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Effect of active cycle of breathing technique on respiratory parameters and pain regarding abdominal trauma

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Abstract
Active Cycle of Breathing Technique (ACBT) is a breathing exercise technique which used to remove secretions from the lungs. So this study aimed to assess effect of active cycle of breathing technique on patients' outcomes regarding abdominal trauma. A quasi experimental design was used.
Setting: This study was carried out in trauma intensive care unit at Assuit University Hospital.
Sample: 60 adult critically ill patients with abdominal trauma.
Tools: Patient's assessment sheet and abdominal trauma severity assessment tool and Patients respiratory parameters and abdominal pain evaluation sheet.
Main results: There were 65% males and 35% females. Mean Age was 37.56 ± 11.34 for study group and 36.50 ± 11.12 for control one. There was a reduction in the respiratory rate in study group after application of ACBT with statistically significant differences between both groups. There were statistical significance differences regarding PaO_2, $PaCo_2$, SaO_2 between both groups at 5th day with P. value (0.041, 0.002, 0.007) respectively. Statistical significance differences between before and after intervention regarding abdominal pain was found in both groups.
Conclusion: Active cycle of breathing technique is a vital procedure for abdominal trauma patient to improve outcomes.
Recommendations: ACBT can be used to abdominal trauma patients in ICU to improve respiratory parameters, so that oxygen needs are met.

Keywords: Abdominal trauma, active cycle of breathing technique, pain, respiratory parameters

Introduction

Trauma (injury) has been defined as damage to the body caused by an exchange with environmental energy that is less than the body's resilience, (Panchal and Ramanuj, 2016) [23]. Abdomen is the third most common area of the body that is damaged because of trauma. Severe abdominal trauma is diagnosed in up to 20% of severe trauma patients and is associated with an increase in mortality rate up to 20%, (Bouzat *et al*., 2020) [6]. Some abdominal organs are damaged with a higher prevalence due to trauma. In addition to the mechanism of injury, it relays on size and location of the organs in the abdominal cavity, (Rajaei *et al*., 2012) [25]. Abdominal trauma can be classified basically into two types: penetrating (open) and blunt (closed). (Bordoni *et al*., 2017) [5].

The initial assessment and resuscitation of the abdominal trauma injured patient should follow the advanced trauma life support (ATLS) sequence of airway, breathing and circulation as airway compromise causes death within seconds, breathing derangement causes death within minutes and circulatory impairment causes death within hours, (Weledji and Tambe, 2018) [36].

It is usual for patients following abdominal surgery to be admitted to intensive care units (ICU). Patients can develop impaired oxygenation. In addition, they are susceptible to respiratory complications due to immobility and nosocomial infections. The most common complications are atelectasis, pneumonia, pleural effusion and tracheobronchial infection, pneumonia being the main cause of mortality. These complications are due to shallow breathing, increased secretions and reduced pulmonary compliance, and to changes in muscle tone and to the lung parenchyma. Other factors, such as pain, residual anaesthetic effects and prolonged bed rest, contribute to their development. These complications have high rates of morbidity and mortality, increased hospitalization rates and longer hospital stays.

(Viguria *et al*., 2018) [33]
Airway management is a vital and important skill that all nurses should possess. Skill in managing a patient's airway forms part of the core critical care skills that the National Institute for Health and Clinical Excellence (NICE) (2007) have identified as essential for all nurses to possess. In addition, all nurses should be competent in performing a respiratory assessment using the look, feel and listen principles. Based on the assessment, nurses should also be able to implement appropriate airway management strategies. Using these skills, patients will receive appropriate respiratory care quickly, efficiently and effectively. (Higginson *et al*., 2010) [15].
The active cycle of breathing technique (ACBT) is a short-term secretion clearance technique derived from the forced expiration technique, which consists of breathing control and huff. (Lewis *et al*., 2012) [18]. A typical ACBT cycle consists of breathing control, thoracic expansion exercises and the forced expiration technique. The frequency of ACBT is flexible, but all parts of the cycle must be included and interspersed with breathing control (Yanga *et al*., 2018) [37].
Critical care nurses assess, plan, implement and evaluate health care services for patients suffering with a broad range of health conditions. Trauma victims and patients recuperating from complex surgeries frequently need nursing care of critically care specialists as well. Intensive care unit nurses work closely with physicians and other members of the health care team. They need to be skilled in the assessment of patients and able to use high technique equipment, (Efccna, 2007) [10].

Significance of the study
The most common respiratory complications following abdominal trauma surgeries are atelectasis, pneumonia, pleural effusion and tracheobronchial infection, pneumonia being the main cause of mortality (Viguria *et al*., 2018) [33]. Respiratory complications occurred to patients with abdominal trauma and especially to those undergoing surgery and considered the second most common complications. (Jain *et al*., 2018) [17].
The nurse must be aware of specific assessment findings associated with abdominal trauma and immediate recognition of problems and prevention of occurrence complications, (Urden *et al*., 2018) [32].

Aim of the study
To assess effect of active cycle of breathing technique on respiratory parameters and pain regarding abdominal trauma.

Hypothesis of the study
To fulfill the aim of this study the following research hypothesis was formulated.

- **Hypothesis (1):** There were statistically significance differences between study and control groups regarding respiratory parameters.

- **Hypothesis (2):** There were statistically significance differences between study and control groups regarding abdominal pain.

Patients and Method
Research design
Quasi-experimental research design was utilized in this study.

Study Variables
- **Independent variable:** Active cycle of breathing technique for abdominal trauma patients.

- **Dependent variable:** Patient's respiratory parameters and abdominal pain.

Setting of the study
The study was conducted in trauma ICU at Assuit university hospital. The number of beds in Trauma intensive care unit was 12 beds.

Sample
Convenient sample of sixty adult males and females patients with abdominal trauma who admitted to trauma intensive care unit constituted the sample. They were randomly assigned into two equal groups; study group who received active cycle of breathing technique in addition to routine hospital care and the control group received routine hospital care only.

The sample was calculated according to the following equation

$$n = \frac{N Z^2 \sigma^2}{Z^2 \sigma^2 + N e^2}$$

$$n = \frac{306 \times (1.96)^2 \times (0.221)^2}{(1.96)^2 \times (0.221)^2 + 306 \times (0.05)^2} = 60$$

Where

$Z = 1.96$ [standard scores],

$e = 0.05$ [error],

$\sigma = 0.221$ [SD],

$N = 306$ [population],

$n = 60$ [sample]

Inclusion criteria
- Age >18 years old.
- Patient with operative abdominal trauma.

Exclusion criteria
- Pregnant women.
- Patient on a warfarin.
- Patient with previous history of abdominal diseases as (pancreatitis, liver diseases, malignancy).
- Patient with preexisting lung diseases as COPD or Lung resection.

Tools for data collection

Three tools were used by the researcher based on reviewing of the relevant literature and used to collect data pertinent to the study.

Tools used by the researcher based on reviewing of the relevant literature and used to collect data pertinent to the study: Panchal & Ramanuj (2016) [23], Gad *et al*., (2012), Moore *et al*., (1981) [19], Dogjani *et al*., (2016) [9], Naqvi *et al*., (2016) [21] Shojaee *et al*., (2014) [28], Shojaee *et al*., (2020) [29], Ferreira *et al*.,(2011) [12]

First Tool: Patient's assessment tool

It assessed the studied patients regarding the socio-demographic and clinical data as base line data; it included following parts:

Part 1: **Personal and Clinical data**

This part was developed by the researcher after reviewing relevant literature (Panchal & Ramanuj 2016) [23]. It is used to collect personal and clinical data of the patient as code, age, gender, occupation, presence of past medical history, date of admission and affected abdominal organs.

Part 2: Hemodynamic parameters assessment sheet

This part was developed by the researcher after reviewing relevant literature (Gad *et al*., 2012.) [13]. It was used to assess hemodynamic stability of the patient. It included temperature, respiratory rate, and heart rate.

Second tool: Abdominal trauma severity assessment tool: It consisted of two parts:

Part one: Penetrating abdominal trauma index (PATI)

It was adopted from (Moore *et al*., 1981) [19] and reused by (Dogjani *et al*., 2016) [9]. It is a method of quantifying the risk of complication following penetrating abdominal trauma. A trauma index score was calculated by assigning a risk factor (1-5) to each organ injured and then multiplying this by a severity of injury estimate (1-5). The sum of the individual organ scores comprised the final penetrating abdominal trauma index (PATI). The sum of the individual organ scores comprised the final PATI. The range is 0-200. The risk of postoperative complications increases in PATI scores greater than 25.

Penetrating abdominal trauma index score (PATI) is a valuable scoring tool for severity estimation of penetrating abdominal injuries and there outcome. (Naqvi *et al*., 2016) [21]

Part two: Blunt abdominal trauma scoring system (BATSS): It was adopted from (Shojaee *et al*., 2014) [28]. A 24-point blunt abdominal trauma scoring system (BATSS) was developed and used to assess severity of injury. Patients were divided into three groups including low (score<8), moderate (8≤score<12) and high risk (score≥12). It was developed based on sums obtained from each factor. The point of each factor was: abdominal pain, 2; abdomen tenderness, 3; chest wall sign, 1; pelvic fracture, 5; FAST, 8; SBP<100 mmHg, 4; PR> 100 beats/min; 1.

Reliability of the scoring system using Cronbach's alpha was 0.76 showing the reliability to predict the future of patients. (Shojaee *et al*., 2020) [29].

Third tool: Patients respiratory parameters and abdominal pain evaluation

- **Part one:** Respiratory parameters included (PH, PaO_2, SaO_2, $PaCO_2$, HCO_3) and respiratory rate.

- **Part two:** Numerical rating pain scale. It is adopted from (Ferreira *et al*., 2011) [12]. It measure pain intensity. 0-to-10 ratings that represent mild, moderate, and severe. Most often pain ratings between 1 and 4 indicate mild pain, scores of 5 or 6 indicate moderate pain, and ratings of 7 to 10 indicate severe pain

Methods

Data was collected in three phases

- **Preparatory phase for both study and control groups:** An official permission to conduct the study was obtained from the hospital responsible authorities after explaining the aim and the nature of the study.

- **Content validity:** The tools were tested for content related validity by 5 specialists in the field of critical care nursing and critical care medicine from Assuit and Sohag University.

- **Reliability** of the adapted tools had been done after reviewing relevant literature using Cronbach's alpha test.

- **A pilot study** was conducted on 10% (6 patients) of the sample to test the feasibility and applicability of the tools and time needed to collect the data. The tools were applicable and the pilot study subjects were excluded from the actual study.

- **Ethical Considerations** to protect human rights were followed:

The research protocol was approved from ethical committee in the faculty of nursing at Assuit University. The researcher ensured that there was no risk for study subject during application of the research and the study was following common ethical principles in the clinical research. A written consent was obtained from patients or guidance that was willing to participate in the study after explaining the nature and purpose of the study. Patients had been assured that the data of this research will be used only for the purpose of research**,** also Confidentiality and anonymity had been assured. Finally, patients had the right to refuse to participate and/or withdraw from the study without any rational at any time.

Implementation Phase

- The data were collected from trauma intensive care unit during period from "October 2018 till February 2020" then the data was recorded.
- The researcher and ICUs administrators formulated team (research assistants) to be responsible for application of ACBT. This team consisted of the researcher, the responsible physician and the responsible nurses who were trained on the application of ACBT. Research assistants were distributed according to planned schedule.

- The researcher introduced herself for the patients and nursing staff and explained the nature and purpose of the study.
- Study group received active cycle of breathing technique in addition to routine hospital care and the control group received routine hospital care only which consisted of using incentive spirometry and chest percussion and vibration.
- The ACBT intervention was performed to every patient from the end of the second day after operation until 5th day. ACBT was done one session each day, each session consisted of 3 courses and each course lasts for 10 minutes with 15 minutes of rest between those courses.

The patient was placed in a fowler position and ACBT was performed in three stages.

1. The first stage was the breathing control.

- Breathing was carried out slowly through the nose. If breathing through the nose was not possible, it was done through the mouth. This should be performed with the lips of the bud".
- Encourage the patient to maintain calm by closing their eyes and away from any tension.
- He/she places one hand on his/her abdomen and exhales as if the shoulders move downwards and feel burning in the abdominal area.

2. The second stage is the practice of extending the chest wall to provide airflow in small airways.

- The air flows deeply, slowly and continuously through the nose into the lungs, so that the chest wall is expanded.
- The air is held for 2 - 3 seconds, and then it deflates out slowly and through the mouth.
- This step was repeated 3 times.

3. The final was the huff stage and the integral part of this technique.

- In this stage, coughing was done through open mouth and throat. This will move the discharge from small airways to the larger airways and eventually discharges it.
- For this purpose, at first, the patient performed an intermediate respiration.
- With opened mouth and with the help of respiratory muscles, he/she took a deep tail and then coughed.
- Perform splinting and coughing: Position a folded towel, blanket, or pillow against the abdomen to provide support when coughing - Splinting helps to allay the patient's fear that coughing will open the incision.

Evaluation phase

The data regarding respiratory parameters included ABG was recorded at 5th day using (tool three, part one). Abdominal pain score was measured before and after intervention at 2nd and 5th day after application of ACBT and recorded using (tool three, part two).

Statistical analysis

All data were recorded in a special chart for every patient. The collected data were coded, analyzed and tabulated. Data entry and analysis were done using SPSS 24.0 statistical software package. Categorical variables were described by number and percent (N,%), where continuous variables described by mean and standard deviation (Mean, SD). Chi-square test used to compare between categorical variables where comparisons between continuous variables by independent t-test.

Results

Fig 1: Personal distribution of patient in study & control groups as regard gender (n=60)

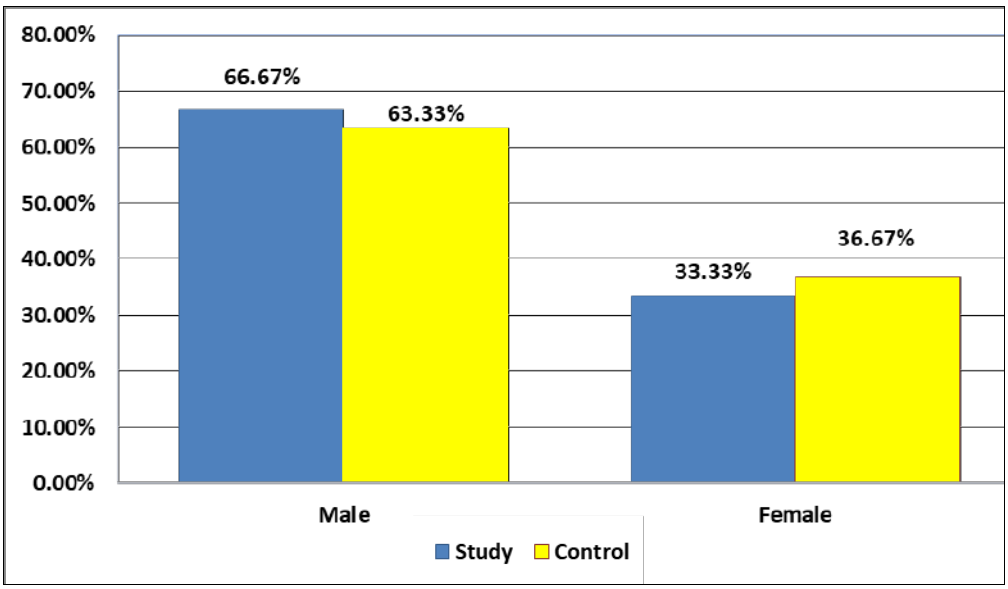

Fig 1: Distribution of gender

Figure 2: Personal distribution of patients in the study & control groups as regard age groups (n=60)

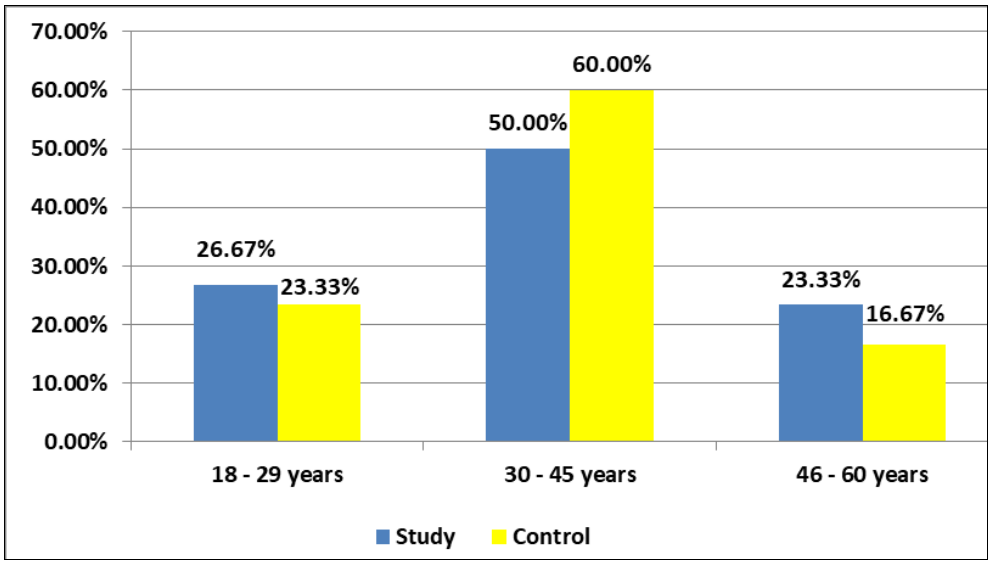

Fig 2: Distribution of age groups

Figures (1&2) represent personal distribution of demographic data in study & control groups. It was found that twice of gender in both groups were males and more than half of the studied sample aged (30-45).

Table 1: Comparison between the study & control groups as regard personal and clinical data (n=60)

Clinical data	Study (n= 30)		Control (n= 30)		P-value
	No.	%	No.	%	
Age (Mean ± SD)	37.56 ± 11.34		36.50 ± 11.12		0.714
Past medical history					0.405
Yes	8	26.67	11	36.67	
No	22	73.33	19	63.33	
Cardiac	2	25.00	3	27.27	0.622
Hypertension	3	37.50	***2***	18.18	
Cardiac – hypertension	3	37.50	***6***	54.55	
Affected abdominal organs					
Diaphragmatic tear	2	6.67	3	10.00	
Hepatic injury	9	30.00	7	23.33	
Stomach injury	1	3.33	0	0.00	
Spleenectomy	6	20.00	8	26.67	
Mesenteric injury	1	3.33	0	0.00	
Smallintestinal perforation	3	10.00	4	13.33	0.884
Pancreatic injury	3	10.00	4	13.33	
Post nephrectomy	3	10.00	2	6.67	
Large bowel perforation	1	3.33	2	6.67	
Bladder tear	4	13.33	2	6.67	
Retroperitoneal tear	1	3.33	2	6.67	
Rectal injury	0	0.00	1	3.33	

Chi-square test Independent samples t-test * Statistical significant difference (p<0.05)

Table (1) represents comparison between the study and control groups as regard their personal and clinical data. It was found that the mean age in study group was 37.56 ± 11.34 years versus 36.50 ± 11.12 years in control group. It noticed that more than half of study and control groups had no past medical history (73.33% vs. 63.33% respectively). Regarding of diagnosis of the most affected organ; it noticed that liver and spleen were the most affected organs with percentage (30% & 20%) for study group vs. (23.33% & 26.67%) for control group.

Table 2: Comparison between both study & control groups in relation to abdominal trauma scores (n=60)

Trauma scores	No.		Study (n= 30)		Control (n= 30)		P-value
	Study	Mean ± SD	Mean ± SD				
PATI (n=8)	5	11.20	±3.56	8.33	±6.51	0.440	
BTASS (n=52)	25						
	Mean ± SD		14.36	±5.32	12.59	±5.27	0.235
			No.	%	No.	%	
Low risk (< 8)			2	8.00	7	25.93	0.226
Moderate risk (8≥score<12)			5	20.00	5	18.52	
High risk (score ≥12)			18	72.00	15	55.56	

Chi-square test Independent samples t-test. *Significant (p<0.05) (BATTS: Blunt abdominal trauma scoring system, PATI: Penetrating abdominal trauma index)

Table (2) shows comparison between both groups in relation to abdominal trauma scores. It was found that there were no significant differences regarding BATSS and PATI between both groups. Also the table shows comparison between both groups in relation to risk assessment of blunt abdominal trauma scoring system. It was found that the majority of the cases in study and control groups were at high risk to developed complications at admission with percentage (72% & 55.56%) respectively.

Table 3: Comparison between the study & control groups as regard hemodynamic parameters (n=60)

Hemodynamic parameters	Study (n= 30)	Control (n= 30)	P-value
	Mean ± SD	Mean ± SD	
HR			
2nd day			
Before intervention	90.0 ± 7.5	90.3 ± 6.1	0.851
After intervention	89.9± 7.9	90.1± 5.7	0.925
P-value	0.966	0.852	
5th day			
Before intervention	83.0± 7.1	84.5 ± 7.4	0.437
After intervention	83.4± 5.0	84.4± 6.4	0.504
P-value	0.657	0.982	
RR			
2nd day			
Before intervention	24.0 ± 4.9	22.5± 3.3	0.152
After intervention	19.1± 2.1	21.4± 2.9	0.001*
P-value	0.000*	0.106	
5th day			
Before intervention	21.9± 3.2	22.6± 3.2	0.417
After intervention	18.6± 2.2	21.1± 3.1	0.000*
P-value	0.000*	0.052	
Temperature			
2nd day			
Before intervention	37.2 ± 0. 5	37.5 ± 0.8	0.078
After intervention	37.3 ± 0.4	37.7 ± 0.7	0.011*
P-value	0.304	0.185	
5th day			
Before intervention	37.4 ± 0.7	37.7 ± 1	0.151
After intervention	37.5 ± 0.7	37.6 ± 0.8	0.652
P-value	0.217	0.520	

Independent t-test Paired t-test P >0.05 non significant, *P<0.05 statistical significant difference

Table (3) illustrates that there was a reduction in the respiratory rate in study group after application of ACBT with statistically significant differences with p. value (0.000) at 2nd and 5th day. Also there were statistically significant differences between study and control group at 2nd and 5th day with P value (0.001 & 0.000) respectively.

Table 4: Comparison between the study & control groups as regard ABG parameters (n=60)

ABG	Study (n= 30)	Control (n= 30)	P-value
	Mean ± SD	Mean ± SD	
PH			
Baseline	7.39 ± 033	7.4 ± 0.05	0.862
5th day	7.4 ± 0.030	7.4 ± 0.05	0.789
PaO_2			
Baseline	83.1± 5.5	83.3± 7.2	0.904
5th day	86.8 ± 4.6	84.2± 5.03	0.041*
PaCO2			
Baseline	41.2 ± 4.8	41.5 ± 5.0	0.813
5th day	38.0 ± 2.8	41.1 ± 4.5	0.002*
Sao_2			
Baseline	91.0 ± 2.8	91.6 ± 2.6	0.342
5th day	95.1 ± 2.5	93.3 ± 2.3	0.007*
Hco_3			
Baseline	23.0 ± 3.2	24.6 ± 4.5	0.120
5th day	23.1 ± 2.6	24.0 ± 2.7	0.230

Independent t-test P>0.05 non-significant, *P<0.05 statistical significant difference

Table (4) shows comparison between both study & control groups in relation to ABG parameters. There were statistical significance differences regarding PaO_2, $PaCo_2$, SaO_2 between both groups at 5th day with P. value (0.041, 0.002, 0.007) respectively.

Table 5: Comparison between the study & control groups as regard abdominal pain (n=60)

Pain	Study (n= 30)	Control (n= 30)	P-value
	Mean ± SD	Mean ± SD	
2nd day			
Before intervention	2.4 ± 0.9	2.1 ± 0.9	0.259
After intervention	3.0 ± 0.8	2.8 ± 1.0	0.390
P-value	0.000	0.009	
5th day			
Before intervention	1.4 ± 0.8	1.2 ± 0.6	0.215
After intervention	1.8 ± 0.8	1.6 ± 0.7	0.478
P-value	0.048	0.002	

Independent t-test Paired t-test P>0.05 non-significant, *P<0.05 statistical significant difference

Table (5) shows comparison between both study & control groups in relation to presence of abdominal pain before and after intervention. There were statistical significance differences between before and after intervention in both groups at 2nd and 5th day, but there were no statistical significance differences between both groups before and after intervention.

Discussion

Abdominal trauma leading to marked morbidity and mortality of trauma patients, (Arumugam *et al*., 2015) [3]. About one-third of all trauma patients have abdominal injuries. These injuries require careful triaging for appropriate interventions and care, (Ntundu *et al*., 2019) [22].

Outcomes of abdominal trauma are account for the majority of health problem and leading to hospitalization, long-term disability and death, (Challinor *et al*., 2020) [7].

ACBT is a simple technique associated with arm mobilization and forced expiratory maneuver which ensures airway clearance and ensure adequate ventilation

Regarding description of current study, the study revealed that the sample included 60 traumatic abdominal trauma patients who were admitted to Trauma intensive care unit. Number of males aged between (30-45) years in the present study constituted more than half of the patients.

The current study was supported with Behboodi *et al*., (2016) [4] in study "Outcome of blunt abdominal trauma with stable hemodynamic and positive FAST findings" who reported that from 180 patients, the majority were males included within his study. The mean age of the current study not supported with the study done by Alqarafi *et al*., (2019) [2] when assessed "The patterns of abdominal trauma and factors associated with ICU admission in a major trauma center in Medina" and study of Saleem *et al*., (2016) [26] when assessed "Epidemiological evaluation and outcome of pure abdominal trauma victims who underwent surgical exploratory laparotomy".

The main reason that males and middle age group were predominant in the study was that they have more freedom and more outdoor activities and they are the most productive age group of society suggesting huge economic loss to the country related to their injuries.

Regarding past medical history, the current study documented that the majority of the studied patients had no past medical diseases. This study was supported with Alqarafi *et al*., (2019) [2] who cleared that most of patients had no past medical diseases. Absence of past medical diseases in present study may be related to that most of the patients aged less than 46 years old and all patients had sudden accidents.

Concerning affected abdominal organs with injury, the present study illustrated that liver and spleen were the most affected organs in both groups. Current study was supported with Alqarafi *et al*., (2019) [2] and Smith *et al*., (2005) [30] in study of " Abdominal trauma: a disease in evolution" reported that liver and spleen were the most affected organs. The main cause that spleen and liver are the most commonly injured organs because of their relative size, relatively fixed positions and abundant vascular supply which make them prone to injury.

Naeem *et al*., (2018) [20] disagreed with the current study and revealed that most affected visceral injuries are pointed to intestinal injuries. This contradiction comes from that majority of the patients of the current study had blunt abdominal trauma while Naeem *et al*. found that the penetrating trauma was the predominant.

Concerning Blunt abdominal trauma scoring system (BATSS), the current study showed that more than half of studied patients for both groups at high risk for development complications and need further observation from ICU staff. Shojaee *et al*., (2014) [28] reported that patient with high BTASS suffered intra-abdominal injuries and need medical or surgical care.

Regarding Penetrating abdominal trauma index (PATI) at admission, present study revealed that the mean of (PATI) for study group was higher than this reported with Agron *et al*., (2016) [1] when evaluated "Severity Score, as predictive factors in management of Penetrating abdominal Trauma", while the score of control group was less.

Concerning application of active cycle of breathing technique, the current study revealed that there was decreased in the respiratory rate after application of ACBT with statistically significant differences before and after intervention. Wahyudi al., (2021) [34] comes in line in study of Active Cycle of Breathing to Respiratory Rate in Patients with Lung Tuberculosis, cleared that the mean respiration rate scores before ACBT was more than that after intervention.

Elsayed *et al*., (2015) [11] mentioned that The Active Cycle of Breathing Technique (ACBT) can clean the airways so that respiratory rate is reduced and the breathing pattern improves. Breathing Control which can prevent bronchospasm and oxygen desaturation, Thoracic Expansion Exercise can help loosen and clear sputum and improve collateral ventilation, and the last exercise, the Forced Expiratory Technique, can remove sputum by pressing the thorax and airway.

The present study revealed that ACBT improve oxygenation of the study group more than the control. The improvement is presented at increase SaO2 and PaO2 and decrease PaCO2 when comparison was made between study and control group.

Holden *et al*., (2015) [16] revealed that Active Cycle Breathing Technique (ACBT) is a breathing exercise technique which used to remove secretions from the lungs. This technique uses deep breathing to move the sputum from the small airways at the bottom of the lungs to the larger airways at the top, making it more easier to expel by coughing. In the thoracic expansion stage, exercise can develop lung tissue and made an increase in the lung volume. The forced expiration technique can prevent airway bronchospasm and remove sputum covering the respiratory tract.

Wange *et al*., (2016) [35] reported that Active cycle of breathing techniques is better technique in post abdominal surgery patients and had a better performance in improving pulmonary function in patients undergoing abdominal surgery. It supported the present study as there was an improvement in the respiratory status in the study group (was applied ACBT) rather than control group who didn't.

Also, Syropoulos *et al*. (2016) [31] observed that application of ACBT led to a significant increase in the SPO_2. Grammatopoulou *et al*., (2010) [14] cleared that ACBT has a more positive effect on patients undergoing abdominal surgery and on blood oxygenation than on pulmonary function.

As regard before and after intervention in study group, the present study was supported with Derakhtanjani *et al*.,

(2019) [8] who cleared that there was increase in SaO2 and PaO2 and decrease in PaCO2 before and after intervention in the first and second day of application of ACBT.

Sheraz *et al*., (2019) [27] revealed that there was highly significant difference in pre-test and post-test values of PCo_2 and oxygen saturation in experimental group as compared to control group.

According to Parshall *et al*., (2012) [24]**;** Active cycle of breathing exercises can return to normal breathing and improve ventilation and oxygenation. Besides, it can increase maximum alveolar inflation and relax muscles, eliminate anxiety, get rid of uncoordinated patterns of respiratory muscle activity, slow down the frequency and reduce breathing work.

Regarding pain; at the end of 2nd day the present study revealed that pain was increased after intervention as the patient had an operation. Although the mean score of pain decreased at the 5th day as the patient with ACBT became well tolerated of pain and more relaxed. Grammatopoulou *et al*., (2010) [14] who cleared that he ACBT appeared to reduce pain in patients with rib fractures and trend analysis revealed that pain was reduced significantly across day to day treatment, for both groups. On the other hand, Derakhtanjani *et al*., (2019) [8] the results of the pain severity comparison showed that, in both groups on the first and second days, the pain significantly increased at post intervention phase and this come in line with current study.

Conclusion

Active cycle of breathing technique is a vital procedure for abdominal trauma patient to improve outcomes which represented in respiratory rate and ABG parameters.

Recommendations

- ACBT can be used to abdominal trauma patients in addition to incentive spirometry and chest percussion and vibration in ICU to improve respiratory parameters, so that oxygen needs are met.
- For further researchers: In order to conduct research on efforts to reduce complaints of respiratory complications using other methods.

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