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ORIGINAL ARTICLE

Influence of physiotherapeutic practice in mechanical ventilation process of patients admitted to the ICU overnight after non-complicated cardiac surgery

Influência da atuação fisioterapêutica no processo de ventilação mecânica de pacientes admitidos em UTI no período noturno após cirurgia cardíaca não complicada

La influencia de la acción fisioterapéutica en el proceso de ventilación mecánica de pacientes internados en UCI durante el periodo nocturno tras realizar cirugía cardiaca no complicada

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ABSTRACT | The aim of this study was to verify the influence of physical therapists on the mechanical ventilation process of patients who underwent non-complicated cardiac surgery admitted to the Cardiac ICU overnight. Documentary and retrospective study with adult patients who underwent cardiac surgery admitted to the ICU overnight from November 2010 to October 2011 with physiotherapeutic care for 12 hours (n=51), and from November 2011 to October 2012 with physiotherapeutic care for 24 hours (n=43), at the University Hospital of the Federal University of Maranhão. For statistical analysis, we used Chi-square, Student's t, and G tests; data were considered statistically significant when p<0.05. The duration of the mechanical ventilation was lower when physiotherapeutic care occurred at night (6.7±3.7 h vs. 8.7±3.1 h, p=0.02). In this same period, the number of patients extubated in less than 6 hours was also significantly higher (53.4% vs. 27.4%, p=0.0182), as well as the number of scheduled extubations (79% vs. 43.1%, p=0.009). The physiotherapeutic practice influenced the mechanical ventilation process of patients who underwent non-complicated cardiac surgery admitted to the ICU overnight, reducing the time of mechanical ventilation and increasing the number of extubations in less than 6 hours, as well as the number of extubations scheduled during the night.

Keywords | Physical Therapy Modalities; Night Work; Respiration, Artificial; Thoracic Surgery.

RESUMO | Este estudo pretendeu verificar se a presença do fisioterapeuta influencia no processo de ventilação mecânica de pacientes submetidos à cirurgia cardíaca não complicada e admitidos em UTI cardiológica no período noturno. Trata-se de estudo documental retrospectivo com pacientes adultos submetidos a cirurgia cardíaca e admitidos na UTI no período noturno nos meses de novembro de 2010 a outubro de 2011, com assistência fisioterapêutica por 12 horas (n=51) e entre novembro de 2011 e outubro de 2012, período com assistência fisioterapêutica por 24 horas (n=43), no Hospital Universitário da Universidade Federal do Maranhão. Para análise estatística, foram utilizados os testes qui-quadrado, t de Student e G, sendo os dados considerados estatisticamente significantes quando p<0,05. A duração da ventilação mecânica foi menor quando ocorreu assistência fisioterapêutica no período noturno (6,7±3,7 horas vs. 8,7±3,1 horas, p=0,02). Nesse mesmo período, o número de pacientes extubados em tempo inferior a seis horas também foi significativamente maior (53,4% vs. 27,4%, p=0,0182), assim como o número de extubações programadas (79% vs. 43,1%, p=0,009). A atuação fisioterapêutica influenciou o processo de

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ventilação mecânica de pacientes submetidos à cirurgia cardíaca não complicada e admitidos na UTI no período noturno, reduzindo o tempo de ventilação mecânica e aumentando o número de extubações em tempo inferior a seis horas e o número de extubações programadas durante a noite.
Descritores | Modalidades de Fisioterapia; Trabalho Noturno; Respiração Artificial; Cirurgia Torácica.

RESUMEN | En este estudio se propone a verificar si la presencia del fisioterapeuta influencia en el proceso de ventilación mecánica en pacientes sometidos a cirugía cardiaca no complicada e internados en el sector cardiaco de una UCI durante el periodo nocturno. Estudio de carácter documental retrospectivo con pacientes adultos sometidos a cirugía cardiaca e internados en una UCI en el periodo nocturno de noviembre de 2010 hasta octubre de 2011, con cuidados fisioterapéuticos de 12 horas (n=51), y entre noviembre de 2011 hasta octubre de 2012, periodo con cuidados fisioterapéuticos de 24 horas (n=43), en el Hospital Universitario de la Universidade Federal do Maranhão, en Brasil. Para el análisis estadístico, se emplearon las pruebas chi-cuadrado, t de Student y G, siendo los datos considerados significativos estadísticamente cuando p<0,05. La duración de la ventilación mecánica ha sido menor durante el cuidado fisioterapéutico en el periodo nocturno (6,7±3,7 horas *vs.* 8,7±3,1 horas, p=0,02). En ese mismo periodo, el número de pacientes que extrajeron los tubos en tiempo inferior a seis horas también ha sido significativamente mayor (53,4% *vs.* 27,4%, p=0,0182), así como la cantidad de retirada programada de los tubos (79% *vs.* 43,1%, p=0,009). La acción fisioterapéutica influyó en el proceso de ventilación mecánica de los pacientes sometidos a cirugía cardiaca no complicada e internados en la UCI durante el periodo nocturno, les redujo el tiempo de ventilación mecánica y aumentó el número de retirada de los tubos en tiempo inferior a seis horas y la retirada programada durante el periodo nocturno.
Palabras clave | Modalidades de Fisioterapia; Trabajo Nocturno; Respiración Artificial; Cirugía Torácica.

INTRODUCTION

Cardiac surgery is a complex procedure that involves the alteration of several physiological mechanisms, the contact with medicines and materials that may be harmful to the organism, as well as the imposition of a high organic stress, requiring thus intense postoperative care for the maintenance of the patient's healthy recovery[1].

The use of anesthesia is one of the factors that causes ventilation-perfusion mismatch, probably associated with secondary atelectasis and with the closing of distal airways. The postoperative pain and the presence of drains imply low lung volumes. Considering that this case of pulmonary dysfunction is related to cardiac surgery and its possible repercussions, physiotherapy has been required as an attempt to reverse or reduce such conditions, avoiding pulmonary complications[2].

In Brazil, physical therapists are increasingly present in the Intensive Care Units (ICU). This insertion was initiated in 1970 and its assurance as part of the intensive care team has been progressive. The reflection on this subject could generate guidelines and goals to provide recommendations of therapeutic practices, standardization of the administrative structure, technical and managerial training, definitions of labor relations, health and cost effectiveness, and qualified remuneration, with more efficient results along with the population of critical patients[3].

Physiotherapy in the pre-and postoperative (PO) period is part of the treatment of patients who underwent cardiac surgery. Physiotherapeutic care encompasses a variety of techniques, including breathing pattern exercises, early ambulation, kinesiotherapy, positioning, and stimulus to cough. Respiratory physiotherapy, following the arrival in the ICU, contributes a lot to the proper ventilation and to the success of the extubation[4].

Mechanical ventilation (MV) is a resource used therapeutically in ICU, aiming at the maintenance of gas exchange, replacement of spontaneous breathing, reversal or prevention of respiratory muscle fatigue, decreased oxygen uptake, and application of specific therapies[5]. Recent studies show that 33% to 46% of the patients admitted to these units use MV sometime during the hospitalization[6,7]. Currently, most patients submitted to mechanical ventilatory support can be quickly removed from the ventilator, as soon as the condition responsible for their hospitalization has been treated and/or stabilized[8].

The patients in the postoperative period of cardiac surgery are usually extubated immediately after the anesthesia effect; however, approximately 3 to 6% of them may require prolonged MV, due to the complexity of the cardiovascular pathology, pulmonary dysfunction

or other systemic changes. The amount of material and financial resources used by these patients are high, therefore, strategies to reduce such costs are necessary[9].

In clinical or general ICU units it remains controversial whether full-time physiotherapeutic care is able to reduce the time of mechanical ventilatory support[10,11]. On the other hand, studies showed that a reduction in the time of mechanical ventilation is one of the main clinical benefits of the implementation of the night practice of physiotherapy in ICU, especially in postoperative units[12,13].

The aim of this study was to verify if physical therapists influence the mechanical ventilation process of patients who underwent non-complicated cardiac surgery admitted to the Cardiac ICU overnight.

METHODOLOGY

Documentary and retrospective study developed in a university hospital, after approval by the Research Ethics Committee, under opinion no. 428,632, according to Resolution CNS/MS no. 466/12.

The population of the study consisted of adult patients who underwent cardiac surgery admitted to the Cardiac ICU overnight from November 2010 to October 2011 (with physiotherapeutic care only during the day) and from November 2011 to October 2012 (with physiotherapeutic care 24 hours). This ICU offers 10 beds, with one physical therapist for every 10 beds in both moments of the research.

We included all adult patients submitted to myocardial revascularization surgery and valve replacement (aortic and/or mitral valve) with the use of cardiopulmonary bypass (CPB) in the periods proposed, they were extubated within 12 hours after admission to the ICU. This time is considered, because the need for prolonged mechanical ventilation after cardiac surgery is usually associated with the occurrence of postoperative complications, such as metabolic acidosis or excessive bleeding.

We excluded individuals with lung or neurological disease, the ones who underwent associated or emergency surgeries, and those who died in the perioperative period, before the weaning from the ventilatory support.

The necessary data for the study were taken from the Physiotherapeutic Evolution of the Cardiac ICU Form. In this unit, the physical therapist conducts the mechanical ventilation process, since the hospitalization until the interruption or weaning, which was shared with the medical team.

All patients used the mechanical ventilator Evita 2 dura (Dräger Medical, Lübeck, Germany). They were admitted to the Cardiac ICU according to the protocol established in the volume-controlled mode, with the following parameters: tidal volume between 6 and 8 ml/kg; positive end expiratory pressure (PEEP) of 8 cmH_2O; respiratory rate equal to 14 ipm; inspiratory flow from 8 to 10 times the volume; inspiratory time of 1 second, and inspired oxygen fraction of 40%. In the period in which there were only 12 hours of physiotherapeutic care, the mechanical ventilators were programmed by the physical therapist of the afternoon shift, according to the patients' characteristics, previously passed by the surgical center.

As soon as the patients showed satisfactory clinical conditions, such as hemodynamic stability, absence or minimal bleeding; Glasgow Coma scale $\geq$10, the spontaneous breathing trial was initiated (SBT) according to the routine of the sector, in the pressure-support mode (PS=7cmH_2O, PEEP=5cmH_2O, FiO_2<40%), being conducted the extubation after 30 minutes to 2 hours, as long as the patient did not show any sign of intolerance to SBT.

The collected data were subjected to statistical analysis using the program Stata/SE 11.1 (Statacorp, College Station, Texas, USA). Quantitative data are expressed through mean and standard deviation, and their differences were verified using the Student's t-test. The qualitative variables were expressed in the form of proportions and the association was tested through G or Chi-square test, using the Yates correction. The results were considered statistically significant when $p<0.05$.

RESULTS

Ninety four patients were included in this survey, 51 of the first period, with physiotherapeutic care during the day (Group 12), and 43 of the second, with 24 hours of physiotherapeutic care (Group 24). Table 1 shows the demographic and clinical characteristics, and Table 2 shows the surgical characteristics. The groups were homogeneous regarding these variables, which may suggest that there is no difference in the severity of patients from both periods studied.

Table 1. Demographic and clinical characteristics of patients according to the periods with physiotherapeutic care for 12 and 24 hours

Variables	Group 12 (n=51)	Group 24 (n=43)	TOTAL	P
Sex				0.82[a]
Male	37	33	70 (74.4%)	
Female	14	10	24 (25.6%)	
Age (years)	58.8±10.7	59.3±11.4	59±11	0.80[b]
BMI (kg/m^2)	26.2±4.0	25.8±3.9	26±3.9	0.70[b]
Origin				0.90[a]
Capital	23	19	42 (44.7%)	
Countryside	28	24	52 (55.3%)	
EuroSCORE II (%)	0.86±0.59	0.95±0.69	0.91±0.64	0.46[b]
Medical history				
SH	40	31	71 (75.5%)	0.63[a]
Diabetes mellitus	24	18	42 (44.6%)	0.76[a]
Tabagism	20	12	32 (34%)	0.35[a]
Dyslipidemia	10	8	18 (19.1%)	0.88[a]
AMI	10	8	18 (19.1%)	0.88[a]
CRF	5	3	8 (8.5%)	0.90[c]
Angioplasty	2	2	4 (4.2%)	0.73[c]

BMI – Body Mass Index; ASA – American Society of Anesthesiologists; SH – systemic hypertension; AMI – acute myocardial infarction; CRF – chronic renal failure. [a]Chi-square test; [b]Student's t-test; [c]G test

Table 2. Surgical characteristics of patients according to the periods with physiotherapeutic care for 12 and 24 hours

Variables	Group 12 (n=51)	Group 24 (n=43)	TOTAL	P
Type of surgery				0.60[a]
Myocardial revascularization	42	32	74 (78.8%)	
Mitral valve replacement	4	6	10 (10.6%)	
Aortic valve replacement	5	5	10 (10.6%)	
Duration of CPB (min)	83.3±27.6	82.1±24.4	82.7±26.1	0.82[b]
Duration of anoxia (min)	64.1±27.1	57.8±21	60.3±23.5	0.21[b]
Duration of the surgery (min)	209.5±37.1	205.4±46.3	207.1±41.1	0.40[b]

CPB – cardiopulmonary bypass. aG test; bStudent's t-test

The average time of mechanical ventilation was 7.8±3.5 h, being lower when physiotherapeutic care occurred at night (6.7±3.7 h vs. 8.7±3.1 h, p=0.02) (Figure 1). In this same period, the number of patients extubated in less than six hours was also significantly higher (53.4% vs. 27.4%, p=0.0182), as well as the number of scheduled extubations (79% vs. 43.1%, p=0.009) (Table 3).

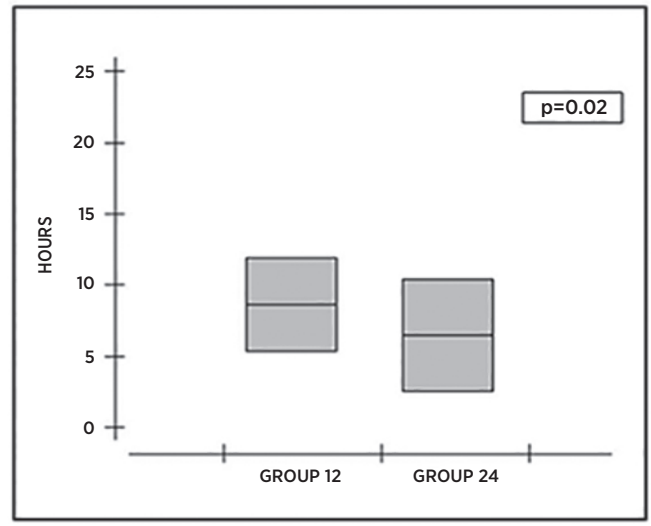

Figure 1. Duration of the mechanical ventilation of patients who underwent cardiac surgery according to the periods with physiotherapeutic care for 12 and 24 hours

Table 3. Number of patients extubated in less than 6 hours and extubations scheduled at night according to the periods with physiotherapeutic care for 12 and 24 hours

Variables	Group 12 (n=51)	Group 24 (n=43)	P
Duration of MV			0.0182
≥6 hours	14 (27.4%)	23 (53.4%)	
>6 hours	37 (72.6%)	20 (46.6%)	
Extubation scheduled at night	22 (43.1%)	34 (79%)	0.0009

MV – mechanical ventilation. Chi-square test

DISCUSSION

This study observed average time of mechanical ventilation of approximately 8 hours and showed that the increase of physiotherapeutic care overnight, for a total of 24 hours, provided significant clinical benefits: reduction in the time of mechanical ventilation and greater number of extubations in less than 6 hours after surgery. These benefits were achieved mainly by the great number of extubations carried out at night.

According to Mendez-Tellez and Needham[14], early rehabilitation interventions for mechanically ventilated patients are safe and viable. These authors cite, as benefits of this practice, the improvement of the functional status and the reduced duration of mechanical ventilation and hospitalization.

In historical controlled trial with 501 patients, Malkoç et al[15] found that the group that received respiratory physiotherapy had a significant reduction in

the time of mechanical ventilation and hospitalization in the ICU when compared with a control group, reinforcing the importance of this professional in the intensive care unit.

Lima[16] evaluated the profile of patients submitted to myocardial revascularization with physiotherapeutic care only during the day (12 hours) and observed average time of mechanical ventilation of 10 hours, a result similar to this research. Ribeiro and Santana[17] studied the same practice and showed high mechanical ventilation time (16 hours) in patients who underwent surgery using cardiopulmonary bypass for more than 90 minutes (an average of 100 minutes), little more than the one verified in this research. Also, the authors consider that the absence of the physical therapist at night lengthens the time of mechanical ventilation, since this professional, along with the medical team, is responsible for the processes of weaning from the ventilatory support and extubation.

In this context, Nunes[18] conducted a study that verified the view of the multidisciplinary team on the participation of the physical therapist in the weaning and extubation processes in the ICU with physiotherapy care for 12 or 24 hours, and found that most (>75%) professionals consider the mechanical ventilatory weaning the responsibility of doctors and physical therapists. The author also noted that the physical therapist has greater autonomy in handling the mechanical ventilation in the 24-hour care when compared with the 12-hour practice. Confirming these findings, Nozawa et al.[3] outlined the profile of physical therapists who work in Brazilian intensive care units and showed that most of them (80%) declared to carry out the procedures of mechanical ventilation weaning and extubation.

International research[19] and national[13,20,21] studies corroborate the findings of this research, indicating the decrease in the time of mechanical ventilation as the main result of the implementation of physiotherapeutic care at night.

Study conducted in Cingapura[19] showed a case of patient admitted to the ICU with physiotherapeutic care (24 hours) due to acute respiratory failure, the individual was subjected to six sessions on the first day and five on the second, which resulted in improved arterial oxygenation with radiographic resolution, being avoided the endotracheal intubation and the invasive mechanical ventilation. For the author the possibility of 24-hour access to physiotherapy reduces the chance of pulmonary complications.

Davidson and Velloso[13] surveyed two hospitals that performed cardiac surgery and showed that the full-time presence of the physical therapist on the team was one of the factors that accelerated the process of mechanical ventilation weaning and the discharge of the patient from the ICU, reinforcing the results of this study.

Castro et al.[20] conducted a bicentric study aiming to assess the differences between a hospital where patients received physiotherapeutic care 24 hour per day and another hospital with only 6 hour per day; the conclusion was that the presence of the physical therapist full time (24 hours) in the intensive care unit contributes to the early recovery of the patient, reducing the length of stay in the mechanical ventilation and hospitalization, as well as the incidence of respiratory infection and mortality, which corroborates the findings of this research.

In similarity to this research, Silva[12] conducted another one in a general postoperative unit comparing the results before and after the implantation of overnight physiotherapy. Although the patients with full-time care were older, had greater number of comorbidities, higher frequency of intraoperative complications, higher incidence of dialytic acute renal failure, and moderate to high-risk of surgery, in comparison with patients with partial care, they showed better clinical outcomes, characterized by shorter time of mechanical ventilation (4 days vs. 6 days) and less time in ICU (10 days vs. 15 days), endorsing this study.

Fernandes and Esbell[21] conducted a retrospective study involving six months before and six months after the implementation of the 24-hour intensive physiotherapeutic care. Data were collected from medical records of adult patients admitted to the ICU of the General Hospital of Roraima and they observed a reduction in the number of deaths and reduced length of stay in the ICU. This study did not examine these variables, which limits the comparison with the outcomes mentioned above.

Teixeira[10] did not observe reduced time of mechanical ventilatory support when the overnight physiotherapy, of 24 hours, was implemented; however, when the patients with neurological diseases were separated, the time of mechanical ventilation was lower. Methodological differences explain this divergence. The author conducted the research in a general clinical-surgical unit

with patients on mechanical ventilation for more than 72 hours, and she also compared the results obtained after 18 hours (three physiotherapeutic sessions) and 24 hours (four physiotherapeutic sessions).

In contrast to this study, Santos et al.[11] also did not verified reduction of time of mechanical ventilation and hospitalization in comparison with the results of both physiotherapy practices in ICU (12 h vs. 24 h), however, the research shows methodological limitations due to the differences involving the classification of the ICU, number of beds, number of exclusive physical therapists, physical therapist/number of beds relation, and epidemiological profile of the patients in both hospitals.

The research described above seems to demonstrate the reduction of time in mechanical ventilation as the main clinical benefit from the implementation of the overnight practice of physiotherapy in ICU. This outcome is particularly achieved in postoperative units, as demonstrated by Silva[12] and Davidson and Velloso[13], as well as by this research. In clinical or general units, however, it remains controversial if full-time physiotherapy (24 hours) is able to reduce the time of mechanical ventilatory support, as shown by Teixeira[10] and Santos et al.[11]

The lack of assessment of secondary outcomes (permanence in the ICU, cardiac and pulmonary complications, mortality, and costs) can be considered a limiting factor of this research.

CONCLUSION

The physiotherapeutic practice influenced the mechanical ventilation process of patients who underwent non-complicated cardiac surgery admitted to the ICU overnight, reducing the time of mechanical ventilation and increasing the number of extubations in less than six hours, as well the number of extubations scheduled during the night.

REFERENCES

1. Vasconcelos Filho PO, Carmona MJC, Auler Júnior JOC. Peculiaridades no pós-operatório de cirurgia cardíaca no paciente idoso. Rev Bras Anestesiol. 2004;54(5):707-27.
2. Renault JA, Costa-Val R, Rossetti MB. Fisioterapia respiratória na disfunção pulmonar pós-cirurgia cardíaca. Rev Bras Cir Cardiovasc. 2008;23(4):562-9.
3. Nozawa E, Sarmento GJV, Vega JM, Costa D, Silva JEP, Feltrim MIZ. Perfil de fisioterapeutas brasileiros que atuam em unidades de terapia intensiva. Fisioter Pesqui. 2008;15(2):177-82.
4. Arcêncio L, Souza MD, Bortolin BS, Fernandes ACM, Rodrigues AJ, Evora PRB. Cuidados pré e pós-operatório em cirurgia cardiotorácica: uma abordagem fisioterapêutica. Rev Bras Cir Cardiovasc. 2008;23(3):400-10.
5. Silveira LTY, Fu C. Modos convencionais de ventilação mecânica. In: Guimarães FS, Martins JA (org.). PROFISIO – Programa de Atualização em Fisioterapia em Terapia Intensiva Adulto. Porto Alegre: Artmed/Panamericana; 2010. p. 125-62.
6. Esteban A, Anzueto A, Alía I, Gordo F, Apezteguía C, Pázilas F et al. How is mechanical ventilation employed in the intensive are unit? An international utilization review. Am J Respir Crit Care Med. 2000;161(5);1450-8.
7. Knebel AR, Janson-Bjerklie SL, Malley JD, Wilson AG, Marini JJ. Comparison of breathing comfort during weaning with two ventilatory modes. Am J Respir Crit Care Med. 1994;149(1):14-8.
8. Piotto RF, Maia LN, Machado MN, Orrico SP. Efeitos da aplicação de protocolo de desmame de ventilação mecânica em unidade coronária: estudo randomizado. Rev Bras Cir Cardiovasc. 2011;26(2):213-21.
9. Nozawa E, Kobayashi E, Matsumoto ME, Feltrim MIZ, Carmona MJC, Auler Júnior JOC. Avaliação de fatores que influenciam no desmame de pacientes em ventilação mecânica prolongada após cirurgia cardíaca. Arq Bras Cardiol. 2003;80(3):301-5.
10. Teixeira VA. A participação da Fisioterapia respiratória intensiva no tempo de ventilação, no tempo de permanência e mortalidade de pacientes internados na unidade de terapia intensiva de um hospital privado. Brasília. Dissertação [Mestrado em Ciências Médicas] – Universidade de Brasília; 2006.
11. Santos AE, Souza GRM, Silva SF. Análise dos resultados de dois serviços de Fisioterapia Respiratória em UTI: comparação do serviço 24 horas com o serviço em tempo parcial. Belo Horizonte. Trabalho de conclusão de curso [Graduação em Fisioterapia] – Universidade Federal de Minas Gerais; 2008.
12. Silva JM. Impacto da assistência fisioterapêutica em unidade de terapia intensiva no tempo de ventilação mecânica, tempo de internação e custos do paciente cirúrgico. São Paulo. Dissertação [Mestrado em Ciências] – Faculdade de Medicina da Universidade de São Paulo; 2012.
13. Davison J, Velloso M. Importância da Fisioterapia pneumofuncional para a retirada de ventilação mecânica dos pacientes submetidos à cirurgia de revascularização do miocárdio; Rev Soc Cardiol Estado de São Paulo. 2003;5(supl A):12-20.
14. Mendez-Tellez PA, Needham DM. Early physical rehabilitation in the ICU and ventilator liberation. Respiratory Care. 2012;57(10):1663-9.
15. Malkoç M, Karadibak D, Yildririm Y. The effect of physiotherapy on ventilatory dependency ant the length of stay in an intensive care unit. Int J Rehabil Res. 2009;32(1):85-8.

16. Lima IM. Perfil epidemiológico dos pacientes submetidos à cirurgia de revascularização do miocárdio com circulação extracorpórea no Hospital do Coração José Murad, entre janeiro de 2009 a janeiro de 2010. São Luís. Trabalho de conclusão de curso [Graduação em Fisioterapia] – Faculdade Santa Terezinha; 2010.
17. Ribeiro JA, Santana RKP. Estudo do tempo de circulação extracorpórea nas complicações pós-cirurgia cardíaca. São Luís. Trabalho de conclusão de curso [Graduação em Fisioterapia] – Faculdade Santa Terezinha; 2009.
18. Nunes MM. A visão da equipe multidisciplinar sobre a participação do fisioterapeuta no processo de desmame e extubação nas unidades de terapia intensiva com serviço de Fisioterapia por 12 ou 24 horas. Brasília. Trabalho de conclusão de curso [Graduação em Fisioterapia] – Centro Universitário de Brasília; 2010.
19. Wong WP. Physical therapy for a patient in acute respiratory failure. Phys Ther. 2000;80:662-70.
20. Castro AAM. Chest physiotherapy effectiveness to reduce hospitalization and mechanical ventilation length of stay, pulmonary infection rate and mortality in ICU patients. Respir med. (2013)107,68-74.
21. Fernandes RA, Esbell RCM. A importância do serviço de Fisioterapia intensiva 24 horas no Hospital Geral de Roraima. Brasília. Dissertação [Mestrado em Terapia Intensiva] – Sociedade Brasileira de Terapia Intensiva; 2012.