for cardiac surgery, patients frequently endure severe physical and psychological strain, as well as elevated levels of anxiety and melancholy brought on by their concerns, fears, and apprehensions about the procedure. These could worsen the disease's symptoms, have a negative impact on physiological variables both before and after anesthesia, and possibly even cause a lengthy recovery. (**Suzanne,et al2019).**

When it comes to socio-demographic characteristics ,the results of the current investigation revealed that the average age of the study participants in both the study and control groups was (36.67 13.64 - 35.57 14.85). The majority of them were men, married, and had graduated from high school. According to the study's findings, there were no appreciable differences in the socio-demographic characteristics of the study group compared to the control group. This showed that the study group was chosen at random.

These results were corroborated by **Patra, et al.2017),** who in India conducted "Assessment of Coronary Artery Bypass Grafts Status in Symptomatic Patients: An Observational Study" and found that over half of the patients evaluated were under the age of 65, with a male preponderance. In addition, researchers **Ahmed, Mohammed and Ghanem (2018)** from Egypt's "Coronary artery bypass grafting, Effect of defining and implementing nursing care standards on patient's outcomes" study found that: - In terms of educational level, more than half of the patients were illiterate.

The current investigation demonstrated that patients in the study and control groups have had surgery to replace their mitral valves and have a history of rheumatic heart disease. These results were consistent with research conducted in Egypt by **Ahmed et al. (2019)** on "Comparison the efficacy of conservative therapy and blow bottle among open heart surgery patients for the avoidance of postoperative pulmonary problems," The majority of individuals had rheumatic fever according to their medical histories. It became clear from that that rheumatic fever was the primary reason for open heart surgery. Additionally, this was in agreement with **Raboi et al. (2018),** who in their study "Mechanical valve dysfunction in yemen" said that rheumatic heart disease is the most prevalent cardiac disease in Yemen and is associated with high morbidity and death.

The current investigation revealed that the valve replacement surgery was more common in both the study and control groups in terms of the kind of operation. This could be because the predominant diagnosis at the time was valve irritation. This concurs with **Saad, Salam, and Hassanein's (2018)** study, "Effectiveness of Planned Preoperative Teaching on Self-Care Activities for Patients Undergoing Cardiac Surgery," which found that valve replacement surgery is the most common open-heart procedure in cardiac centres and was more common in the study and control groups.

According to post-operative arterial blood gas measurements, the study group's PH, PaO2, PaCO2, and SaO2 levels significantly improved compared to the control group. Which shown the success of the nursing interventions offered. The study "Immediate effect of incentive spirometry on arterial blood gases analysis after coronary bypass graft surgery patients" by **Shagufa et al. (2018)** provides support for this conclusion. On the second postoperative day, there were no discernible differences in the mean arterial blood gas values between the two groups; however, on the third postoperative day, there was a discernible difference in the mean arterial blood gas parameters between the two groups.

The results of the current study showed that more than two thirds of the study and control groups had serum sodium, potassium, and calcium values that were within normal ranges, which could have been the outcome of pre- and postoperative inquiry examinations. The results were consistent with those reported by **Jodianne, et al. (2019)** in their study "Evaluation of an Electrolyte Repletion Protocol for Cardiac Surgery Intensive Care Patients," which found that there was no difference in the incidence of cardiac arrhythmias and that both groups had similar proportions of serum electrolyte values above the normal range. According to the same study by **Shahidi, et al. (2019),** "Hypomagnesaemia and other Electrolytes Imbalances in Open and Closed Pediatrics Cardiac Surgery," there is a strong correlation between

serum electrolyte levels and the different types of surgery at various follow-up
Intervals.
Regarding the degree of pain severity on the first day, the current investigation observed no statistically significant difference between the study and control groups. However, there was a statistically significant difference in pain severity across research groups on the second and third days. This could happen as a result of nurse intervention.
This conclusion was consistent with research conducted by **Mello et al. (2018)** in Brazil on "Assessment of pain during rest and during activities in the postoperative period following heart surgery," which revealed that the majority of the sample under study had at least one painful experience. Most patients complained of discomfort on the first and second days following surgery, however pain was most common on the first day.
The current study found that there was a significant difference between the two groups in terms of the average duration of ICU stay (LOS), preoperative days, postoperative days, and the timing of extubation, all of which were shorter in the study group than in the control group. These are brought on by the fact that heart surgery was shut down when the research group was assembled for maintenance purposes. According to **Valkenet et al (2019)**.' study "The effects of preoperative exercise therapy on postoperative outcome: a systematic review," preoperative exercise therapy may be useful for reducing the rates of post-operative complications and length of hospital stay following cardiac or abdominal surgery.
Comparison of the two groups and the impact of deep breathing techniques on the pulmonary function test (PFT) (blow bottle, IS& conservative therapy) during the initial phase following open heart surgery, reductions in lung volumes and oxygenation are frequent. Lung function is adversely affected by the use of cardiopulmonary bypass, internal mammary artery dissection, hypothermia for myocardial protection, median sternotomy, and hypothermia for other reasons **(Freitas et al., 2019).**
The results of the present investigation demonstrated a mean decline in forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), and vital capacity (VC) on the fourth postoperative day when compared to the preoperative day. And the current study makes clear that there is a statistically significant difference between the two groups in terms of vital capacity (VC), with improved FVC, FEV, and VC in patients who perform deep breathing with IS as opposed to regular deep breathing and coughing exercises.
There are numerous studies that corroborate this conclusion. According to **Stavroset al. (2019),** the pulmonary function following open heart surgery was significantly decreased in all treatment groups on the fourth post-operative day, with a mean of 60 to 75% of pre-operative values.
In comparison to the preoperative period, **(Murata et al., 2021)** demonstrated a 33% reduction in pulmonary function on postoperative day 3 and a 23% reduction on postoperative day 6.
According to **(Gao et al., 2011),** pulmonary function declined after CABG, reaching its lowest point on day three after surgery and starting to recover on day fifteen. After cardiac surgery, there are lower forced vital capacity (FVC), expiratory volume in the first second of forced expiration (FEV1), and maximum voluntary breathing than in the preoperative period, according to **(Rheeet al., 2018).**
According to **(Franco et al., 2021),** patients who undergo upper abdominal and cardiac surgery operations experience proportional decreases in all lung volumes without clinically significant changes in FEV1, FVC. However, patients who received IS recovered from their VC more quickly than those who received conservative therapy, and both treatment groups also experienced improvements in their FVC and FEV. According to **(Nicholson et al., 2010),** a mean decrease in FVC & FEV was 40-50% on the first to third postoperative days, and on the second day, a mean decrease in vital capacity was 63% when compared to the preoperative day.
The results of the current study indicate a statistically significant relationship between the socio-demographic features of the study group and postoperative complications and education. Age, sex, and marital status did not have any statistically significant relationships with the socio-demographic parameters of the study group that were connected to postoperative complications. These findings conflict with those of **Kurfirst, et al (2018)**. Who carried out the study "Health Related Quality of Life after Cardiac Surgery-The Effects of Age, Preoperative Conditions and Postoperative Complications"? It was shown that heart failure, dysrhythmia, postoperative bleeding, breathing issues, neurophysical disorders, myocardial dysfunction, and renal failure were the most common surgical complications in the group of elderly patients.

Conclusion

According to the current study's findings, incentive spirometers have a good impact on the

postoperative occurrence of pulmonary problems in open heart patients by reducing their frequency.
- Better postoperative oxygenation, incentive spirometer prophylaxis, and decreased incidence of atelectasis, hospital length of stay, and duration of mechanical ventilation

Recommendations

The findings of the current investigation lead to the following recommendations:
• Offer a training program to refresh critical care nurses' knowledge and expertise about new deep breathing techniques.
• Conduct this study again with a large sample size to assess the impact of incentive spirometry on postoperative pulmonary problems and oxygenation following open heart surgery.
• Teaching the patient how to perform incentive spirometry before surgery.

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