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Effect of Lung Breather on Hospital Stay in Patients with Acquired Pneumonia: a Randomized Clinical Study

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ABSTRACT

INTRODUCTION. Acquired pneumonia is a severe medical condition that is addressed as life-threating issue requiring intensive care. The Medical Breather device can activate and strengthen both the inspiratory and expiratory muscles, so it can be useful for patients with pneumonia.

AIM. To investigate the breather effect on length of hospital stay in patients with pneumonia.

MATERIALS AND METHODS. Sixty participants diagnosed with acquired pneumonia "30 women, 30 men stayed in hospital in ICU for two weeks; aged 30–40 years old" selected from chest department of Kasr Al-Aini Intensive Care Unit (ICU) at Cairo University. They were randomly allocated into equal groups; Group A received respiratory training via incentive spirometer, and traditional chest physiotherapy; and Group B received respiratory training via Breather, and traditional chest physiotherapy, both received 3 session daily/2 weeks. Diaphragmatic excursion, Respiratory Distress Observation Scale, and ICU discharge were assessed before and after the treatment.

RESULTS. Both groups revealed significant improvement after the treatment, while Breather group showed a high significant increase in pH 1.23 %, PaO_2 11.79 %, SaO_2 6.1 %, and diaphragmatic excursion by 36.97 %, also decrease in $PaCO_2$ 2.78 %, RDOS 39.06 % and NEWS2 by 50.72 % in comparison to incentive spirometer group that recorded significant increase in pH 0.68 %, PaO_2 6.69 %, SaO_2 by 2.66 %, and diaphragmatic excursions by 8.15 %, also significant decrease in $PaCO_2$ 12.12 %, RDOS 15.01 % and NEWS2 by 20.93 %. HCO_3 revealed no significant difference post treatment ($p > 0.05$).

DISCUSSION. Breather usage in inspiratory musculatures training (IMT) gained Maximum Inspiratory Pressure (Pimax) significant improvement. IMT enforces both diaphragm and accessory respiratory musculatures. Probably functional capabilities improvements based on enhanced respiratory musculatures' both endurance and strength that improve pulmonary oxygen uptake thus minimize dyspnea severity. Respiratory muscles training program improves not only cognitive function. Moreover, IMT could be addressed as a prime component of respiratory training in combine with expiratory one that is why whom has preserved pulmonary function.

CONCLUSION. Breather as a respiratory training technique has remarkable results in reducing hospital stays in patients with acquired pneumonia, and significant positive effects on diaphragmatic function, oxygenation levels. Therefore, it is recommended to use Breather for routine acquired pneumonia care.

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KEYWORDS: incentive spirometry, Breather, acquired pneumonia, chest physiotherapy, breathing exercise, arterial blood gases.

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Влияние легочного респиратора на продолжительность стационарного лечения пациентов с приобретенной пневмонией: рандомизированное клиническое исследование

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РЕЗЮМЕ

ВВЕДЕНИЕ. Приобретенная пневмония — это тяжелое заболевание, которое рассматривается как проблема, угрожающая жизни, и требует интенсивной терапии. Медицинский легочный респиратор позволяет активизировать и укрепить как инспираторную, так и экспираторную мускулатуру; таким образом, он может быть полезен для пациентов с пневмонией.

ЦЕЛЬ. Изучить влияние легочного респиратора на продолжительность пребывания в стационаре пациентов с пневмонией.

МАТЕРИАЛЫ И МЕТОДЫ. Шестьдесят участников с диагнозом «приобретенная пневмония» (30 женщин и 30 мужчин в возрасте 30–40 лет) в течение 2 недель находились в отделении интенсивной терапии. Пациенты были отобраны из фтизиатрического отделения интенсивной терапии медицинского факультета Каср Алайни Каирского университета. Они были распределены на равные группы методом случайного отбора; группа А проходила дыхательную тренировку с помощью стимулирующего спирометра и традиционную физиотерапию грудной клетки; группа В — дыхательную тренировку с легочным респиратором и традиционную физиотерапию грудной клетки. Обе группы проходили по 3 сеанса в день в течение 2 недель. Оценивались диафрагмальная подвижность, шкала оценки респираторного дистресса и данные выписки из отделения интенсивной терапии до и после лечения.

РЕЗУЛЬТАТЫ. В обеих группах было выявлено значительное улучшение после лечения по сравнению с предшествующим, при этом в группе с использованием легочного респиратора наблюдалось значительное увеличение pH на 1,23 %, PaO_2 — на 11,79 %, SaO_2 — на 6,1 %, диафрагмальной подвижности — на 36,97 %, а также снижение $PaCO_2$ на 2,78 %, RDOS — на 39,06 % и NEWS2 — на 50,72 % по сравнению с группой, в которой использовались стимулирующие спирометры, где зафиксировано значительное увеличение pH на 0,68 %, PaO_2 — на 6,69 %, SaO_2 — на 2,66 %, диафрагмальной подвижности — на 8,15 %, а также значительное снижение $PaCO_2$ на 12,12 %, RDOS — на 15,01 % и NEWS2 — на 20,93 %. Показатели HCO_3 после лечения не имели существенных различий ($p > 0,05$).

ОБСУЖДЕНИЕ. Использование респиратора при тренировке инспираторной мускулатуры (ТИМ) позволило значительно улучшить максимальное инспираторное давление (Pimax). ТИМ укрепляет как диафрагму, так и вспомогательные дыхательные мышцы. Вероятно, улучшение функциональных возможностей основано на повышении выносливости и силы дыхательной мускулатуры, что улучшает поглощение кислорода легкими и уменьшает выраженность одышки. Программа тренировки дыхательных мышц улучшает не только когнитивные функции. Более того, ТИМ можно рассматривать как основной компонент дыхательной тренировки в сочетании с экспираторной, поэтому у них сохраняется легочная функция.

ЗАКЛЮЧЕНИЕ. Легочный респиратор как метод тренировки дыхания дает замечательные результаты в плане сокращения сроков пребывания в стационаре пациентов с приобретенной пневмонией и оказывает значительное положительное влияние на функцию диафрагмы и уровень оксигенации. Дыхательный аппарат рекомендуется для планового лечения приобретенной пневмонии.

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INTRODUCTION

Clinically, pneumonia is recognized as recent lung infiltrates plus obvious infectious evidence involving fever onset, leukocytosis, purulent sputum, also limited oxygenation. Hospital-acquired pneumonia (HAP), addressed as the 2nd commonest nosocomial "lower respiratory tract" infection resulted in parenchyma inflammation that did not incubate, even with extended clinical ≥ 2 days after hospitalization. Where later form might be addressed as community-acquired pneumonia (CAP), with multiple risk issues such as aging and specific gender, plus autoimmune and heart diseases those influence leading origin easily defined as an etiology [1]. Acquired pneumonia negatively resulted in inadequate gas exchange that alter oxygenation ($\downarrow O_2$). Therefore, HAP was classified as a life-threatening disorder that might leads to respiratory arrest, even death if neglected. HAP might be due to Ventilation/perfusion inequality (flow of circulating blood at unventilated lungs), which resulted in diminished arterial PO_2 in respiratory failure, restrictive diseases, and/or ARDS [2].

Mild hypoxemia results in limited physiologic alterations. Recalled arterial O_2 saturation for around 90 % when PO_2 is at 60 mmHg within normal pH. Only alterations were addressed in scope of mental performance, reduced visual acuity, also mild hyperventilation. Quick drop PO_2 arterial to 40–50 mmHg results in overall deleterious influences. First of all, the central nervous system is vulnerable, which is often manifested by somnolence, headaches, even fluctuations in consciousness, also retention of CO_2 leads to even respiratory sever acidosis. Unless the patient develops gradual respiratory failure, he or she may retain bicarbonate in significant amounts, so routine assessment of pH drop is mandatory to prevent exacerbations. Acidemia might recognized due to CO_2 retention with severe hypoxemia that results in liberation of lactic acid leading to metabolic sort, which aggravated in case of altered end-organ perfusion i.e., shock or reduced venous return as a result of elevated intra-thoracic pressure among mechanical ventilated patients [3]. Thus, incentive spirometer aims to get and sustain maximal breathing in that reserve healthy lungs as much as possible.

Clinically, the incentive spirometer permits improving respiratory function in an easy approach. Airflow of visual feedback and volume is a unique advantage for incentive spirometer that gains effective breathing in, easier flow control, also higher enthusiasm to extended practice [4]. Breather is a medical device permits respiration versus resistance, thus accelerates strengthening and activating both components of respiratory musculatures that ensures ventilation support, permitting better cough, safe swallowing, and speech training. In addition, an effective approach to resistive breathing revitalizes the respiratory muscles of the throat and neck [5].

AIM

To investigate breather effect on hospital stay in pneumatic patients.

MATERIALS AND METHODS

Subjects

Sixty patients 30–40 years old, diagnosed with acquired pneumonia (referred diagnosis) stayed in hospital in ICU for two weeks were included in this study. They recruited from chest department of Kasr Al-Aini ICU — Cairo University, conducted this study from April 2022 to 2023. All the patients were carefully examined and referred by their physicians. Demographics tabulated in Table 1. Careful recruitment of participants based on the study criteria by both ICU resident and PT consultant. Identified inclusive criteria included conscious individuals of both sexes aged 30–40 years old with body mass index (BMI) ranged from 25 to5 29.9 kg/m^2 had an acquired pneumonia with a mild hypoxemia (O_2 saturation was 90–95 %). Conscious participants who co-operated through clear understanding and adherence to instructions. Excluding patients through identified inclusive criteria that if they had a history of any malignant tumors, hearing impairment or mental disorder, auto-immune diseases, a history of any surgical transplantation, unstable hemodynamics, rib fracture, a history of neuromuscular disease, spinal injuries, or BMI > 30 kg/m^2. Also, patients receiving mechanical ventilation, or whom require MV, but contraindicated for rehabilitation i.e., pulmonary emboli were excluded.

Ethical considerations and design: approval for this study by Faculty of physical therapy ethical committee, Cairo University, Egypt (No. P.T.REC/012/003760). The signed informed consent was obtained from all the participants who were allocated randomly into two equal groups; Group A, and B via envelope method by a blinded physical therapist.

PROCEDURES

Evaluation

Demographic recording sheet for each participant including name, address, age, weight, height, and BMI, were collected. Measures of SaO_2, HR, arrhythmias, and blood pressure were taken for monitoring patients. All participants were asked to report any harms across study protocol.

Procedures of the Study

A brief history was first collected, any chronic respiratory disease, musculoskeletal conditions such as kyphosis, neurological conditions that may affect the respiratory musculature such as NMD, and active or significant haemoptysis that may interfere with the study were excluded. Full clinical and physical examinations were conducted i.e., vital signs and O_2 saturation per session, thus exclude clinical features those could interfere with our study. Safety issues via monitoring HR and blood pressure applied and in case must terminate treating session i.e., HR > 140 or < 60 b/m, or BP > 140/90 or < 90/60 mmHg), also request accurate reporting of any adverse events during this study. Instructed all participants not have a heavy meal 2 hours before any session.

Measurement method: measuring the variables of assessment and the outcomes.

The Blood gas analyzer (ABGs): have been conducted for all pre and post treatment. Sample was taken from the radial artery to measure the following parameters [6]: 7.35–7.45 pH, 35–45 mmHg $PaCO_2$, 22–28 meq/L HCO_3, and 95–100 % SaO_2.

Diaphragmatic excursion also was measured diaphragmatic movement for each subject by using the Diaphragmatic ultrasound at 3.5–5 MHz probe that aimed at midclavicular line under rib cage aiming posterior 3rd of hemi diaphragm. Normal healthy non-ventilated values differ between genders (18 ± 3 for men and 16 ± 3 mm for women, respectively), same as baseline values in mechanically ventilated individuals. Could address diaphragm dysfunction as < 10 mm excursion, even negative values or paradoxical motion as weaning failure predictors [7].

Respiratory distress observation scale (RDOS) for evaluate severity and discomfort experienced by patients who are unable to communicate their dyspnea levels during monitoring for palliative sedation therapy [8]. The following instructions were to be followed when using the RDOS: a) record the respiratory and heart rates for a complete minute; b) grunting sounds can be detected with or without auscultation; c) a RDOS score of less than 3 indicates that the patient is breathing comfortably; d) a RDOS value ≥ 3 means respiratory distress that require palliative measures, and e) higher RDOS scores indicate a worsening of the patient's condition.

The National Early Warning Score 2 (NEWS2) scoring system for evaluating hospital discharge. It measures six physiological items; respiration and pulse rates, O2 saturation, systolic blood pressure, consciousness level or recent onset confusion, also temperature [9]. Each parameter is given a score of 0, 1, 2, or 3, elevated values indicate that is far away from normal values. Proper clinical reacts were addressed for triggers that advised globally. The following were the recommended responses for different NEWS2 aggregate scores: a) Low risk (aggregate score of 1–4). The ward nurse should promptly assess patient to determine if there is a need for a change in clinical care escalation or monitoring frequencies; b) Low to moderate "3 in a single item" risk. Ward-based physician must check case to address cause and decide if there is a need for a change in clinical care escalation or monitoring frequencies; c) Moderate risk (aggregate score of 5–6). Ward-based or urgent nurse/physician should urgently review patient to determine if there is a need for escalation to critical team of care; d) Maximum risk (≥ 7 value). Critical team of care should perform an emergency assessment, often advice transfer case to a higher dependency unit, and e) a NEWS2 ≥ 0 i.e., no change, it means that the check should be done at least twice a day.

Therapeutic Procedures

The preparation and positioning instructions for patients were: loosen any tight or binding clothing, particularly around the neck area, ensure comforted patient positioning, and explain treatment clearly and concisely.

The Incentive Spirometer for Group A

The respiratory muscle training (RMT) program had the following parameters: duration: 20 minutes per session, intensity: clinical adjustment of training intensity based on actual participants' status across session time, holding time, and repetitions, frequency: 30 per set, with each is 5–6 times [10]. The procedure for the RMT program was as follows: a deep slow inspiration while lips fitted around mouthpiece. Visual feedback was provided to the patient, such as a ball rising to a preset marker, to motivate them during the exercise. The patient was instructed to get the planned flow at the preset amount. The patient was asked to maintain breathing in for 2–3 seconds. These guidelines should be followed during RMT [11].

The Breather Respiratory Muscle Trainer Device for Group B

Utilizing a pre-session checklist can improve the success rate of using the breather for RMT. The following items should be included in the checklist: check the patient's posture, ensuring that they are in a comfortable crook lying or sitting position, initial easiest resistances by manipulating both dials to one, ensure the patient is using the diaphragmatic breathing technique, as this is crucial for the proper use of the breather, and make sure that the patient secures lips on mouthpiece [5].

Training Procedures

Use a nasal clip during training. The optimal technique was to take a rapid inhale, pause slightly, and then exhale forcefully. After exhaling slowly through pursed lips, seek deep inspiration, even enforced for about 2–3 seconds. Observe the patient's stomach, rib cage, and neck muscles during inhalation against resistance. Make sure upper chest and shoulders are relaxed. Sustain for a bit of second. Forced expiration along 2–3 seconds without puffing cheeks out. The inhale settings can be adjusted from 1 easier to 6 hardest. Such expiration can be adjusted from 1–5, with 1 being the easiest and 5 being the hardest. Complete 2 sets of 10 breaths, three sessions per day, for 2 weeks. When using the breather trainer, it is important to consider certain precautions to ensure proper use: patients should be informed that accepted approach only through expanding and contracting abdomen. When inhaling, supposed abdomen be pushed out, no extra chest inflation or heave up/down shoulders. Patients should be instructed regarding expiration; abdomen is supposed to automatically deflate and relax.

Participants conducted abdominal approach even in front of a mirror to ensure minimal expanding chest than abdomen. Such natural respiration, ensure not to expand chest than abdomen as it addressed an abnormal breathing maneuver. Following these precautions can help ensure that the breather trainer is used properly and effectively for RMT. The following is a protocol for using the breather for RMT.

Train and explain to the patient how to properly use the breather. Instruct the patient to sit upright and hold the mouthpiece between their lips without clenching it using their teeth to avoid tension on the jaw. Seek patient to breathe via mouthpiece in diaphragmatic maneuver, not through the nose. The patient should start by inhaling forcefully for 2–3 seconds, pause, exhale forcefully for 2–3 seconds and pause again. Instruct the patient to attempt to complete breaths in a row (inhale/exhale). If the patient feels light-headedness, they should stop and take a break. This is normal and expected when first beginning training. Repeat the rhythm to complete a set. Each set was 10 times (breathing cycle), followed by a 1–2-minute rest, then another set conducted. Increase resistance by increasing either/both inhale and exhale dials once 10 breaths per set become easy. Patients may notice positive benefits after a week of use. Aim to complete RMT sessions with effort in the zone, which is the orange section of steps 5–7, representing 50–70 % of maximum effort. Listen for a strong "wind" sound for inhale and exhale to indicate doing RMT with effort in the zone. Use The Breather effort scale to rate the patient's effort during training sessions. The scale ranges from 0–10, with the following categories: 0–4 — the patient can carry on a conversation with little to no breathlessness, indicating little benefit from RMT; 5–7 — the patient is in the zone and can take part in a conversation but breathes heavily. Speaking is limited to 1–2 sentences with heavy breathing, and breathing is heavy and speaking in broken sentences; 8–10 — the patient is breathing heavily, using short words or is unable to speak, and gasping for air. Following the given protocol, patients can effectively utilize the breather for respiratory muscle training, leading to potential benefits for their respiratory health.

Traditional chest physiotherapy in form of diaphragmatic, segmental costal, basal breathing, percussion and suction, even vibration for all participants in both groups conducted 3 times/day, along double weeks.

Deep Breathing Exercise

a. Diaphragmatic Breathing Exercise

Diaphragmatic breathing conducted through comfortable relaxed position that permit diaphragm assisted by gravity. Semi-Fowler's with forearms relaxed and knees bended, and place therapist's hand on patient's upper abdomen, just below the xiphoid. Then ask patient to breathe in deep slowly through nose with relaxed shoulders via ensuring quiet patient's upper chest, thus patient's abdomen slightly rise. Patient sustained relaxed, then slow exhale through the mouth. The exercise should be repeated three or four times, followed by a rest period. Once the patient has developed an understanding of and control over their breathing in various positions (such as sitting or standing) and during activities (such as walking or climbing stairs), they can move on to other breathing exercises.

b. Localized Breathing Exercise

Localized breathing exercises are recommended after the patient has developed an understanding of diaphragmatic breathing. Targeted posterior and lateral lower segmental breathing enhancement through costal expansion training, which can be performed unilaterally or bilaterally. To perform this exercise, the hooked patient moves to a sitting position. From laterally therapist's hands directing patient's lower ribs to where movement directed. Light manual resistance should be applied to improve patient's awareness through deep breathing and chest expands through flaring ribs. While, expiration, therapist slightly squeeze patient's rib cage in an inward and downward in assistive manner. Later, seek this maneuver independently using patient's own hands exerting resistance via belt or a towel.

c. Posterior Basal Expansion

An emphasis on posterior basal expansion in combine with deep breathing is especially important for patients with acquired pneumonia whom sustained in a semi-reclining posture that often led to additional secretion at posterior lung segments. To perform exercise, initially patient lean forward over pillow in sitting position with hips bended. From behind therapist's hands be over patients' lower ribs then conduct as lateral costal expanding protocol. That will help patient to improve their breathing and clear any secretions that might have accumulated in posterior segment of lower ribs.

Statistical Analysis

Statistical analysis through Unpaired t-test for between groups age comparison, and Chi-squared test for gender distribution analysis. Data normal distribution had been checked via Shapiro-Wilk test. Variance homogeneity analysis using Levene's test between groups. Two-way mixed MANOVA was conducted either within and between groups for time and treatment effects on pH, $PaCO_2$, PaO_2, oxygen saturation, HCO_3, diaphragmatic excursion, RDOS and NEWS2. Bonferroni corrections were performed for later multiple comparisons. $p < 0.05$ was addressed as significance level while using version 25 statistical package for social studies (SPSS) for windows (IBM SPSS, Chicago, IL, USA).

RESULTS

Demographics: no significant difference was revealed ($p > 0.05$) in mean age values ($p = 0.78$), sex ($p = 0.79$) in both groups (Table 1).

Table 1. Comparison demographics between both groups

Parameter	Group A	Group B	Statistics	*p*-value
Age (years)	35.26 ± 3.32	35.03 ± 3.12	t = 0.28	0.78
Sex				
Female	12 (40 %)	13 (43 %)	($\chi^2 = 0.06$)	0.79
Male	18 (60 %)	17 (57 %)		

Note: *p-value — level of significance; SD — standard deviation; t — unpaired t value; χ^2 — Chi-squared value.*

Treatment effect on pH, $PaCO_2$, PaO_2, O_2 saturation, HCO_3, diaphragmatic excursion, RDOS, and NEWS2: two-way mixed MANOVA revealed a significant of treatment and time interaction ($F = 61.02$, $p < 0.001$). Also, a significant main time effect ($F = 310.64$, $p < 0.001$). As well, a significant main treatment effect ($F = 4.75$, $p < 0.001$).

Within groups compare a significant increase in pH, PaO_2, SaO_2 and diaphragmatic excursion of both groups post treatment in compare with pretreatment ($p < 0.001$). Also, a significant decrease in $PaCO_2$, HCO_3, and RDOS and NEWS2 of both groups post treatment compared with pretreatment ($p < 0.001$).

Revealed improving percentages in of pH, $PaCO_2$, PaO_2, SaO_2, HCO_3, diaphragmatic excursion, RDOS and NEWS2 of Group A were 0.68, 5.87, 6.69, 2.66, 2.92, 8.15, 1.66, and 20.83 %, respectively; while in Group B were 1.23, 22.78, 11.79, 6.1, 2.76, 36.97, 39.06, and 50.72 %, respectively (Table 2 and Table 3).

Between group compare no significant difference between groups at baseline of the trial ($p > 0.05$) was observed. Also, a significant increase in pH, PaO_2, SaO_2 and diaphragmatic excursion of Group B in compare with Group A post treatment ($p < 0.05$) was recorded. As well, a significant decrease in $PaCO_2$, RDOS and NEWS2 of Group B in compare with Group A post treatment ($p < 0.01$) was shown. Finally, no significant difference in HCO_3 between both groups post treatment ($p > 0.05$) was demonstrated in Table 2 and Table 3.

DISCUSSION

This study main findings are reporting a significant pH, PaO_2, SaO_2, also diaphragmatic excursion increases in both groups by the end of the study protocol with improving percentage in Group B were 1.23, 11.79, 6.1, and 36.97 %, respectively; while in Group A were 0.68, 6.69, 2.66, as well 8.15 %, respectively, which reveals a significant difference between groups, unless HCO_3 shows no significant differences. Also, $PaCO_2$, RDOS, and NEWS reveals significant decrease in both groups with improvement percentage in Group B were 22.78, 39.06, and 50.72 %, respectively while t in Group A were 12.12, 15.01, and 20.83 %, respectively.

Table 2. Mean pre and post treatment pH, $PaCO_2$, PaO_2, O_2 saturation and HCO_3 of both groups

Parameter	Group A	Group B	MD	*p*-value
	Mean ± SD	Mean ± SD		
pH				
Pre-treatment	7.33 ± 0.01	7.32 ± 0.02	0.01	0.81
Post-treatment	7.38 ± 0.02	7.41 ± 0.03	–0.04	0.001
MD	–0.05	–0.09		
% of change	0.68	1.23		
	p = 0.001	*p* = 0.001		
$PaCO_2$ (mmHg)				
Pre-treatment	48.43 ± 2.02	48.90 ± 2.85	–0.47	0.46
Post-treatment	80.26 ± 5.77	85.63 ± 7.16	–5.37	0.002
MD	–5.03	–9.03		
% of change	6.69	11.79		
	p = 0.001	*p* = 0.001		
PaO_2 (mmHg)				
Pre-treatment	75.23 ± 7.61	76.60 ± 9.69	–1.37	0.54
Post-treatment	80.26 ± 5.77	85.63 ± 7.16	–5.37	0.002
MD	–2.44	–5.53		
% of change	6.69	11.79		
	p = 0.001	*p* = 0.001		
SaO_2 (%)				
Pre-treatment	91.63 ± 3.37	90 ± 3.17	0.93	0.27
Post-treatment	94.07 ± 3.02	96.23 ± 2.06	–2.16	0.002
MD	–2.44	–5.53		
% of change	2.66	6.1		
	p = 0.001	*p* = 0.001		
HCO_3 (mEa/L)				
Pre-treatment	23.67 ± 1.29	1.34 ± 23.90	–0.23	0.47
Post-treatment	94.36 ± 0.88	24.56 ± 0.81	–0.2	0.36
MD	–0.69	–0.66		
% of change	2.92	2.76		
	p = 0.001	*p* = 0.001		

Note: *MD — mean difference; p-value — probability value; SD — standard deviation.*

Table 3. Mean pre and post treatment diaphragmatic excursion, RDOS and NEWS2 of both groups

Parameter	Group A	Group B	MD	*p*-value
	Mean ± SD	Mean ± SD		
Diaphragmatic excursion (cm)				
Pre-treatment	1.84 ± 0.40	1.65 ± 0.46	0.19	0.11
Post-treatment	1.99 ± 0.39	2.26 ± 0.48	–0.27	0.02
MD	–0.15	–0.61		
% of change	8.15	36.97		
	$p = 0.001$	$p = 0.001$		
RDOS				
Pre-treatment	11.06 ± 1.72	11.70 ± 2.05	–0.64	0.42
Post-treatment	9.4 ± 1.27	7.13 ± 1.40	–0.64	0.001
MD	1.66	4.57		
% of change	15.01	39.06		
	$p = 0.001$	$p = 0.001$		
NEWS				
Pre-treatment	6.53 ± 1.22	6.96 ± 1.15	–0.43	0.16
Post-treatment	5.17 ± 1.11	3.43 ± 1.16	1.74	0.001
MD	1.36	3.53		
% of change	20.83	50.72		
	$p = 0.001$	$p = 0.001$		

Note: *MD — mean difference; p-value — probability value; SD — standard deviation.*

Shaikh et al. [12] reported findings agreed with ours, as they stated that Breather usage in inspiratory musculatures training (IMT) gained Maximum Inspiratory Pressure (Pimax) significant improvement, also 6-Minute Walk Distance (6MWD) has ensuring remarkable inspiratory musculatures' improved strength reflected in Chronic Obstructive Pulmonary Disease (COPD) participants' functional capabilities.

In accordance with the results obtained, Al-Najjar et al. [13] recently reported that BMI using the Breather device after mastectomy offers clear benefits, mainly when added to a conventional physiotherapy program, maximizing the improvement in ventilatory function.

Parallel with our findings, Elkins & Dentice [14] had offered an explanation for ventilatory functions improvement based on patient's improved breathing pattern of breathing due to respiratory musculatures enhanced endurance and strength, as IMT enforces both diaphragm and accessory respiratory musculatures as a therapeutic approach to improve overall pulmonary function, particularly tidal volume. Elkins & Dentice reported functional capabilities improvements based on enhanced respiratory musculatures' both endurance and strength that improve pulmonary oxygen uptake thus minimize dyspnea severity.

In line with our findings, Turner et al. [15] has ensured that IMT results in stronger respiratory musculatures, and better training performance mainly in whom suffering from inspiratory musculatures weakness manifested by limited training tolerance.

Cheng et al. [16] agreed with our findings as they reported that respiratory muscles training program along eight weeks improved not only cognitive function, ensured by better COPD assessment test values, modified Medical Research Council dyspnea scale values, also male diaphragmatic thickness, as well COPD non-obese with mild cognitive deficits. Moreover, IMT could be addressed as a prime component of respiratory training in combine with expiratory one that is why whom has preserved pulmonary function (FEV1 ≥ 30 %) has obviously diaphragmatic thickness fraction increase post both training for inspiratory and expiratory components of respiratory rehabilitation.

It was found by Shaikh et al. [12] clinical trial that therapeutic Breather permit valuable lungs training through respiratory active components through muscular strengthens thus facilitate appropriate, even efficient breathing. In addition, adding IMT to routine regimes is advised in cardiorespiratory patients in order to maximize oxygen uptake that results in improving maximal inspiratory pressure, ventilation and required performance.

CONCLUSION

It could be concluded that Group B is superior and has more beneficial effects than Group A. Breather gained benefits on respiratory musculatures training in acquired pneumatic patients' hospital stays are obvious, as well it maximized through added to conventional physical therapy chest protocol mainly on diaphragmatic functionally components, oxygenation, respiratory distress observations and discharge from ICU for these patients. Moreover, the Breather should be recommended to be part of management for patients with acquired pneumonia.

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