Effect of Active Cycle Breathing Technique on Airway Clearance among Patients Underwent Cardiac Surgery

Zainab A .Allam[1], Zeinab M. Shaban Aysha[2] , Olfat Farouk Thabet Mahmoud[3], Sanaa Saber Mohamed[4], Soheir M. Weheida[5]

[1,2]Lecturer of Critical Care and Emergency, Faculty of Nursing, Tanta University, Egypt
[3]Fellow // Lecturer of Medical - Surgical Nursing Assuit University Hospitals, Egypt
[4]Lecturer at Critical care and Emergency Nursing, Faculty of Nursing, Sohag University
[5]Prof Medical Surgical Nursing, Faculty of Nursing, Alexandria University, Egypt

Background: One of the most common problems encountered to patients undergoing cardiac surgery is bronchial secretions. In order to increase the effectiveness of airway clearance, active cycle breathing techniques have been used. **Aim:** To evaluate the effect of active cycle breathing technique on airway clearance among patients underwent cardiac surgery **Design**: A quasi experimental research design. **Setting:** This study was conducted at Cardiothoracic intensive care unit in Assuit Heart University Hospitals, Egypt. **Subjects:** A Purposive sample of 60 adult patients, divided into two equal groups 30 patients each as follows; control group and study group**. Two tools were used**; tool (I) cardiac surgery patient's assessment and tool (II) physiological and air way clearance indicators**. Results;** It was clarified that there were significant improvement regarding FVC, FEV1 , SpO2, and SaO2 among the patients in study group rather than control groups on the 3rd day post active cycle breathing technique ,where P value < 0.05. **Conclusions:** It was concluded that active cycle breathing technique give positive results on improving of spirometric, oxygenic parameters of the study group .**Recommendations**: It was recommended that active cycle breathing technique should be regarded as a standard component of care for cardiac surgery patients and replication of the study on large probability sampling.

Keywords: Active cycle breathing technique, Air way clearance, Cardiac surgery

Introduction:

The terrible increase in the incidence of heart disease is usually due to the epidemiologic transition implicating atherosclerosis, hypertension, and lifestyle risk factors [(1).] Replacement of the heart valve and coronary artery bypass grafting are the two most common cardiac procedures performed worldwide [(2, 3)].Even though cardiac surgery is performed to improve a patient's condition, there are many postoperative complications. The most typical complications are respiratory complications, which are still the most common reason for adverse outcomes post cardiac surgery and clearly contribute to an increase in morbidity and mortality rate[(3,4)].Moreover, impairment of pulmonary function is associated with a reduction in chest expansion, lung volume, and an impairment of the patient's ability to cough effectively [(5)].

Additionally, ineffective airway clearance and sputum retention are common respiratory problems post-cardiac surgery due to the sternal incision, which restricts chest movement and decreases the ability of the patient to cough effectively to remove the secretion that has become lodged in the respiratory tract, resulting in inadequate airway clearance [(3, 6)].

The term "airway clearance techniques refer to several methods used to remove excessive secretions from the respiratory tract and improve gas exchanges through re-expanding the collapsed areas of the lung [(7, 8).] Hence, they are different strategies that are used to improve airway

clearance and respiratory functions post cardiac surgery, as chest percussion, vibration, and breathing exercise with or without an incentive spirometer are recommended for cardiothoracic surgery patients to minimize the occurrence of respiratory complications [8, 9].

Consequently, an active cycle of breathing techniques has been performed to enhance the efficiency of airway clearance, which is based on a more consistent pattern of breathing control by the patient to improve airway clearance and encourage self-management by the patient [10, 11]. Moreover, this technique composed of three different breathing cycles performed in sequence as breath control, thoracic expansion exercises, and forced exhalation techniques [12, 13]. Therefore, the current study was done to clearly evaluate the effect of active cycle breathing technique on airway clearance among patients underwent cardiac surgery**.**

Significance of the study:

Patients who are undergoing cardiac surgery require specialized care. Recent studies suggest the prevalence of respiratory problems increases from 20% to 79% after cardiothoracic operations. However, the literature reports a 5.4% disability rate and a 3.7% mortality incidence [1, 6, 14]. The impaired ability of the patient to maintain efficient airway clearance post cardiac surgery remains a challenge for the patient and health care providers. Therefore, the nurse faces a great challenge in order to maintain efficient airway clearance. Furthermore, the implementation of active cycle breathing techniques aims to increase airway clearance effectiveness and promote patient autonomy [10,11]. Hence, there are limited studies have been done to evaluate the effects of ACBT on respiratory parameters and airway clearance in patients undergoing cardiac surgery. Therefore, the present study aimed to evaluate the effect of ACBT on airway clearance among patients underwent cardiac surgery**.**

Aim of the study: Was to evaluate the effect of active cycle breathing technique on air way clearance among patients underwent cardiac surgery**.**

Research hypothesis:

-Patients undergoing cardiac surgery who are exposed to active breathing techniques exhibit an improvement in oxygenic and spirometric parameters compared to the control group**.**

-Patients undergoing cardiac surgery who are exposed to active breathing techniques exhibit an increase of daily amount of expectorated sputum compared to the control group**.**

Subjects and Method:

Research design:

A quasi experimental research design was utilized to conduct this study.

Study Setting:

This study was carried out at the Cardiothoracic Intensive Care Unit (CTCU) in Assuit Heart University Hospitals, Egypt. It was prepared with three rooms, each equipped with four beds.

Subjects:

A Purposive sample of 60 adult patients was assigned in the current study from the previously mentioned settings. The sample size was calculated using the Epi Info software statistical package.

According to an analysis of statistical data from Assuit Heart University Hospital, there were a total of 171 patients admitted in 2021–2022 [15]**.** Confidence level= 99.9%, an expected frequency of 50%, an accepted error of 5%, and a confidence coefficient of 95%. The accepted sample size was 60 patients.

The patients were allocated into two equal groups, each with 30 patients.

The control group was composed of 30 patients who were managed by routine CTCU care such as routine respiratory physiotherapy such as chest percussion, vibration, and an incentive spirometer.

The study group consisted of 30 patients who were exposed to an active cycle of breathing techniques alongside routine care.

Inclusion criteria:

-Adult patients of both genders.

-After extubation for at least 6 hours post operation.

- Hemodynamic stable patients who did not receive any of the hemodynamic interventions as (any quantity of inotropic and vasopressor, medications, fluid therapy (colloid or crystalloid 400-2600/8h, packed red blood cells 500-800ml/24h)[16].

- Able to communicate.

Tools of the study: Two tools were used to gather data based on reviewing of the pertinent literatures [4-6, 10-14] .

Tool I: Cardiac Surgery Patient's Assessment

It was developed by the researcher after reviewing the pertinent literature [11, 12,13]. It composed 2 parts as the following:

Part (A): Patient's demographic characteristics as patient's code, age, gender**,** marital status, education and occupation.

Part (B): Patient's medical data as medical diagnosis, duration of surgery, body mass index, past medical diseases and smoking history.

Tool II: Physiological and Airway Clearance Indicators

It was developed by the researcher after reviewing the pertinent reviews [4,5,6,13,14]to assess physiological, oxygenic , spirometric parameters and daily amount of expectorated sputum. It included four parts as follows:

Part (A): Physiological parameters; it was used to assess body temperature, pulse rate, respiratory rate and blood pressure).

Part (B): Oxygenic parameters

This part was used to assess oxygenic parameters through SPO2 and arterial blood gas which include (SaO_2, PaO2, and $PaCO_2$).

Part (C) Spirometric parameters: This part was used to assess vital capacity (VC), forced vital capacity (FVC), and forced expiratory volume (FEV).

Part (d) Daily Amount of Expectorated Sputum

-This part was used to measure the amount of expectorated sputum at the end of each session .At the end of the day, the total amount of sputum is calculated separately for each patient.

-The total amount of sputum collected and measured by using calibrated cups with milliliter.

Method

1-Written approval was taken from the director of the (CTCU) is affiliated to Assuit Heart University, by official letters from the faculty of nursing after clarification of the purpose of the study before gathering of related data.

2-Ethical consideration:

The ethical committee for the Faculty of Nursing approved the research proposal. During the execution of the study, emphasizing that there was no hazard to the study participants.

-The ethical code was **37-357-2022**.

-Before the patient's participation in this study and after clarification of the aim of this study, informed written consent was taken from the patients.

-The privacy of the patients was respected.

-Data confidentiality was assured to all studied patients.

-Tools development: All tools were created by the researchers based on a review of the pertinent literature.

- To ensure validity, five experts in the fields of critical care nursing, anesthesiologist, and medical biostatistics were examined the content validity of each study tool.
- Cronbach alpha technique was used to examine reliability of all tools of the study and reported to be 0.944 of too I and tool II.
- A pilot study was carried out on 10% of the sample after completion of the data gathering tools. It was used to test the tool for its clarity; feasibility and applicability of the tool. Studied patients in the pilot study were involved in the study.

Data collection:

-The researcher evaluated each patient who was a part of the study and met the inclusion criteria.

- Data collection was started from the end of February to the end of October 2022.

The present study was carried out through four phases' assessment, planning, implementation and evaluation.

A- **Assessment phase;**

Assessment of the baseline data related to demographic characteristic and medical data for cardiac surgical patients by using tool (I).

B- Planning phase;

Objectives of the study were prepared based on the assessment of the patients.

Expected outcomes were formulated;

-Improve of oxygenic parameters.

-Improve of spirometric parameters.

-Increase daily amount of expectorated sputum.

- Educational method composed of one to one instruction and demonstration.

C-Implementation Phases:

All patients in the control and study groups received the same analgesic protocol .

Control group; managed by routine chest physiotherapy post cardiac surgery, which includes breathing exercises with an incentive spirometer.

Study group; managed by the use of active cycle breathing techniques combined with routine physiotherapy.

-Each session of the active cycle breathing technique lasted for 10 to 20 minutes.

-The active cycle breathing technique was given as six sessions per day, two sessions per shift, for three days post extubation**.**

Implementation of active cycle breathing technique [10, 11,13]

-Explain the steps of ACBT to the patient.

- The patient was placed in a semi-sitting position with her or his back absolutely straight, and instructions were given to the patient to do the following steps:

1 .Breathing control phase

-Hold the spirometer straight.

-Exhale, then seal your lips around the mouthpiece and inhale slowly and deeply into your mouth.

-The piston in the incentive spirometer's transparent chamber will rise when you inhale deeply.

- Hold your breath for 3 to 5 seconds after taking a deep breath.

-Remove the mouthpiece and slowly exhale. For a few seconds, until the piston descends to the bottom of the chamber, relax and breathe normally.

-To regain control of their breathing, the patient was told to do lengthy, slow expirations between 5 and 7 times.

2 .Thoracic expansion exercises

-Patient was instructed to relax your upper chest.

-The patient was instructed to breathe slowly and deeply through the nose without using the accessory muscle.

-The patient was instructed to hold their breath initially for 3 to 4 seconds and gradually increase it to the maximum time.

- Don't force the breath out; instead, softly exhale through pursed lips until your lungs are empty.

-Repeat the previous steps from 3to4 times.

3- Forced expiration technique (huffing**)**

- Patient was instructed to support the incision site by using a chest binder or keeping your hands over your incision.

- Cough twice as many times as they huffed two to three times**.**

- This steps was repeated a minimum of two times and a maximum of three times in one session.

D-Evaluation

-Evaluation of patient's physiological and airway clearance indicators of control and study groups were assessed pre and post intervention by using tool II. This was done pre and post at 1st and 3rd day. The mean of the measurements of both control and study groups were obtained separately**.**

- Daily amount of expectorated sputum post sessions was collected daily in calibrated cup by millimeter. Comparison between the control and study groups regarding total amount of expectorated sputum was done on 1st day and 3rd day.

Statistical analysis

The mean and standard deviation values were computed for each group in each test. Shapiro-Wilk and Kolmogorov-Smirnov tests were used to determine if the data had a non-parametric (not normal) distribution. Continuous variables were recorded by mean and standard deviation (Mean, SD).Whereas categorical variabl were described by number and percentage (n, %), the Chi square test and Fisher exact test were used to compare categorical variables, while continuous variables were compared between more than two groups in non-related samples .Mann Whitney was used to compare two groups in unrelated samples. The Wilcoxon t test was used to compare two groups in related samples. For correlation coefficients, use the Spearman correlation test. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM® SPSS® Statistics Version 26 for Windows [(17).]

Results:

Table (1) demonstrates that more than two thirds (70.0% and 76.7%) of studied patients were in the age group over 50 years with a mean ±SD 49.75±7.44&50.50±8.79 and more than half (60.0% and 53.3%) of them were male in both the control and study groups, respectively. Furthermore, more than two-thirds (70.0%) of studied patients in both control and study groups had a secondary education**.**

Table (2) illustrates that the majority (83.3% and 86.7%) of studied patients were diagnosed with ischemic heart disease, with the mean duration of surgery being (5.38±0.96 and 5.25±0.91) of control and study groups, respectively. As regards past medical history, it showed that (33.3% and 30.0%) of patients in the control and study groups had hypertension. Additionally, more than half (56.7% and 53.3%) of them were smokers**.**

Table (3) presents the mean scores of physiological parameters for patients in the control and study groups. As regards body temperature, pulse rate, systolic and diastolic blood pressure, there were no significant changes were observed between the control and study groups pre /post ACBT. On the other hand, there was a significant change in respiratory rate post ACBT between both control and study groups in the 1st and 3rd days, with p values (0.046, 0.001) respectively**.**

Table (4) indicates the total mean scores of oxygenic parameters between studied patients in the control and study groups. This result showed that there were statistically significant differences in SpO2, and SaO2 between the control and study groups on the 3rd day post ACBT, with p values of 0.006, 0.048, respectively. However, there was no statistically significant difference found between PaO2, PaCO2 among the studied patients in the control and study groups with P> 0.05.

Table (5) demonstrates the total mean scores of spirometric parameters pre / post active cycle breathing technique of the control and study groups. It was noticed that there were statistically significant differences in FVC, FEV1, and FEV1/FVC between control and study groups on the 3rd day post-ACBT, where p values were 0.001, 0.000, and 0.003, respectively.

Table (6) shows the mean scores of daily amount of expectorated sputum of the studied patients in both groups **.**It was observed that there was a significant increase of the total amount of expectorated sputum from 22.2±5.12 to 69.64±3.56 among studied patients in control group while the total amount among patients in study group increased from 25.42±4.1 to78.45±2.06 on the 3rd day with significant difference between the control and study groups where p value 0.001**.

Table (7) shows that there was a statistically significant negative correlation between body mass index and FEV1/FVC among the studied patients in the study group (r = -460, p* = 0.041). Additionally, there was a statistically significant negative correlation between smoking and FEV1/FVC (r = -481, p* = 0.032

Table (1): Percentage distribution of the studied patients in both groups according to their demographic characteristics

Demographic characteristics	Studied patients				P. value
	Control (n=30)		Study(n=30)		
	n	%	n	%	
Age					
20 <30 years	0	0.0	2	6.6	0.159
30< 40 years	2	6.7	0	0.0	
40 <50 years	7	23.3	5	16.7	
50 ≥ years	21	70.0	23	76.7	
Mean ±SD	**49.75±7.44**		**50.50±8.79**		**0.524**
Gender					
Male	18	60.0	16	53.3	0.376
Female	12	40.0	14	46.7	
Marital Status					
Single	1	3.3	0	0.0	0.598
Married	28	93.4	29	96.7	
Separated	1	3.3	1	3.3	
Education					
Basic education	2	6.6	0	0.0	0.347
Secondary	22	73.3	23	76.7	
High education	6	20.0	7	23.3	
Occupation					
Employee	21	70.0	21	70.0	0.607
does not work	5	16.7	7	23.4	
Manual worker	4	13.3	2	6.6	

**** Statistical significant difference (P < 0.05)***

Table (2): Percentage distribution of the studied patients of both groups according to their medical data

Medical data	Studied patients				P. value
	Control (n=30)		Study(n=30)		
	n	%	n	%	
Diagnosis					
Ischemic heart disease	25	83.3	26	86.7	1.000
Angina	5	16.7	4	13.3	
Duration of surgery	**5.38±0.96**		**5.25±0.91**		0.808
Body mass index	**29±3.78**		**28.86±4.02**		0.957
Past medical					
Non	3	10.0	4	13.3	0.782
GIT	5	16.7	6	20.0	
Hypertensions	10	33.3	9	30.0	
Diabetes mellitus	6	20.0	6	20.0	
Rheumatic heart diseases	6	20.0	5	16.7	
Smoking history					0.377
yes	17	56.7	16	53.3	
No	13	43.3	14	46.7	

Significant level at P value < 0.05

Table (3): Mean scores of physiological parameters of the studied patients of both groups

Physiological parameters		Studied patients			
		Control (n=30)	Study(n=30)	Z	P.value
		Mean±SD	Mean±SD		
Temperature					
1st day	**Pre**	36.13±0.16	36.17±0.33	1.08	0.280
	Post	36.62±0.17	36.72±0.22	1.77	0.077
3rd day	**Pre**	36.84±0.56	36.59±0.36	1.472	0.141
	Post	37.14±0.28	37.12±0.2	0.368	0.713
Pulse rate					
1st day	**Pre**	105.35±20.42	107.7±13.35	0.353	0.724
	Post	106.45±20.35	108.65±13.45	0.095	0.924
3rd day	**Pre**	107.2±7.34	106.2±6.1	0.61	0.539
	Post	115.9±7.39	113.3±6.33	1.66	0.097
Respiratory rate					
1st day	**Pre**	25.75±8.13	25.45±7.49	0.313	0.754
	Post	33.9±2.17	32.2±2.59	2.00	**0.046***
3rd day	**Pre**	23.75±4.78	23.85±3.1	0.329	0.742
	Post	31±2.34	27.7±3.01	3.46	**0.001****
S B P					
1st day	**Pre**	117.1±22.63	122.1±20.4	0.421	0.674
	Post	120.65±13.27	114.2±10.2	1.626	0.104
3rd day	**Pre**	129.9±4.12	128.3±2.3	1.29	0.198
	Post	134.4±6.59	133.6±2.21	0.57	0.568
DBP					
1st day	**Pre**	65.3±14.83	72.2±15.29	1.354	0.176
	Post	71.85±10.75	69.6±8.7	0.774	0.439
3rd day	**Pre**	71.85±8.89	74.85±6.61	1.129	0.259
	Post	71.85±8.89	74.85±6.61	1.129	0.259

SBP. Systolic Blood Pressure ***DBP. Diastolic Blood Pressure***

Mann Whitney Test quantitative data between the two groups
****Significant level at P value < 0.05***

Table (4): Mean scores of oxygenic parameters among studied patients of both groups

Oxygenic parameters		Studied patients			
		Control (n=30)	Study(n=30)	Z	P. value
		Mean ±SD	Mean ±SD		
SpO2					
1st day	**pre**	95.05±3.8	95.55±0.51	1.394	0.163
	Post	96.32±8.0	96.85 ± 2.9	1.460	0.144
3rd day	**pre**	97.8±1.7	97.9±1.45	0.028	0.977
	Post	97.34±0.68	99.9±0.31	2.77	**0.006****
PaO2					
1st day	**pre**	91.7±3.71	91.6. ±3.33	1.826	0.068
	Post	92.51±3.72	93.80±3.13	0.541	0.588
3rd day	**pre**	94.66 ± 5.43	96.85±2.98	0.417	0.674
	Post	94.66 ± 5.43	96.85±2.98	0.417	0.674
PaCO2					
1st day	**pre**	40.3±10.73	38.8±7.64	0.203	0.839
	Post	39.68±6.63	37.74±5.10	0.394	0.694
3rd day	**pre**	37.25±6.3	39.85±6.25	1.099	0.272
	Post	38.31±6.16	38.71±6.44	0.16	0.871
SaO2					
1st day	**pre**	96.01±2.38	96.21±2.30	0.148	0.880
	Post	96.31±3.00	96.43±1.57	1.360	0.143
3rd day	**pre**	96.61±2.08	96.98±2.55	0. 879	0.352
	Post	96.91±3.00	98.69±1.40	1.974	**0 .048***

SpO2:
PaCO2: Partial pressure of carbon dioxide in arterial blood
PaO2: partial pressure of oxygen in arterial blood
SaO2: Arterial blood oxygen saturation
*Significant level at P value < 0.05

Table (5): Mean scores of spiro-metric values among patients of both studied groups

Spiro-metric values		Studied patients			
		Control (n=30)	Study(n=30)	Z	P. value
		Mean ±SD	Mean ±SD		
FVC					
1st day	**pre**	2.17±0.13	2.16±0.24	0.886	0.376
	Post	3.12±0.27	3.33±1.07	0.989	0.323
3rd day	**pre**	4.00±0.52	4.07±0.72	1.20	0.231
	Post	3.49±0.46	4.16±0.45	4.373	**0.001****
FEV1					
1st day	**pre**	3.10±0.24	3.23±1.06	0.977	0.311
	Post	3.20±0.36	3.43±1.34	0.998	0.335
3rd day	**pre**	4.07±0.72	4.68±0.6	1.20	0.231
	Post	4.73±0.84	5.41±0.42	3.66	**0.000****
FEV1/FVC					
1st day	**pre**	78.45±2.06	79.3±3.16	0.581	0.561
	Post	78.45±2.06	79.3±3.16	0.581	0.561
3rd day	**pre**	80.3± 6.34	81.2. ± 6.28	0.632	.528
	Post	81.23±2.73	83.81±2.89	3.624	**0.003***

FVC: Forced Vital Capacity
FEV1: Forced Expiratory Volume in one second
Mann Whitney Test quantitative data between the two groups
Wilcoxon Test for quantitative data
*Significant level at P value < 0.05,
**Significant level at P value < 0.01

Table (6): Mean scores of daily amount of expectorated sputum of the studied patients in both groups

Daily amount of expectorated sputum	Studied patients		Z	P. value
	Control(n=30)	Study(n=30)		
	Mean ±SD	Mean ±SD		
1st day	22.2±5.12	25.42±4.19	0.446	0.655
3rd day	69.64±3.56	78.45±2.06	5.199	0.001**
1st day versus 3rd day	2.096 0.036*	4.373 0.001**		

Mann-Whitney Test quantitative data between the two groups
Wilcoxon Test for quantitative data
*Significant level at P value < 0.05,
**Significant level at P value < 0.01

Table (7): Correlation between spirometric values with demographic and clinical data of studied patients in both groups

Demographic and clinical data		Spirometric values					
		Control(n=30)			Study(n=30)		
		FVC	FEV	FEV1/FVC	FVC	FEV	FEV1/FVC
Age	r	0.119	-0.234	0.118	0.062	-0.241	-0.339
	P	0.618	0.320	0.620	0.795	0.306	0.144
Gender	r	-0.204	0.226	0.029	-0.142	0.242	0.336
	P	0.388	0.337	0.903	0.551	0.304	0.147
Marital Status	r	0.000	-0.329	-0.261	-0.160	-0.323	-0.338
	P	1.000	0.157	0.266	0.500	0.165	0.144
Body mass index	r	-0.349	0.135	0.059	0.198	-0.172	**-.460-**
	P	0.132	0.570	0.805	0.404	0.470	**0.041***
Past medical	r	**-.491-***	**-.457-***	-0.032	0.264	0.380	0.334
	P	**0.028**	**0.043**	0.895	0.261	0.099	0.151
Smoking	r	-0.172	-0.376	0.281	0.212	-0.061	**-.481-**
	P	0.470	0.102	0.230	0.370	0.799	**0.032***

FVC: Forced Vital Capacity
FEV1: Forced Expiratory Volume in one second
***** Statistically Significant correlation at P. value <0.05

Discussion

Active cycle breathing technique and routine physiotherapy could be safely used post cardiac surgery. Moreover, the ACBT has been shown to be effective in improving airway clearance and spirometric parameters post cardiac surgery [18,19].

In regards to the age and gender of the studied patients, the current study shows that more than two thirds of the patients in the control and study groups were over 50 years old, and more than half of them were male. This might be explained by the increased susceptibility of this age group to cardiac illnesses**.** This finding was congruent with **Helmy et al, (2019) [20]** and **Derakhtanjani et al, (2019) [11]** who revealed that the majority of the patients in both groups who had been studied were men, married, and had a mean age of 52 years. In addition to **Eid et al.,(2022)[21]** noticed that the age of patients was more than 60 years, and more than half of them were male.

In relation to the medical data, the current findings revealed that the majority of the patients in the study and control groups were diagnosed with ischemic heart disease, and had a history of hypertension and diabetes mellitus. This result supported by **Abd El Hafeez et., (2018) [22]** who recorded that the most common comorbid diseases among studied patients were hypertension, and diabetes mellitus. Additionally**, Afxonidis etal.,(2021) [10]**who documented that the studied groups had similar characteristics regarding gender and age.

As regards body temperature, pulse rate, systolic and diastolic blood pressure, no significant changes were observed between the control and study groups. On the other hand, there was a significant change of respiratory rate post ACBT of the study groups on the 1st and 3rd days. It can be justified by the fact that tidal volume and inspiratory effort rise simultaneously when inspiratory work-load increases, which causes an increase in parasympathetic stimulation and thus respiratory rate increase **[12].** The result was in agreement with **Helmy et al, (2019) [20]** who showed a significant difference in respiratory rate between the study and control groups. In addition to **Derakhtanjani et al.,(2019) [11],** reported a significantly increased of respiratory rate post-active cyclic breathing technique between studied patients on the 1st and 2nd days.

Concerning comparison between control and study groups in relation to oxygenic parameters, this finding showed that there were statistical significant differences regarding SpO2and SaO2 among control and study groups on the 3rd day post ACBT. On the other hands, no statistically significant difference between the study and control group's PaO2 and PaCO2 levels were noticed. This may be attributed to the effect of ACBT on improving lung function by reducing bronchospasms, enhancing collateral ventilation, re-expansion of collapsed alveoli through thoracic expansion and inspiratory holds which promote redistribution of gas between the lung segments **[14, 15].**

These results were consistent with **Jain and Mistry (2017) [23]** who stated that the active cycle of breathing technique had a positive effect on the

improvement of Spo2 and oxygenation for patients undergoing uncomplicated coronary artery bypass grafting surgery .Moreover, these results are congruent with **Hussain et al (2022)** [19] who stated that ACBT had a significant improvement in Sao_2, Pao2, and decreased paco2 in the study rather than the control group. Additionally, **Elsayed. et al. (2015)** [24] and **Taha et.al, (2021)** [13] clarified that chest physiotherapy improved oxygen saturation and promoted normal results of arterial blood gases .

In relation to spirometric values, the findings of the present study showed that there were significant statistical differences regarding **FVC, FEV1, and FEV1/FVC** among control and study groups on the 3rd day post ACBT.

This result was consistent with **Hussain et al.,(2022)** [19] who noticed that ACBT had a positive effect on improving FEV1 and chest expansion in the interventional group. Moreover, **Monisha** and **Muthukumar,(2018)**[12] noticed that ACBT significantly improved lung volumes, and functional work capacity due to improved ventilation perfusion matching. On the other hand, these results were contradicted by **Alwekhyan et al., (2022)**[25] who recorded that there was no significant statistical difference between the study and the control group in postoperative on pulmonary function , Also, **Shen et al., (2020)** [26] recorded that there was no positive impact of ACBT on pulmonary function and arterial blood gas results.

As regards daily amount of expectorated sputum post ACBT. This result showed a significant increase daily amount of expectorated sputum post ACBT sessions on the 3rd day compared to the 1st day of both studied groups. It can be justified by the effect of ACBT, which enhances movement of the bronchial secretion through the forced expiration technique **(huffing),** which helps to expel the secretion more easily through coughing. [25]

This result was in the same direction as **Zisi et al, (2022)** [27] who concluded that ACBT is a method that has been found to be effective in increasing sputum removal from the airway**.** Additionally **,Elsayed et al., (2015**) [24] mentioned that the application of ACBT helps to clean the airways from the excessive secretion**.** Moreover, **Zhong et al., (2021**) [28] who demonstrated that ACBT is an effective approach for significantly increased sputum wet weight in study group.

The present study clarified that there was a negative statistical correlation between body mass index and FEV1/FVC. These findings were supported by **Bhatti etal., (2019)** [29], who found that there was a significant correlation between pulmonary function parameters and body mass index. Additionally, **Ruby (2022)** [30] reported a significant negative correlation between body mass index and FEV1/FVC in both males and females.

Conclusion:

It was concluded that ACBT gives positive results in conjunction with routine chest physiotherapy in relation to improve airway clearance (oxygenic parameters, spirometer measurements and increase amount of expectorated

sputum among the studied patients post cardiac surgery.

Recommendations:

The following recommendations have been offered in light of the findings of the study:

Active cycle breathing technique should be integrated with routine chest physiotherapy for patient undergoing cardiac surgery. Moreover, replication of the study using large probability sampling should be performed.

Limitations of this study:

Findings of research cannot be generalized because of the small sample size among patients who meet the research's inclusion requirements, which lengthens the time for data collection. Another limitation is that the present study was accompanied and restricted to one hospital

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