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The Influence of Core Training In Cardiorespiratory Hospitalized Patients-Case Report

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Abstract

Purpose: Evaluate the influence of core training on functionality and peak cough flow in hospitalized patients.

Methods: Core training was applied 3 times to 5 patients and consisted of 4 exercises (lateral trunk rotation with Swiss ball in hand and throwing the ball; squatting to pick up the swiss ball from the floor; sitting on a chair, perform hip flexion; sitting on the edge of the chair, lean back and return to the starting position). The progression of patients was assessed through the tests: Supine Bridge Test (SBT), Flexor fatigue Test (FFT), Peak Cough Flow (PCF) and Short Physical Performance Battery (SPPB) and during the course of the sessions it was continuously monitored saturation (SpO2), heart rate (HR) and dyspnea with modified borg scale (MBS).

Results: All patients obtained improvements in FFT, PCF and SPPB. 4 out of 5 patients achieved improvements inSBT.

Conclusion: Core training appears to have positive results in improving functionality and values of cough peak flow in hospitalized patients.

Keywords: Core Muscles; Functional Capacity; Peak Cough Flow; Hospitalized Patients; Case Report

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Introduction

The "core" has been used to refer a three-dimensional space, the lumbopelvic-hip complex, which involves deeper muscles, such as the internal oblique, transverses abdominals, transversospinalis (multifidus, rotators, semispinalis), quadratus lumborum, and psoas major and minor, and superficial muscles, such as the rectus abdominis, external oblique, erector spinae (iliocostalis, spinalis, longissimus) latissimus dorsi, gluteus maximus and medius, hamstrings, and rectus femoris [1, 2]. Core muscles can be divided in two groups, the local stabilizers and the global mobilizers [2]. The local stabilizers are made up of the deep muscles, which control the movement [2, 3] while the global mobilizers are made up of the superficial muscles, which connect the trunk to the extremities, being responsible for producing force and increasing intra-abdominal pressure, performing an important role in terms of breathing and coughing [2, 3]. Core muscle development is believed to be important in many functional activities, because core muscle recruitment should enhance core stability and help provide proximal stability to facilitate distal mobility. Many studies describe that before any movement of superior or inferior limbs there is a core muscle contraction [2] The challenge for the Central Nervous System (CNS) move and stabilize the spine is enormous, has to continually analyse the state of stability, plan mechanisms to respond to predictable disturbances and quickly initiate activity in response to unforeseen disturbances [4]. Lumbopelvic stability is controlled by feed forward mecanism when the disturbance applied to the trunk is predictable. Activation of the local stabilizing muscles occurs before the muscles responsible for the movement of the upper and lower limbs and before a load is added to the trunk in a planned manner [4] In this type of task, the CNS predicts the effect that movement will have on the body and plans a sequence of muscle activation to respond to this disturbance [4].

Cough is a defence reflex of the respiratory system that can be done voluntarily or involuntarily. Its function is to remove secretions or foreign bodies, in order to keep the airway unobstructed. The mechanical events of a cough can be divided into three phases: Inspiratory phase, compression phase and expiratory phase. During the inspiratory phase there is the contraction of the diaphragm and the abductor muscles of the larynx [5, 6]. In the compressive phase occurs the closure of the larynx combined with contraction of muscles of chest wall, diaphragm, and abdominal wall result in a rapid rise in

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intrathoracic pressure. In the expiratory phase the glottis opens, resulting in high expiratory airflow and the coughing sound.

Large airway compression occurs. The high flows dislodge mucus from the airways and allow removal from the tracheobronchial tree [7-9]. Any change in one of these phases will affect the efficiency of coughing [10]. If there is a decrease in abdominal muscle strength, the intrathoracic pressures generated will be lower, which will cause changes in the ability to remove secretions.

During hospitalization approximately one-third of older adults experience a loss of activities in daily living (ADLs) [11, 12]. The physical inactivity and bed rest during hospitalization lead to a loss of muscle mass and muscle strength (Coker et al., 2015). Bed rest studies in healthy older adults reported more than 10% loss of muscle mass over 7 to 10 days of inactivity strength [13]. With increasing age, there is a decrease in muscle strength and an increase in adipose tissue, contributing to the decrease in functional capacity [14, 15]. Individuals with increased abdominal adipose tissue have smaller lung volumes and decreased respiratory muscle strength than healthy individuals [16]. Each day of hospitalization promotes a decrease in functional capacity and increases the probability of the patient acquiring hospital infections, and consequently increases the hospital costs. Strengthening exercises have an effective impact to improve physical functions and to prevent disability and according to Granacher et al. (2013a, 2013b) and Shi and Zhou (2014), strengthening exercises can also increase dynamic balance and functionality in elderly people.

Methodology

This study was carried out in January 2022, and were recruited patients admitted in cardiology and pneumology units in Tondela-Viseu hospital center, who met the following inclusion criteria: Conscious, oriented and collaborative with a score greater or equal to 13 on the Glasgow Coma Scale; Scoreless or equal to 3 on the Modified Rankin Scale; Hemodynamic ally stable; Hemoglobin ≥ 8g/dl; Platelets ≥ 70 x 109; Written consent signed by the patient/legal representative.

As a form of evaluation, the Glasgow Coma Scale was applied to assess the level of consciousness of individuals, the Modified Rankin Scale to assess the degree of disability and the clinical analyses of the patients were observed to ensure that hemoglobin levels and platelets were within the reference values.

As a way of evaluating progression, the Supine Bridge Test (SBT) - figure 1, was used to measure muscle strength of the extensors, Flexor fatigue Test (FFT) - figure 2, to assess muscle strength of the flexors, Peak Cough Flow (PCF) - figure 3, was used to measure peak cough, and the Short Physical Performance Battery (SPPB) – figure 4, used as a predictive measure of disability.

At the beginning of the session HR, respiratory rate (RR), SpO2, Blood pressure (BP), dyspnea (using the MBS) was monitored for all patients and for those who have diabetes was also monitored glucose levels. During the course of the sessions, SpO2, HR and dyspnea were continuously monitored. Each test was performed twice and the best value obtained was recorded. The intervention was applied 3 times to each patient and consisted of 4 exercises focused on the core (lateral trunk rotation with swiss ball in hand and throwing the ball – figure 5; squatting to pick up the swims ball from the floor – figure 6; sitting on a chair, perform hip flexion - figure 7; sitting on the edge of the chair, lean back and return to the starting position - figure 8), with 2 sets of 8 repetitions. During the intervention, rest periods were performed between sets and exercises, and this time was defined according to patient´s tiredness and shortness of breath. Assessment, reassessment and interventions were carried out over a 7-day period (**Figure 1**).

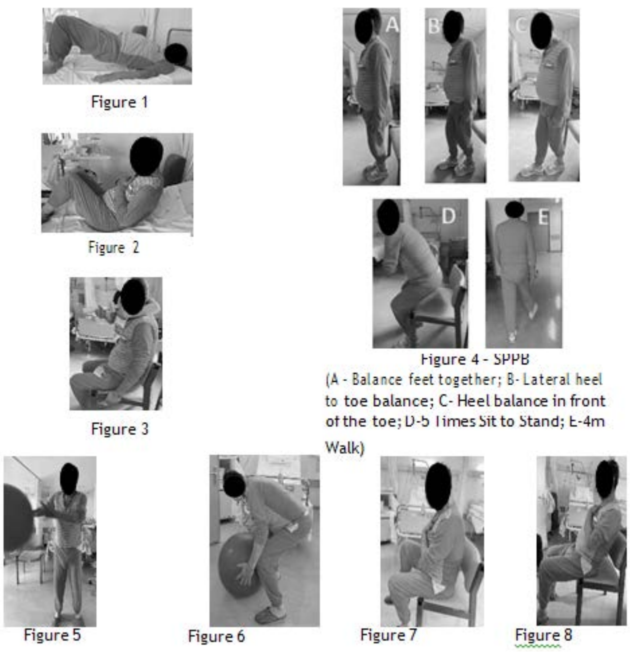

Figure 1 Sitting on the edge of the chair, lean back and return to the starting position - figure 8), with 2 sets of 8 repetitions.

Description of cases

Patient 1: A 71 year-old-man was hospitalized on 25/12/21 due to acute myocardial infarction (AMI) with ST depression, affecting the anterior descending (AD) and circumflex artery (CX). Angioplasty was performed, which resulted in a thrombolysis in myocardial infarction (TIMI) 3 flow and no residual lesion. Personal history (PH) of SARS-CoV2 pneumonia in March 2021 (hospitalized for 1 month in the Intensive Care Unit (ICU) using mechanically invasive ventilation), type 2 diabetes mellitus (DM) treated with premixed insulin, polyneuropathy for more than 10 years, arterial hypertension (AH), chronic kidney disease (CKD), coronary heart disease (placement stent in 2010), dyslipidaemia, chronic gastritis, lithiasis and renal cysts. Currently, the patient is under the effect of a beta-blocker (carvedilol 6.5mg).

Patient 2: A 60 year-old-man, admitted on 30/12/21 due to hypertensive acute pulmonary edema (APE), being transferred to the ICU on January 1, 2022 due to acute respiratory failure (ARF) with imminent indication of mechanical ventilation. He remained hospitalized in the ICU for 4 days, being later transferred to the cardiology unit. He has a left ventricular ejection fraction (LVEF) of 25%. PH of smoking and drug addiction (active use of cocaine and heroin), chronic obstructive pulmonary disease (COPD) not studied, heart failure, AH, cured hepatitis C and latent tuberculosis.

Patient 3: A 73 year-old-man, admitted on 19/12/2021 due to complaints of cough with purulent sputum and chest pain on the right side, associated with cough with 5 days of evolution. The medical diagnosis was complicated right pleural effusion (RPE), exuded pleural fluid, clinical signs of acute respiratory infection and presentation of rise of the right diaphragmatic hemisphere on chest ultrasound. He has a PH of AH and benign prostatic hyperplasia (BPH).

Patient 4: A 52 year-old-man was hospitalized on 16/12/21 due to severe SARS-CoV-2 pneumonia combined with type 1 acute respiratory failure, and remained in the ICU for 7 days. PH of type 2 DM, obesity and dyslipidaemia. When assessed, the patient has a dry cough with some white phlegm and had a support of 1.5 L/min of oxygen. The patient performs long- term walks while hospitalized in pulmonology.

Patient 5: A 63 years-old-women, hospitalized on 01/01/22 due to acute asthma with respiratory failure. It presents as PH of nasal polypoid, allergy to no steroidal anti- inflammatory drug (NSAID´s), obesity, depressive syndrome, hiatal hernia, duodenal ulcer and cholecystectomy. Currently, the patient reports having little cough with some yellowish sputum, requiring the addition of oxygen at 2 L/min (**Table 1**).

Results

The aim of this study is to evaluate the influence of core training on peak cough flow and functionality of patients, so it is expected that there will be an increase in these components after the interventions. For the reassessment (M1), performed after the 3 interventions, were applied the same tests as in the assessment (M0).

Table 1. Patient's description.

	Gender	Years	Days of hospitalization	Clinical history
P1	Male	71	10	AMI with ST depression
P2	Male	60	11	Cardiac insufficiency
P3	Male	73	17	Right peural effusion
P4	Male	52	25	Bilateral pneumonia SARS-CoV2
P5	Female	63	10	Acute asthma with respiratory failure

Patient 1: In M0, after 10 days of hospitalization, this patient performed all tests without the need of external help. In M0, he obtained 6.7 seconds in the FFT, 36 seconds in the SBT, 290 L/min in the PCF and 8 points in the SBPTS, being considered pre-frail. In the M1, he achieved 8.3 seconds in the FFT, 1 minute and 16 seconds in the SBT, 300 L/min in the PCF and 9 points in the SBPT, continuing to be considered a pre-frail patient. The mean during the 3 interventions for SpO2, HR and MBS were 98.6%, 78.1 bpm and 2.6, respectively. During the 1st intervention, the mean values of SpO2, HR and MBS were 98.3%, 78.6 bpm and 2.8, respectively. During the 2nd intervention, the mean values of SpO2, HR and MBS were 99.1%, 78.6 bpm and 2.4, respectively. And during the 3rd intervention, the mean values of SpO2, HR and MBS were 98.5%, 77.7 bpm and 2.5, respectively.

Patient 2: In M0, after 11 days of hospitalization, this patient obtained 26.6 seconds in the FFT, 2 minutes and 3 seconds in the SBT, 170L/min in the PCF and 9 points in the SPPB (pre- frail). In M1 he obtained 2 minutes and 19 seconds in the SBT, 34.53 seconds in the FFT, 205 L/min in the PCF and obtain a maximum classification of 12 points in the SPPB ("normal").

The mean during the 3 interventions for SpO2, HR and Borg were 94.3%, 91.2 bpm and 4.2, respectively. During the 1st intervention, the mean values of SpO2, HR and MBS were 92.8%, 86.8 bpm and 4.7, respectively. During the 2nd intervention, the mean values of SpO2, HR and MBS were 93.6%, 98.1 bpm and 4.7, respectively. And during the 3rd intervention, the mean values of SpO2, HR and MBS were 96.6%, 88.6 bpm and 3.1, respectively.

Patient 3: In M0, after 17 days of hospitalization, was on oxygen therapy at 1.5 L/min. He performed 6.29 seconds in the FFT and 2 minutes and 38 seconds in the SBT. He presented a PCF of 150 L/min and a score of 8 points in the SPPB, being considered pre-frail. In M1, with oxygen therapy at 0.5 L/min, he performed 12.77 seconds in FFT, 4 minutes and 48 seconds in SBT, 165 L/min in PCF and 9 points in SPPB. The mean during the 3 interventions for SpO2, HR and MBS were 96%, 78.5 bpm and 3, respectively. During the 1st intervention, the mean values of SpO2, HR and MBS were 95.7%, 83.6 bpm and 2.5, respectively. During the 2nd intervention, the mean values of SpO2, HR and MBS were 96.1%, 80.3 bpm and 3.3, respectively. And during the 3rd intervention, the mean values of SpO2, HR and MBS were 96.3%, 71.7 bpm and 3.2, respectively.

Patient 4: In M0, after 25 days of hospitalization, was on oxygen therapy at 1.5 L/min. He performed 51.89 seconds on FFT and 2 minutes and 58 seconds on SBT. He presented a PCF of 170 L/min and a score of 9 points in the SPPB, being considered pre-frail.

In M1, without oxygen therapy, he performed 1 minute and 10 seconds in the FFT, 2 minutes and 13 seconds in the SBT, 200 L/min in the PCF and 10 points in the SPPB, being considered "normal" in the SPPB.

The mean SpO2, HR and MBS during the 3 interventions were 94.3%, 90 bpm and 0.1, respectively. During the 1st intervention, the mean values of SpO2, HR and MBS were 94.1%, 100.3 bpm and 0.2, respectively. During the 2nd intervention, the mean values of SpO2, HR and MBS were 94.2%, 86.8 bpm and 0, respectively. And during the 3rd intervention, the mean values of SpO2, HR and MBS were 94.7%, 83 bpm and 0, respectively.

Patient 5: In M0, after 10 days of hospitalization, was on 2L/min of oxygen therapy and performed 38.83 seconds in FFT and 43.79 seconds in SBT. He presented a PCF of 130 L/min and a score of 8 points in the SPPB, being considered pre-frail. In M1, without oxygen therapy, he performed 1 minute and 20 seconds in the FFT, 1 minute and 12 seconds in the SBT, 185 L/min in the PCF and 9 points in the SPPB, continuing to be considered pre-frail.

The mean during the 3 interventions for SpO2, HR and MBS were 96.4%, 101.1 bpm and 0.6, respectively. During the 1st intervention, the mean values of SpO2, HR and MBS were 96.8%, 103.3 bpm and 0.6, respectively. During the 2nd intervention, the mean values of SpO2, HR and MBS were 96.6%, 99.7 bpm and 0.4, respectively. And during the 3rd intervention, the mean values of SpO2, HR and MBS were 95.9%, 100.2 bpm and 0.8, respectively (**Tables 2 and 3**).

Discussion

This study presents 5 cases with different pathologies in the cardiorespiratory area. Evidence shows that exercises for core stabilization have an influence on respiratory parameters, in particular on peak expiratory flow, in various pathologies [17, 18].

Although there are no studies demonstrating that core training influences peak coughing, the results obtained in our study suggest that core training increases peak coughing. In the 5 cases presented, the mean difference in PCF between M0 and M1 was 29± 16.49 L/min, the mean difference in FFT between M0 and M1 was 15.06± 14.12 seconds , the mean difference in SBT between M0 and M1 was 51.84± 40.35 seconds, and the mean difference in SPPB between M0 and M1 was 1.4± 0.8 points.

Also several studies demonstrate that core training has an impact on functional capacity in various populations [19-21] our study is in agreement with the literature, since all users had a better score in SPPB, in M1. All who had a score lower than 10 had been hospitalized for more than 10 days. Probably, the decrease in functional capacity is related to the loss of muscle mass due to immobility [17].

Table 2. Initial and final patient´s assessment.

		PCF	SBT	FFT	SPPB
Patient 1	M0	290L/min	36.8s	6.7s	8
	M1	300L/min	1min 16s	8.3s	9
Patient 2	M0	170L/min	2min 3s	26.6s	9
	M1	205L/min	2min 19s	34.5s	12
Patient 3	M0	150L/min	2min 38s	6.29s	8
	M1	165L/min	4min 48s	12.77s	9
Patient 4	M0	170L/min	2min 58s	51.86s	9
	M1	200L/min	2min 13s	1min 10s	10
Patient 5	M0	130L/min	43.79s	38.83s	8
	M1	185 L/min	1 min 12 s	1 min 20s	9

Table 3. Media of SpO2, HR, Dyspnea Monitoring of interventions.

Means					
		1ºInt	2ºInt	3ºInt	All
Patient 1	SpO2	98.3	99.1	98.5	98.6
	HR	78.6	78	77.7	78.1
	Dyspnea	2.8	2.4	2.5	2.6
Patient 2	SpO2	92.8	93.6	96.6	94.3
	HR	86.8	98.1	88.6	91.2
	Dyspnea	4.7	4.7	3.1	4.2
Patient 3	SpO2	95.7	96.1	96.3	96
	HR	83.6	80.3	71.7	78.5
	Dyspnea	2.5	3.3	3.2	3
Patient 4	SpO2	94.1	94.2	94.7	94.3
	HR	100.3	86.8	83	90
	Dyspnea	0.2	0	0	0.1
Patient 5	SpO2	96.8	96.6	95.9	96.4
	HR	103.3	99.7	100.2	101.1
	Dyspnea	0.6	0.4	0.8	0.6

Decreased functionality increases the risk of falls in the elderly. Since all users are over 50 years old, it is important to maintain functionality. Evidence shows that core strength training allows to develop a more stable and stronger core and this improves balance and prevents falls in the elderly (Granacher et al., 2018).

Our study suggests that there is an increase in the strength of the core muscles, both flexors and trunk extensors, due to the increase in time maintained in the FFT and SBT tests in the assessments (M0 and M1). In all patients, there was an improvement in the FFT, PCF and SPPB. Our study demonstrates that 3 core training interventions in a 7-day period can positively influence peak coughing and functional capacity. Probably, peak cough flow increased due to increased strength of the core muscles, particularly the expiratory ones. The greater strength of the respiratory muscles translates into greater maximal inspiratory and expiratory pressures, which consequently leads to increased lung volumes, with less effort/tiredness.

Core training, in addition to increasing the strength of the core muscles, also improves spinal mobility. This is necessary to perform activities of daily living, especially in the elderly [20].

Core training also allows greater stability of core muscles, which creates a stable proximal base for a better quality of movement of the lower limbs, also preventing the risk of injury to the lower limbs (Bliven and Anderson, 2013). That said, core training allows for more fluid and stable movements, thus increasing the functional capacity of patients in ADLs.

The limitations of this study are: small sample size because some patients did not complete the intervention due to various reasons and some did not meet the inclusion criteria; some patients benefited from breathing exercises, which may have contributed to the positive results the fact that some patients are under the effects of medication, namely antihypertensive drugs, may cause some bias in the data, taking into account that they cause a decrease in blood pressure and heart rate during exercise the possibility that there are other exercises with a greater focus on the core, more exercises against gravity, which perhaps would be more effective; the short intervention time, only 3 workouts were performed on consecutive days because physical therapist accompanies the patient daily, and the literature says that strength training should be performed 2/3x a week with rest intervals of 24h-48h (F, 1967). In our study, this was not the case, due to the uncertainty the days of hospitalization; the non-existence of progression, due to the short time interval of the study, in 3 interventions the progression would be something difficult to perform; other studies that performed core training, the interventions lasted a period of at least 4 weeks [20, 21].

Conclusion

Based on the data collected, we were able to see that there was an evolution in the results obtained in the SPPB, FFT and PCF. Demonstrating an improvement in the functionality and ability of patients to cough.

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