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RESPIRATORY REHABILITATION OF THE PERSON WITH INVASIVE MECHANICAL VENTILATION

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ABSTRACT

Objective: To improve the respiratory *performance* in the person submitted to invasive mechanical ventilation, through a rehabilitation program.

Method: a pilot study, involving the quantitative, descriptive and cross-sectional case study methodology applied to people undergoing mechanical ventilation, to an accidental sample of four people. The Glasgow Coma Scale, the Richmond Stimulation and Sedation Scale and the Pain Scale were used, as well as a recording instrument including the parameters of respiratory perfomance evaluation. Descriptive statistics were used to analyze the results obtained.

Results: there was improvement in respiratory *performance*, namely in dynamic *compliance*, dynamic pulmonary resistance, partial pressure of O2, PH, tidal volume and expired volume, as a result of the rehabilitation program.

Conclusion: the improvement of the respiratory *performance* during the specialized intervention in rehabilitation nursing in these people submitted to invasive mechanical ventilation is proven. Given the limitations of the sample and the design, it is suggested the development of research projects focused on this problem, to confirm the effectiveness of rehabilitation programs in improving the ventilatory *performance* of these people.

Keywords: Rehabilitation Nursing; respiratory *performance*; mechanical ventilation.

INTRODUCTION

The context of intensive care units mostly involves people with critical pathology who often require invasive mechanical ventilation, subject to long periods of physical inactivity. Thus, there is often atrophy of the musculoskeletal apparatus, muscle weakness and consequent alteration in respiratory and cardiovascular function[1].

Invasive mechanical ventilation, as a solution, frequently causes changes in two pulmonary dynamics phenomena: compliance and pulmonary resistance. Pulmonary compliance is defined by the ability of the lung to receive a certain volume of air through a pressure change, ie, it is the direct relation between the pressure required to receive a certain volume and the lung resistance, in turn, is defined by the pressure generated in the upper airways up to the alveoli in order to receive a certain volume of air.

The person undergoing invasive mechanical ventilation may be subject to respiratory dysfunction[2-4]. In turn, respiratory dysfunction caused by invasive mechanical ventilation is exacerbated by the increase in days to which the person is subjected to it[4-6]. This respiratory dysfunction translates into a negative set of changes in parameters essential to a good respiratory performance, such as: compliance and dynamic resistance, O2 peripheral saturation (SPO2), PH, CO2 partial pressure (PaCO2), O2 partial pressure (PaO2), lactates, bicarbonate [HCO3-], tidal volume (TV) expired volume (EV), respiratory rate (RR), among others[7].

Also, muscle weakness quickly sets in, essentially translating into dysfunction of the main respiratory muscle, the diaphragm. The major changes in the diaphragm are identified by atrophy, decreased range of motion, and decreased fiber strength resulting in an inability to effectively mobilize the structures of the abdomen, reducing the space the lungs have to be able to expand effectively[8-10].

Prolonged mechanical ventilation and/or absence of specific intervention in diaphragmatic re-education may prove to be a predominant negative factor in early extubation and reduced risk of re-incubation[6].

Other complications may result from prolonged mechanical ventilation, such as: pulmonary stasis, decreased mucociliary bronchial activity and consequent accumulation of secretions and atelectasis, frequent complications in people undergoing invasive mechanical ventilation with long hospital stays in intensive care units[2,11].

The person hospitalized in intensive care is exposed to numerous aggressions, mostly from the medical devices that are added to them to promote ventilatory support, medication, among others, and at the same time increase the risk of complications[1,4].

In this very specific context, it is essential that a set of standards and procedures be defined that respond to an early intervention to the person undergoing invasive mechanical ventilation in order to provide early extubation and to prevent or reduce the risks of immobility associated complications and dysfunction of the muscles responsible for breathing, as well as, to promote their autonomy, reducing not only the time of physical inactivity, but also the respective hospital admission[12].

The rehabilitation nurse can intervene with a set of rehabilitation interventions, involving respiratory functional reeducation techniques and motor functional reeducation in these people, in order to prevent and/or reduce respiratory complications and improve pulmonary performance through pulmonary expansion maneuvers, diaphragmatic training and airway cleansing.

Functional respiratory reeducation

Respiratory rehabilitation and the implementation of respiratory exercises can prevent complications and promote the resolution of respiratory disorders by enhancing pulmonary performance[7].

Respiratory rehabilitation techniques and maneuvers must take into account the specific characteristics of the critically ill person. It should include maneuvers aimed at improving the respiratory pattern, essentially through pulmonary expansion maneuvers, namely selective costal opening exercises, directed ventilation and abdominal-diaphragmatic exercises. These exercises should be adapted according to the degree of collaboration of the person and, at the same time, according to the present ventilatory modality.

Diaphragmatic re-education allows the person to reduce their ventilatory dysfunction, while at the same time significantly increasing the inspiratory lung volumes in most cases, improving oxygenation and decreasing the residual volume, improving the release of CO2[7]. It should involve abdomino-diaphragmatic exercises, re-education of the posterior portion of the diaphragm and re-education of the right and left hemicules. In this case, the procedures are adapted according to the person who may not be able to collaborate in a controlled ventilatory modality (controlled volume/controlled pressure) or assisted ventilation mode (support pressure/support volume) or to the ventilated person who collaborates in assisted ventilation mode (support pressure/support volume).

Selective costal opening exercises allow the person to promote and maximize their costal mobility, while allowing the pulmonary expansion to be affected[7,13-14]. These procedures are adapted according to the person who does not cooperate in a controlled ventilatory modality (controlled volume/controlled pressure) or assisted ventilation mode (support pressure/support volume) or to the ventilated person collaborating in assisted ventilation support/support volume).

Directed ventilation consists of directing airflow to a specific pulmonary segment[7,13-14]. During the implementation of therapeutic exercises, directed ventilation should be performed by coordinating inspiratory time simultaneously with the compression of a hemithorax. This exercise should be performed alternately, directing the flow of air to the lung contralateral to compression. The procedures shall also be adapted in according to the person's collaboration.

Motor functional reeducation

Passive mobilization is understood as a movement of a body segment that is produced entirely by an external force (nurse, mechanical device), providing little or no voluntary muscular contraction[14]. The main objective of passive mobilization exercises is to reduce the complications associated with immobility, since passive mobilization does not prevent muscular atrophy, does not increase physical strength or endurance, or improves peripheral circulation[14].

The specialist rehabilitation nurse should carefully evaluate the person's joint and muscular condition, if there are already joint adhesions, inflammatory processes, pain, fractures or acute lacerations[14].

Scapulo-humeral joint mobilization exercises in the context of selective costal opening exercises, passive trunk mobilization and placements are associated with functional respiratory re-education exercises.

Considering the above and assuming that associated with the use of invasive mechanical ventilation in critically ill people there is a high risk of complications and alterations of respiratory and cardiovascular function and considering that, the nurse specialist in rehabilitation nursing can play a determining role in the prevention and reduction of complications, through a process of evaluation and re-education, which involves a set of therapeutic exercises of rehabilitation to the person, we defined as central objective for this study:

- Improve respiratory performance in the person undergoing invasive mechanical ventilation, through a rehabilitation program.

We believe that the results of this study can be an important contribution to the reflection on this problem and the relevance of the specialized intervention of Rehabilitation Nursing, aiming at the implementation of intervention plans adjusted to the needs of each person's care, in order to improve the performance ventilation in people with mechanical ventilation.

METHOD

A pilot study involving the use of a quantitative, descriptive and cross-sectional case study methodology performed at a Multipurpose Intensive Care Unit of a health institution in the south of Portugal between October 2016 and January 2017.

The sample included people who underwent invasive mechanical ventilation. Excluded from the intervention plan were people who met exclusion criteria and who had acute pathological conditions in which their mobilization, or increased pressure and thoracic volumes could trigger severe hemodynamic instability. The exclusion criteria were as follows:

1 .Neurological criteria: the person does not collaborate by agitation (score in the Richmond Agitation and Sedation Scale +5 to +1); Pain> 0;

2 .Respiratory Criteria: Does the person have any of the following criteria? Positive end-expiratory pressure ≥10 cmH2O and/or Inspired oxygen fraction ≥ 0.80; Hypoxemia (Spo2≤90%) or frequent desaturation and tachypnea (total respiratory rate> 35 breaths / minute);

3 .Cardiovascular criteria: Does the person have any of the following criteria? New cardiac ischemia; onset of new arrhythmia; systolic blood pressure> 200 mmHg or <90 mmHg; Mean blood pressure> 110 mmHg or <65 mmHg; Heart rate> 130 beats/min. or <30 beats/min.; new dose or increase of vasoactive drug in the last 2 hours and new deep venous thromboembolism).

This evaluation grid was applied before any intervention was initiated, regardless of the number of daily sessions, and the same interventions were interrupted whenever people presented any of the criteria.

The absolute restrictions regarding mobilizations, selective costal opening exercises, ventilation guided by thoracic compression and abdominal-diaphragmatic exercises were: unstable hypertensive pneumothorax, unstable cardiovascular diseases (arrhythmias, severe hypotension, hypertension, congestive heart failure, angina of chest, acute myocardial infarction, and pulmonary edema), acute head or neck surgery/injury or disease with increased intracranial pressure, increased airway edema, dyspnoea (orthopnea, severe pulmonary disease, pulmonary embolism, extensive pleural effusion, pain undiagnosed acute abdomen, surgically drained empyema, unstable fractures of the costal arches, unstable spinal fractures, and acute or surgically unstable diaphragmatic injury, surgical emphysema, chronic obstructive pulmonary disease with cor pulmonale), active tuberculosis cases, undiagnosed acute abdomen, surgically drained empyema severe,

neuromuscular disease, aneurysm or decreased circulation of major blood vessels, esophageal anastomosis, hemoptysis and vomiting[7].

An accidental sample of four people was used, considering the temporal limitations for the development of this pilot study and the fulfillment of the defined criteria.

The rehabilitation program involved techniques for motor functional re-education and functional respiratory re-education, with the following procedures:

1 .Evaluation of the person focused on the following parameters: assessment of the state of consciousness; assessment of sedation-agitation level; evaluation of pain; evaluation of vital parameters and evaluation of gasimetry and ventilatory parameters before the implementation of the rehabilitation nursing program.

2 .Techniques of motor functional reeducation: placements (dorsal, semi-fowler, right lateral, left lateral, right and left semi-dorsal) and mobilization (passive mobilizations of the right, left shoulder and trunk joint).

3 .Respiratory functional reeducation techniques that consisted of the implementation of pulmonary expansion maneuvers (selective costal opening through the right upper limb and left upper limb), directed ventilation (right and left hemithorax compression) and abdomino-diaphragmatic exercises of the diaphragm, right and left hemidiaphragms).

4 .Evaluation of respiratory performance after each session of the rehabilitation program (involving techniques of motor and respiratory rehabilitation) at 20 '(T1) and 60' (T2), focusing on the following parameters and the following physiological intervals:

- Dynamic Compliance (1ml/cmH2O/Kg);
- Dynamic lung resistance (4-8 cmH2O/l/s);
- O2 peripheral saturation (95-100%);
- PH (7.35-7.45);
- CO2 partial pressure (35-45 mmHg);
- O2 partial pressure (80-100 mmHg);
- Tidal volume and expired volume (50 ml/kg/min, approximately 450-500 ml per respiratory cycle in a young adult).

The instruments used were the Glasgow Coma Scale, Richmond Agitation and Sedation Scale and Pain Scale. An instrument for recording the person's evaluation was also created in all the periods in which the patient was assessed, focusing on the parameters defined for respiratory performance evaluation, exclusion criteria and techniques for motor and respiratory rehabilitation that are part of the program. This instrument of registration of the obtained data was submitted to the assessment of two judges, who pronounced on whether each item was related to the domain under study. The opinions were convergent and both considered that the items applied to the domain of the content under study, reason why the instrument was considered that offered guarantees of validity of content.

Prior to the study, the Board of Directors of the health institution involved, as well as the opinion of the ethics committee of the University of Évora, in the area of health and well-being, were submitted for approval and authorization was requested. Efforts were also made among participants and their families to ensure respect for ethical principles, which involved detailed information on the study and signing of the informed consent declaration, in line with the Helsinki Declaration and the Oviedo Convention.

The data was analyzed using descriptive statistics to verify the difference in the indicators used to measure respiratory performance before and after the implementation of the rehabilitation program in people undergoing invasive mechanical ventilation.

RESULTS

In the four people who were part of this sample, 25 sessions of the rehabilitation nursing program were completed. It was not possible to perform the same number of sessions for all people, with each participant in the study having 8, 6, 6 and 5 rehab sessions respectively. It should be noted that 9 sessions were interrupted to these people, and the most frequent exclusion parameter was the heart rate> 130 beats/minute.

Regarding the results obtained in the dynamic compliance, it was verified that none of the people submitted to the program managed to reach the ideal dynamic compliance, even after the implementation of the therapeutic exercises. However, there was a significant improvement in three people and remained linear in one participant.

The dynamic pulmonary resistance reached values closer to the standard values, although still outside the reference range. The implementation of the therapeutic exercises led to an improvement in the results of this indicator in three participants.

The results obtained in the peripheral saturation of O2 allowed to verify some improvement after the program of rehabilitation in two people, being that in the others the changes are little significant.

In general, PH values increased in T1 and T2 or, when lower than pre-session values, practically did not reach the lower physiological value that could be translated into an acidosis. Only in one of the 25 sessions did the PH value fall below 7.35 and the pre-session value was above the lower limit. PH values remained between physiological or more alkaline values.

In the CO2 partial pressure, there was a decrease in one person in T1 and T2 and in T2 in another person. In the rest of the population there was a trend towards an increase in CO2.

At the O2 partial pressure level, an increase in O2 values in T1 and T2 predominated in three of the study participants.

With regard to tidal volume, the increase in values in two persons predominated; the decrease in values in one person and in another, the volumes remained unchanged.

The results in the expired volume revealed that in particular in T2 and, overall, there was an increase in the volume expired in all the people although little significant.

Thus, respiratory performance was improved, namely in dynamic compliance, dynamic pulmonary resistance, partial pressure of O2, PH, tidal volume and expired volume, as a result of the rehabilitation program.

DISCUSSION

The results obtained through the application of rehabilitation nursing exercises compared to recent studies revealed several similarities and few divergences.

The review of the literature on this subject essentially addresses studies where the rehabilitation intervention involves manual chest compression exercises and manual hypersufflation, and no study has shown a relationship of exercises so vast and similar to those prepared in the project of professional intervention. All studies referenced exclusively involve persons undergoing invasive mechanical ventilation. Regarding the latency periods, these also differ from the times initially planned for this intervention project.

In order to determine the impact of respiratory and motor functional rehabilitation exercises on the respiratory performance of patients submitted to invasive mechanical ventilation, it was necessary to define indicators that could measure respiratory performance. These indicators are specific and fundamental in a rigorous assessment of the respiratory function of persons with invasive mechanical ventilation in an intensive care unit.

Concerning dynamic compliance (reference: 1ml/cmH2O/kg), it was observed that there was a significant increase in the four people observed in both times after implementation of the therapeutic exercises, similar to other studies[15-19], although in these studies have only implemented manual chest compressions as a therapeutic exercise. A balance was shown between the number of times T1 and T2 values were higher, indicating a positive impact on compliance after the implementation of therapeutic exercises regardless of the latency period.

In the dynamic resistance (reference range: 4-8 cmH2O/l/s) there was a significant decrease in relation to the initial values, as well as a greater approximation to the reference values, mainly in T2. Regarding the literature, no reference was found to the study of dynamic resistance, and the only reference detected is associated with total respiratory resistance in two studies[16,20], but no significant changes were observed after the implementation of respiratory therapy exercises, namely bilateral chest compressions. Since it was not possible to isolate and determine the dynamic resistance of this study, a degree of comparison.

Concerning peripheral O2 saturation (reference range: 95-100%), similar to other studies[15,21], it was verified that the changes in values were not significant, with only short oscillations. However, there are studies[16,18] in which there was a significant increase in peripheral O2 saturation after the implementation of therapeutic exercises through

compressed ventilation of the rib cage. Although the alterations were not very significant with respect to the increase of the O2 percentage, it was verified that, for once only the SPO2 value was lower than 95%, demonstrating that the therapeutic exercises did not have a negative impact.

Concerning PH values (reference range: 7.35-7.45), it was observed that, in general, the values increased in T1 and T2 or, when lower than the pre-session values, practically did not reach the lower physiological value which could translate into an acidosis. It should be noted that in one of the studies[16], many of the PH values remained stable.

Concerning the data obtained in the CO2 partial pressure (reference range: 35-45 mmHg) there was a decrease in one person in T1 and T2 and in T2 in another person, in line with the results of two other studies[16,22] who report a significant decrease in PaCO2 after the implementation of respiratory exercises. In the remaining two people observed a slight oscillation occurred, although, a tendency appeared for a slight increase. These results are in agreement with the studies by Kohan, Rezaei-Adaryani, Yarandi, Hoseini and Mohammad-Taheri[23], where there is a reference to minor changes in PaCO2.

In relation to the data obtained in the O2 partial pressure (reference range: 80-100 mmHg), it was observed that, in the majority, there was a significant increase, except for one person, meeting the results obtained by the authors Kohan et al.[23]. This indicator presented the best results in relation to the reference values, indicating a potential efficacy of exercises of pulmonary expansion maneuvers and abdominal-diaphragmatic training.

As in PaO2, we can conclude that pulmonary expansion maneuvers were effective, since there was a significant increase in tidal volume (reference value: 50 ml/kg/min, approximately 450-500 ml per respiratory cycle) in three people, in both latency times. This data is in line with results obtained in other studies[18,22,24].

Although the expired volume (reference value: 50 ml/kg/min, approximately 450-500 ml per respiratory cycle) is not subject to regular study in ventilated patients, regarding the implementation of the intervention project, an increase in this volume was observed, as claimed in one of the studies[17], mainly because the increase in these values of expired volume is more relevant because of its importance in CO2 elimination.

CONCLUSION

In summary and in view of the objective for this study, there was an improvement in the respiratory performance of people undergoing invasive mechanical ventilation. The intervention of the nurse specialist in rehabilitation nursing was fundamental in the implementation of therapeutic exercises for people with mechanical ventilation in the context of intensive care. The interventions developed are feasible and in this study with evident results in several indicators used to measure respiratory performance, namely in dynamic compliance, dynamic pulmonary resistance, partial pressure of O2, PH, tidal volume and expired volume.

Given the importance of the intervention of the rehabilitation nurse in the development of specialized care for the critically ill person and in this context of care, it is essential that health institutions value the competencies and role of this specialist in the prevention of complications and in the rehabilitation of the people submitted mechanical ventilation assisted.

The training plans in critical care units should value the continuous training of these specialists in rehabilitation nursing, aiming at the development of professional intervention programs and strategies that can improve the respiratory performance of these people and prevent complications due to the situation of immobility and critical condition. In spite of the practical contexts, if they are the structuring axis for the identification of the training needs of the nursing professionals, the curricula of the specialized training in rehabilitation nursing must offer a greater role in the approach of these themes and in the development of this type of professional competences, in a context where their intervention is determinant in the development of quality health care.

The development of studies of this nature and of research projects are fundamental for the development of the knowledge related to the nursing care to the person in critical condition and with assisted mechanical ventilation. Considering that the consistency of the results obtained is limited, given the small number of people who took part in this study and the weakness of the design, with implications for the external validity of the study, we suggest further studies of this nature, within a longer time limit and allow to evaluate the effectiveness of the implementation of therapeutic rehabilitation exercises in the improvement of respiratory performance, in the prevention of complications and in the rehabilitation of people in critical condition and with mechanical ventilation assisted.

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