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Pre-and postoperative care in cardiothoracic surgery: a physiotherapeutic approach

Cuidados pré e pós-operatórios em cirurgia cardiotorácica: uma abordagem fisioterapêutica

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Abstract

It is well known that anesthesia and certain surgeries predispose patients to changes in respiratory function, pulmonary volumes, and gas exchange. Cardiac surgery, which is considered a major surgery, may trigger respiratory complications in the postoperative period. These complications have various causes, such as heart and lung functions in the pre-operative, the use of cardiopulmonary bypass (CPB), and the level of sedation. In these extensive thoracic procedures, respiratory dysfunction may be significant, persisting in the postoperative period. Physiotherapy is offered to patients in the ICU as part of a multidisciplinary treatment plan. It is a time-consuming treatment, and is possible at various times during the patient's stay in the ICU. However, it is particularly valuable in postoperative recovery in order to avoid respiratory and motor complications. Thus, a literature review was performed, aiming to arrange current and relevant information on available resources for respiratory monitoring, as well as its importance in evaluating and treating lung function impairment, as this complication is a frequent cause of death in surgical patients.

Descriptors: **Thoracic surgery. Cardiac surgical procedures. Physical therapy. Postoperative care.**

Resumo

Sabe-se que a anestesia e determinadas cirurgias predispõem a alterações na mecânica respiratória, volumes pulmonares e trocas gasosas. A cirurgia cardíaca, considerada de grande porte, pode desencadear alterações respiratórias no pós-operatório, sendo estas relacionadas a causas diversas, como funções pulmonar e cardíaca no pré-operatório, utilização de circulação extracorpórea (CEC) e grau de sedação. Nestes procedimentos torácicos extensos, a disfunção respiratória pode ser importante, persistindo no período pós-operatório. A Fisioterapia faz parte do atendimento multidisciplinar oferecido aos pacientes em Unidade de Terapia Intensiva, sendo sua atuação extensa, presente em várias etapas do tratamento intensivo, principalmente na recuperação pós-cirúrgica, com o objetivo de evitar complicações respiratórias e motoras. Sendo assim, realizou-se uma revisão bibliográfica com o objetivo de reunir informações atuais e relevantes sobre recursos disponíveis para a monitorização respiratória, bem como a sua importância para avaliação e atuação diante de alterações na função pulmonar, uma vez que tal complicação é causa freqüente de óbito em pacientes operados.

Descritores: **Cirurgia torácica. Procedimentos cirúrgicos cardíacos. Fisioterapia. Cuidados pós-operatórios.**

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INTRODUCTION

In recent years, advances have increased in the monitoring of gas exchange and mechanical respiratory of patients who have undergone mechanical ventilation (MV). Monitoring these parameters is useful in characterizing the physiopathology of respiratory diseases. It helps decide the appropriate adjustment of ventilation parameters, it reduces the risk of complications caused by mechanical ventilators and it optimizes the patient's experience with this equipment. Such information will also help to determine the best time to discontinue respiratory support [1].

Anesthesia and some surgeries can lead to certain changes in mechanical respiratory assistance, in lung volumes and gas exchange [2]. In cardiothoracic surgery, which is considered a major surgery, many complications can occur, including respiratory complications, which can put the patient in intensive care or on respiratory support for a long time. Particularly in patients who underwent surgery with cardiopulmonary bypass (CPB), inflammatory reactions may be triggered by this procedure, causing deterioration of lung function in the postoperative period [3]. These complications are responsible for extended hospital stays and increased hospital costs [4], and is also an important cause of morbidity and mortality [5-7].

Despite the modernization of the procedures used in cardiac surgery, pulmonary function is still impaired [7]. After surgery, patients are more susceptible to developing respiratory complications. About 65% of patients develop atelectasis and 3% catch pneumonia 3% [4]. For this reason, the physiotherapist has an important role in the treatment of these patients, aiming to prevent or reduce such complications [3]. The job of this professional starts when he begins weaning the patient off of the ventilator, as described in some studies [8,9] and finishes with the patient under spontaneous ventilation after extubation [10].

The motivation of this study arose from the experience of the authors in the postoperative unit of cardiothoracic surgery of the Clinics Hospital of Ribeirão Preto - FMRP (Ribeirao Preto Medical School). Here, physiotherapeutic procedures occur at all steps of the patient's recovery due to the hospital's integration of a multidisciplinary team. Although there are few studies in the literature related to the physiotherapy approach in pulmonary complications, such studies show divergent outcomes. Facing the considerable rate of occurrence of postoperative complications in cardiac surgery and the importance of physiotherapy in prevention and treatment of such complications, the literature review presented herein was performed in order to survey the relevant information about this subject.

For acquisition data in this study, scientific articles and an electronic research strategy was used for bibliographic reviews, mainly aiming to identify studies and guidelines that relate to physiotherapeutic performance and cardiothoracic surgery. The study was carried out based on articles that were published in the last 20 years, were available in the MEDLINE database, and used the terms "Physiotherapy", "cardiac surgery", "respiratory monitoring" and/or "respiratory complications". Relevant studies from Brazilian authors were also considered, particularly those published by the Brazilian Journal of Cardiovascular Surgery and the Brazilian Archives of Cardiology (official journals of dissemination of Brazilian cardiology) if the articles contained the key words "physiotherapy" and "monitoring". In addition to this research, additional data from postgraduate studies was found at the Division of Thoracic and Cardiovascular Surgery, FMRP-USP.

The findings included randomized clinical trials, meta-analysis, review articles and consensus guidelines, and were related to physiotherapy, respiratory monitoring, and cardiac surgery and its complications. As the diagram of Figure 1 shows, 623 potentially relevant publications in MEDLINE were found, of which 55 fulfilled all of the scientific criteria.

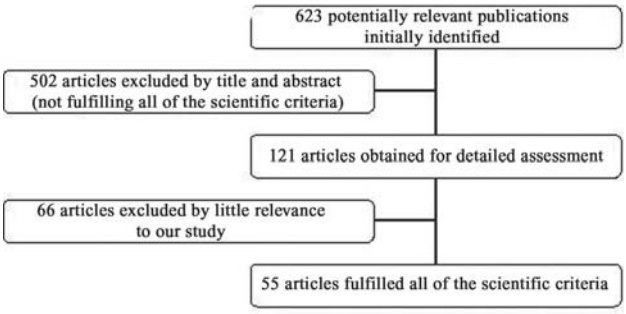

Fig. 1 – Scheme of the strategy for selection of publications found with the use of search engine

CHANGES RESULTING FROM HEART SURGERY

Postoperative respiratory changes may be related to previous heart and lung function, the use of CPB, the degree of sedation [11], the intensity of the surgery, and the number of pleural drains [12]. Events during surgery are most commonly responsible for changing respiratory mechanics in the immediate postoperative period [5.13].

General anesthesia seems to reduce functional residual capacity (FRC) in about 20%, and cardiopulmonary bypass impairs gas exchange. Also, the patients - whose mammary arteries are dissected - present a higher risk of leakage into the pleura with subsequent pulmonary complications [3].

The blood's passage through an artificial circuit in CPB exposes the body to a number of important changes, such as a change in blood flow, a possible increase in body temperature and mechanical stress over the figurative elements of the blood due to its contact with nonendothelial surfaces, filters, compression and turbulence, among other elements. This process may trigger a cascade of inflammatory reactions with postoperative consequences. These reactions always occur to a certain extent, and are more evident and harmful in the elderly and newborns. The reactions may present as a fever and may even cause death [14].

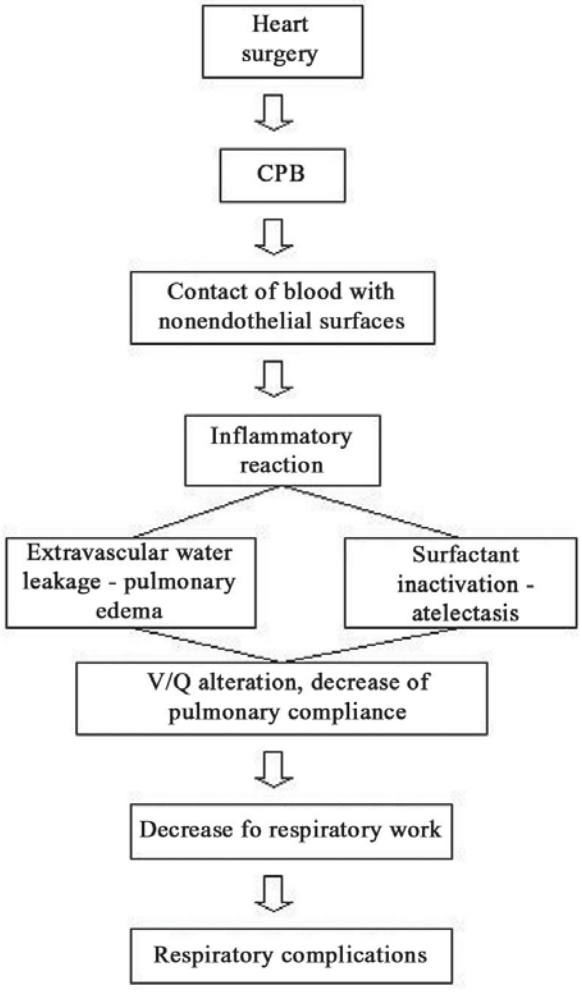

Fig. 2 – Changes caused by cardiopulmonary bypass

Respiratory complications (Figure 2) after coronary artery bypass grafting (CABG) are associated with the incision (sternotomy) and the presence of pleural drains. These drains reduce residual volume (RV), total lung capacity (TLC), vital capacity and FRC, leading to the formation of atelectasis, with alterations in the ventilation-perfusion ratio (V/Q), the partial pressure of carbon dioxide in arterial blood ($PaCO_2$) and partial pressure of oxygen in arterial blood (PaO2) [5]. An increase in extravascular water leakage caused by inflammatory cells occurs in the lungs, and occurs with alveolar filling, leading to surfactant inactivation and the collapse of some regions, changing the V/Q ratio and the PaO_2 and $PaCO_2$ values and decreasing in SaO_2 - with considerable increase in respiratory work in the postoperative period [7.10]. Exposure to hypothermia during CPB also adversely affects lung function, impairing pulmonary endothelium [15].

The severity of a pulmonary lesion associated with CPB depends on the duration of surgery and the patient's age, especially in cases of younger children [15]. Patients who have undergone surgery without use of CPB show better preservation of pulmonary function and a shorter time of tracheal intubation when compared to those operated with CPB [16]. One of the causes of extended MV time is related to prolonged cardiopulmonary bypass. Akdur et al. [17] observed that, among the patients who underwent cardiac surgery with obstructive and restrictive respiratory alterations, those who remained intubated for more than 24 hours needed for a longer period of hospital stay and recovery when compared to patients who had MV interrupted within 24 hours.

It was difficult to determine the rate of pulmonary complications in the literature because the authors often separated the complications based on clinical or even radiological significance of the disease [18]. Feltrin et al. [19] proposed a scale with four levels of severity: Level 1: dry cough, microatelectasis and dyspnea; Level 2: productive cough, bronchospasm, hypoxemia, atelectasis and hypercapnia; Level 3 - pleural effusion, pneumonia, pneumothorax and reintubation; and Level 4 – ventilatory insufficiency. All these factors will determine the need for ventilatory support for an indefinite period, with varying degrees of sophistication.

PHYSIOTHERAPEUTIC APPROACH AND RESPIRATORY MONITORING IN THE HEART SURGERY PROCESS

The role of physiotherapy in heart surgery

Historically, respiratory physiotherapy has been used prophylactically in patients who have undergone heart

surgery in order to reduce the risk of pulmonary complications, such as retention of pulmonary secretions, pneumonia and atelectasis [3]. The pre- and postoperative physiotherapy is part of the treatment for these patients, especially in subpopulations with a higher risk of developing cardiorespiratory postoperative complications [20]. Our practice includes several techniques, and the most commonly employed ones in the immediate postoperative period include ventilatory pattern exercises (deep breathing), early ambulation, kinesiotherapy, positioning, and cough stimulation [3].

After the patient's arrival in the ICU, respiratory physiotherapy contributes greatly to the success of appropriate ventilation and extubation [11].

Below are the stages of physiotherapy performance in cardiac surgery.

The preoperative

More attention to the patient in the preoperative period can lead to a faster postoperative recovery [18]. Patients should be informed about the surgery and the immediate postoperative period, and should receive information about the importance of respiratory exercises and the early ambulation that will be performed [16]. Information such as the previous history of the patient, presence of chronic obstructive pulmonary disease (COPD), smoking, obesity and age are important, because the best recovery of pulmonary function depends on the appropriate preoperative evaluation to determine surgical risk [5]. Important risk factors for cardiac surgery include: demographic characteristics and comorbidities of the patients: age > 70 years, cough and expectoration, diabetes mellitus, smoking, chronic obstructive pulmonary disease, Body Mass Index (BMI) > 27 and pulmonary function (FEV1 <75% and FEV1/FVC <70% (FEV1 is the forced expiratory volume at 1 second and FVC is the forced vital capacity) [6].

Several studies prove that performing preoperative physiotherapy is more effective in reducing respiratory complications in patients with moderate or higher risk than those whose risk was low. Intervention through intensive inspiratory muscle training by device with linear load (based on 30% of maximal inspiratory pressure, with progressive increases in high-risk patients for elective CABG surgery) can reduce the risk of pulmonary complications level ≥ 2 (level cited in the study of FELTRIM et al. [19]), because it improves the strength and endurance of respiratory muscles.

Patient admission at postoperative intensive care unit

At the end of surgery, the patients are transferred from manual ventilation to a postoperative unit where the MV is installed. Recovery from anesthesia allows the patient to reassume spontaneous respiration. During MV, doctors recommend the use of tidal volume of 8 to 10 mL/kg in volume controlled mode or peak/plateau inspiratory pressure sufficient to maintain the same volume in the controlled pressure mode [9] and, as used in Ambrozin and Cataneo study [13], with a PEEP (Positive End-Expiratory Pressure) of 5cm H_2O and inspired oxygen fraction (FiO2) of 100%. Protective ventilation ("physiological" tidal volume and PEEP) can also be used during general anesthesia and in the postoperative. As assessed in some studies, we observed that, when such ventilation is used, the inflammatory response during heart surgery can decrease, improving the lung function and resulting in an earlier extubation [21].

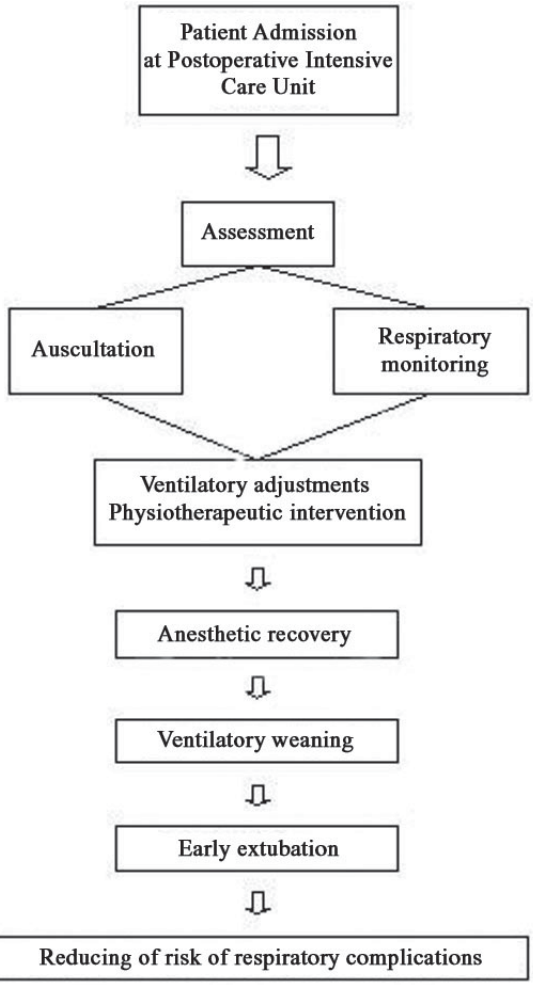

Fig. 3 - Admission and evolution of the patient in the postoperative period of heart surgery

During this period of MV, the FiO2, flow, respiratory rate, tidal volume, inspiratory pressure, final positive pressure, inspiratory and expiratory time should be monitored, in addition to pulse oximetry. Evaluation of chest expansion and symmetry of the vesicular murmur are performed during the lung auscultation. Some adjustments of ventilatory parameters can be performed using the arterial gasometry values. The FiO_2 should be enough to maintain a PaO_2 between 80 and 90 mmHg and a SaO_2 above 90% [11]. From this assessment and monitoring analysis, it is easier to decide whether there is a need for physiotherapeutic intervention during ventilatory weaning (always taking into account the patient's hemodynamic stability).

After complete hemodynamic stabilization, the ideal step is extubation, performed after appropriate clinical and laboratory evaluation, with the patient being well- monitored [11]. The criteria for extubation are: respiratory rate <25 ipm, PaO_2/FiO_2 >200; $PaCO_2$ between 35 and 45 mmHg, maximum inspiratory pressure > 25cmH_2O, spontaneous breathing, presence of airway protective reflexes, obedience of simple verbal commands, peripheral O_2 saturation (SpO_2) > 90% with FIO_2 = 0. 21, tidal volume >7ml/kg, vital capacity >10mL/kg and index and RR/Tv <80. Before doctors proceed with extubation, the patient's bed should be high and at an angle between 30º and 45º. It is recommended that the patient's airway is aspirated before extubation [9]. Figure 3 shows the process of patient's evolution from his admission to his stay in the Postoperative intensive care unit.

Patients on Long-Term MV

Due to complications caused by use of CPB or surgical manipulation, some patients need prolonged ventilatory support. The MV can lead to pulmonary lesions that can be instigated by four specific mechanisms: excessive local cell and/or tissue distension caused by unusual pressure and force during normal breathing; end-expiratory lung volume, and can cause recruitment and repeated collapse of unstable alveolar units, deactivation of pulmonary surfactant by oscillations caused by stress, and increase of high interdependence between cells and tissues with different mechanical properties [21]. Pneumonia and atelectasis are also respiratory complications associated with dependence on mechanical ventilatory assistance [10]. For these reasons, those patients who remain intubated for a long period in postoperative cardiac surgery with impaired lung function should undergo long and intense physiotherapy [17].

In cases of severe pulmonary impairment and low SaO_2, PEEP can be increased in order to improve oxygenation, with no need for increases in inspiratory pressure and tidal volume (which are more aggressive to the lung) [11]. Airway loss can be reduced through the use of low tidal volumes and application of an appropriate PEEP [21]. The PEEP should not exceed 12 to 15 mmHg and should not be used when there is low cardiac output [11] because of the possibility of hemodynamic instability. When PEEP values of 10 and 15 cmH_2O are used, there are significant changes in lung compliance due to supplementary alveolar recruitment. Improvements in the oxygen index can be observed with the use of this technique.

Techniques for positioning, manual hyperinflation, vibration in the chest wall and endotracheal aspiration have been used for the removal of bronchial secretions and improvement of the V/Q after heart surgery [22]. It is recommended for conducting active exercises in patients on MV (capable of performing such exercises) in the cases without contraindications, aiming to reduce the sensation of dyspnea, to increase exercise tolerance, to reduce rigidity and muscle pain, and to preserve the joint range-of-motion [9]. Periodic changing decubitus have proven effective at preventing airway loss [21].

Rosa et al. [23] pointed out that, after the implementation of a service protocol (manual chest compression during expiration, manual hyperinflation, instillation of saline solution and tracheal aspiration), the SpO_2 values remained above the base value for up to two hours. After calculating several variables, a significant reduction in airway resistance after Bronchial Hygiene Therapy was observed when compared to the control group (in which only tracheal aspiration was performed).

Dependence on ventilatory support is directly related to the incidence of morbidity and the increased stay in the intensive care units, resulting an increased time of hospital stay. The incidence of pulmonary complications and time of hospital stay can be reduced with a faster weaning and if the patient is taken off of the mechanical ventilator as early as possible; which usually compromises more than 40% of the total time of MV. Once the patients show a satisfactory spontaneous respiration (that is, they are able to support respiration with an effective gas exchange), these processes should be started. In this moment of transition between MV and spontaneous respiration, many respiratory disorders develop, and are worsened by restrictive factors such as sedation, localized pains and presence of thoracic and abdominal drains [10].

The weaning from MV (transition from artificial ventilation to spontaneous respiration) can be performed using a pressure support ventilation (PSV) or synchronized intermittent mandatory ventilation (SIMV). The test for spontaneous breathing should be performed daily on qualified patients by the ICU physiotherapist, following the Unit's multidisciplinary protocol [9].

Still, to interrupt MV or weaning, a test of spontaneous breathing or pregressive disconnection can be permormed. In the first choice, the patient is placed on spontaneous

breathing without assistance (T tube) or with minimal ventilatory support through continuous positive pressure in the airway (CPAP), or also under a low-pressure support ventilation. The second choice is a more gradual process in which the ventilation working for the patient is progressively decreased. These techniques were validated in two randomized clinical trials, and it was noted that approximately 75% of patients passed the spontaneous breathing test. Most patients recovering from acute respiratory failure pass the spontaneous breathing test, but when the progressive interruption of MV is necessary, the time for weaning is considerable, reaching approximately 40% of the total period on MV, and up to 60% for patients with chronic obstructive pulmonary disease [8].

Costa et al. [8] compared the weaning for patients with and without heart disease using pressure support ventilation and T Tube and concluded that pressure support ventilation improved oxygenation and respiratory functional parameters, proven by the decrease in respiratory rate for at least the first 15 minutes and an increase in the tidal and minute volume. In intergroup comparison between patients with and without heart disease, significantly lower heart rate values were found in the patients with heart disease within 30 minutes in which they remained on pressure support when compared to T tube, probably due to the use of specific drugs such as propranolol, Digoxin, captopril, isosorbide and amiodarone. However, there was a higher incidence of electrocardiographic changes in the ST segment and there was a greater tendency for arrhythmias to occur in the group of patients with heart diseases. But among the patients without heart disease, there was no tendency for a higher incidence of tachycardia.

Physiotherapeutic approach after extubation

After extubation, an important step of physiotherapeutic care is started, essentially aiming to maintain spontaneous respiration in the patient, avoiding a return to ventilatory prosthesis [10].

Some of the resources used in the respiratory physiotherapy are: maneuvers of Bronchial Hygiene Therapy and lung expansion, CPAP, BiPAP (two levels of pressure in the airway), EPAP (Expiratory Positive Airway Pressure), IPPB (Intermittent Positive Pressure Breathing), and the use of an Incentive Spirometer (IS). Such resources are safe and easy to use in the postoperative period [5].

Breathing exercises increase coordination and efficiency of respiratory muscles and mobilize the chest. Such exercises are actively performed with guidance and assistance of the physiotherapist [12]. Deep breathing exercises with at least five consecutive breaths for five to six seconds are effective in the treatment and prevention of refractory atelectasis, improving vital capacity and lung compliance. Moreover, these exercises improve the tidal volume and favor the removal of secretions [3].

With the use of anesthetics, narcotic drugs and interruption of ventilation during on-pump surgery associated with pain, there is decrease of the ciliary function, limitation in inspiratory effort and impairing in the effectiveness of cough reflex, favoring the accumulation of pulmonary secretion [24]. The cough stimulation has been used as a Bronchial Hygiene Therapy for the removal of bronchial secretions in patients in the postoperative period of cardiac surgery [6-7]. Inhalation of hypertonic saline solution with NaCl at 6% associated with respiratory conventional physiotherapy proves to be effective in mucociliar clearance, inducing a productive cough [24].

The physiotherapy intervention in cardiac rehabilitation is routinely used in patients who have undergone cardiac surgery. The application of deep breathing exercises, cough stimulation, chest vibration maneuvers and CPAP may avoid deterioration of lung function and may reduce the incidence of pulmonary complications [7].

Collateral ventilation is important for the normal lung function, and the authors of this study would like to mention that the application of PEEP may promote a more homogeneous distribution of pulmonary ventilation through the interbronchial collateral channels, avoiding collapse during expiration. In this way, physiotherapy intervention associated with application of PEEP through a mask in a pressurized circuit can be effective in minimizing postoperative complications. PEEP assists in the removal of secretions to the main bronchi, favoring the expectoration of such secretions. A lower incidence of complications was observed in a group of patients in which the physiotherapy intervention was associated with application of PEEP. However, lung volumes are not fully reestablished until the 5th postoperative day, suggesting the need for continued treatment after a period of hospital stay. Still, there are studies showing that the prophylactic application of PEEP showed no benefit when compared to the physiotherapeutic approach without PEEP in patients who underwent thoracic surgery [7].

Romanini et al. [5] compared the use of IPPB and an IS in patients after coronary artery bypass grafting, and concluded that there is a functional difference betweeen IPPB and IS. IPPB is a technique for lung expansion in which a device injects pressurized air into the patient's airways. An IS is a device breathing exercises that provides a visual stimulus of the inspired volume during each active breath, improving breathing capacity. For a more rapid reversal of hypoxia, IPPB was more efficient compared to IS. However, an IS seems to be more effective in improving respiratory muscle strength. Thomas and McIntosh [25] carried out a meta-analysis to analyze conflicting publications on the effectiveness of an IS, IPPB and deep

breathing exercises in the prevention of postoperative pulmonary complications in patients who underwent upper abdominal operation. They concluded that deep breathing exercises and the use of an IS are most effective when compared to groups of patients who have not received any treatment. This significant heterogeneity among the studies can be attributed to poor methodology and different types of treatment used in the analyzed studies.

According to Agostini et al. [26], an IS after thoracic surgery is relatively beneficial for verifying lung function and evaluating its improvement after surgery. Physiotherapy with or without the use of an incentive spirometer reduces the incidence of postoperative complications and improves lung function, but there is currently no evidence that the use of a spirometer alone can replace the role of the physiotherapist. Professionals should be alert to the fact that, although the spirometer provides information on the recovering lung, conventional physiotherapy remains as the most effective treatment in the patient's recovery and in the prevention of postoperative complications.

Several studies have proven the effectiveness of non-invasive ventilation (NIV) in the treatment of weaning and maintenance of spontaneous respiration. The use of this procedure promotes the decrease of ventilation work, the decrease of dyspnea index and an increase in residual volume, therefore avoiding the presence of atelectasis and favoring the alveolar recruitment, and also increasing PaO_2 [10].

In the late postoperative period after cardiac surgery, carrying out exercises in patients with valve disease can improve their tolerance of exercise, as well as their quality of life, although there are no significant alterations in lung function [27].

Table 1 shows some respiratory complications resulting from surgery and some suggestions for possible physiotherapeutic interventions evaluated in some studies.

Table 1. Ventilatory changes caused by heart surgery and intervention

Change	Cause	Consequence	Intervention
Limitation of expiratory flow	Decrease of FRC and lung elastic retraction [56]	Decrease of patient's oxygenation [56]	Fio_2 decrease or adjustments of ventilatory parameters [56]
Decrese of lung compliance	Increase of extravascular water [20] and inflammatory response [41]	Alterations in the ventilation-perfusion ratio (V/Q) [20]	Alveolar recruitment with application of PEEP [41]
	Decrease or absence of blood flow through the lungs and pleural space during surgery [57]	Intrapulmonary shunt, increased alveolar-capillary oxygen difference [57]	Using of CPAP during CPB [57]
Atelectasis	Parenchymal compression by intra and extrathoracic processes, increase of superficial tension on alveolus and/or bronchiole and airway obstruction [32]	Decrese of residual volume, vital capacity, functional residual capacity and total pulmonary capacity [52]	Using of hypertonic saline solution with NaCl at 6% for improvement of mucociliar clearance [52]
Increase of airway strength	Pulmonary wall edema, presence of secretions and fluids, loss of pulmonary volume [38]	Intrapulmonary shunt, V/Q alteration, hypoxemia [38]	Increase of PEEP value [38]

PHISIOTERAPY IN THE GRADUATE DEPARTMENT OF THORACIC AND CARDIOVASCULAR SURGERY AT THE RIBEIRÃO PRETO MEDICAL SCHOOL - USP

Utilizing experience acquired during more than 10 years of training, the services of newly trained residents in physiotherapy, and the growing interest of these professionals in participating in postgraduate programs, the Surgery and Anatomy Department of this university created a research line in its discipline. This experiment has been very productive, adding physiotherapists to the schedule for patients who have undergone cardiothoracic surgeries. Although the latter part of this review will question the real importance of physiotherapy, observing daily evolution and the improving care for patients are clearly significant. Although it is difficult to prove such results, it does not mean that physiotherapy does not have real value.

Out of the developed projects, three of them (already completed) are related to the preoperative period. The first study evaluated the effect of a preoperative program of rehabilitation of inspiratory muscles in the hospital evolution of patients who underwent cardiac surgeries. In this study, 30 volunteer patients of both genders at at least 50 years of age and candidates for CABG and/or heart valve surgery were randomly allocated into two groups. In one group, 15 patients underwent training of inspiraotry muscles over a period of at least 2 weeks using the inspiratory muscle trainer "Threshold® IMT" (Respironics, Cedar Grove, NJ, USA), with load of 40% of maximal inspiratory pressure (MIP). The other 15 patients received only general guidelines, without objective training of the respiratory muscles.

The spirometric values were compared before and after training within each group. We compared the evolution of MIP, the maximal expiratory pressure (MEP) and arterial gasometry in both groups before and after training, as well as its temporal evolution in the postoperative period. Clinical evolution was also compared in both groups. It was noted that the training caused significant decrease of forced vital capacity (FVC) and of maximum voluntary ventilation (MVV), and also reduced the relationship between the forced expiratory volume in one second (FEV1) with the FVC. However, there was no difference in the evolution of gasometry and MIP, MEP or clinical evolution between both groups. It was concluded that at-home inspiratory muscle training is feasible and safe, and results in an improvement in forced vital capacity and maximal voluntary ventilation, altough the clinical benefit was not evident in the group of studied patients [28].

The second study focused on the prior knowledge of risk factors when determining the need for prolonged invasive mechanical ventilation, aiming to provide an opportunity for prophylactic measures and better management of available resources. Thus, the purposes of this study were: 1) evaluate the rates and causes of invasive mechanical ventilation for more than 48 hours (PMV) in the postoperative period after on-pump heart surgery and 2) identify the pre and intraoperative risk factors when there is a need for prolonged invasive mechanical ventilation (>48 hours). Clinical data from 501 adult patients who underwent on-pump heart surgery in the period from January 10, 2002 to December 31, 2005 were retrospectively analyzed.

A rate of 10.8% (54 patients) of prolonged invasive mechanical ventilation (PMV) was found in the postoperative period. The respiratory complications were the primary reason for the need for PMV (48.7%), followed by hemodynamic instability (22.2%) and neurological complications (14.8%). Isolated factors associated with the need for prolonged invasive mechanical ventilation in the postoperative period were: age over 60 years, III/IV NYHA functional class, endocarditis, heavy smoking habits, critical medical condition in the preoperative, COPD, duration of CPB> 120 minutes, emergency (non-elective) surgery, and coronary artery bypass grafting associated with heart valve surgery. However, the analysis of multiple variables by means of logistic regression provided a model in which only the age over 60 years, the critical preoperative condition, the COPD, III/IV NYHA functional class and the time of CPB over 120 minutes were included. The incidence and causes of prolonged invasive mechanical ventilation in the postoperative, as well as the pre- and intraoperative risk factors for the occurrence of such a procedure, were similar to those reported in the literature by other authors. Many of these risk factors are suitable for treatment and/or indicative of the need for planning of a more timely operative strategy [29].

The third study aimed to evaluate the conditions of the respiratory muscles and pulmonary ventilation by the evaluation of manovacuometer and ventilometric parameters, as well as to verify whether these parameters have predictive value for respiratory complications. The study involved 226 patients who have undergone CABG or heart valve surgery. The analysis of multiple variables by logistic regression showed that age, COPD, pulmonary artery pressure (greater or equal to 50 mmHg) ejection fraction lower than 0.40 and MIP and MEP (both with values less than 70% of the predicted for age and gender) were predictors of pulmonary complications in the postoperative period. The MIP and MEP values - both lower than 70% of the predicted values - may be considered a useful risk factor in assisting the physiotherapist in the stratification of surgical risk [30].

CONTRADICTORY EVIDENCE ON THE REAL USEFULNESS OF RESPIRATORY PHYSIOTHERAPY IN PREVENTION OF RESPIRATORY COMPLICATIONS AFTER HEART SURGERY

Studies carried out in Australia (Patman et al. [22]) showed no difference among patients who have or not undergone physiotherapeutic treatment in relation to the time of intubation, ICU stay and hospital stay. The same occurred with the values of spirometry and respiratory complications. It was concluded that the provision of physiotherapy during the period of post-intubation does not provide additional benefits for the postoperative evolution of patients who have undergone heart surgery. The authors conclude that performing more studies to investigate risk factors for the development of pulmonary complications after heart surgery is necessary to appropriately allow the physiotherapist to appropriately guide his efforts and resources.

In order to verify whether respiratory physiotherapy helps to prevent pulmonary complications after heart surgery, Pasquina et al. [4] performed a meta-analysis using the following databases: Medline, Embase, CINAHL, and the Cochrane Library. Based on data from 18 trials (1457 patients), they concluded that no physiotherapeutic intervention showed superiority in the adopted parameters. Thus, for these authors, the usefulness of respiratory physiotherapy for the prevention of respiratory complications after heart surgery remains thus far unproven. Moreover, if the benefits are not significant, a cost-benefit analysis can be difficult, since the physiotherapy adds costs for patients who have undergone heart surgery.

Although the relevance of routine physiotherapy is questioned in patients undergoing non-complicated heart surgery, there is no doubt of its value in non-cardiac thoracic surgeries, in which the role of a physiotherapist becomes crucial. In another meta-analysis using the same database of the aforementioned study, we observed that the incentive inspirometry is a good method for the improvement and evaluation of lung function in postoperative thoracic surgeries. The use of incentive inspirometry alone does not replace the role of a physiotherapist and well-organized and consistent physiotherapy.

As mentioned above, the current range of techniques to be used in postoperative heart surgery is wide. However, there are controversies over the effectiveness of these procedures in reducing the incidence of respiratory complications, and also over the most appropriate strategy to identify which patients would benefit from such interventions [6]. Therefore, it knowledge of the physiopathology and mechanisms that involve the postoperative pulmonary dysfunctions are necessary to define the therapy to be used [5]. A correct reading of these data provides a better approach to treat and care for patients in the postoperative period after heart surgery.

The authors report that the evidence of the benefits of prophylactic physiotherapy for avoiding complications is rare. Studies show many different conclusions and, furthermore, the resources used vary widely in each trial. Prophylactic therapy is commonly used, and is believed to reduce the risk of pulmonary complications such as pneumonia and atelectasis. Evidence on the benefits of prophylactic physiotherapy after cardiac surgery is rare [4].

CONCLUSIONS

1. Meta-analysis presented in the literature suggest that, in patients undergoing heart surgery without complications, the use of physiotherapy during the period of post-intubation does not bring additional benefits to the postoperative evolution of patients undergoing cardiac surgery.

2. The usefulness of respiratory physiotherapy for the prevention of respiratory complications after cardiac surgery remains unproven so far. Moreover, if the benefits are not real, a cost-benefit analysis is difficult, since the physiotherapy adds costs for patients who have undergone heart surgery.

3. Although the relevance of routine physiotherapy is questioned in patients who have undergone non-complicated cardiac surgery, its value is clear in non-cardiac thoracic surgeries, in which the role of the physiotherapist becomes crucial.

In the opinion of the authors of this review, the conclusions listed above does not confirm the daily practice of physiotherapy care for patients who have undergone cardiothoracic surgery, which can be criticized for its cost-benefit status. Studies that select patients with risk factors are needed for comparison to patients with lower risk factors. The main factors are primarily respiratory factors, since the benefits of physiotherapeutic care in patients who have undergone non-cardiac thoracic surgeries (especially lung surgeries) are well-established.

Another possible bias to be considered: the role of physiotherapist within the multidisciplinary team (doctors and nurses) of major practices. There is an international unanimity about the high value of this position, regardless of results of meta-analysis. This special position in large practices clearly improves the performance of doctors and nurses in the prevention of postoperative complications in patients who have undergone heart surgery.

REFERENCES

1. Jubran A. Advances in respiratory monitoring during mechanical ventilation. Chest. 1999;116(5):1416-25.

2. Fernandes CR, Ruiz Neto PP. O sistema respiratório e o idoso: implicações anestésicas. Rev Bras Anestesiol. 2002;52(4):461-70.

3. Brasher PA, McClelland KH, Denehy L, Story I. Does removal of deep breathing exercises from a physiotherapy program including pre-operative education and early mobilisation after cardiac surgery alter patient outcomes? Aust J Physiother. 2003;49(3):165-73.

4. Pasquina P, Tramèr MR, Walder B. Prophylactic respiratory physiotherapy after cardiac surgery: systematic review. BMJ. 2003;327(7428):1349.

5. Romanini W, Muller AP, Carvalho KA, Olandoski M, Faria-Neto JR, Mendes FL, et al. The effects of intermittent positive pressure and incentive spirometry in the postoperative of myocardial revascularization. Arq Bras Cardiol. 2007;89(2):94-9.

6. Hulzebos EH, Van Meeteren NL, De Bie RA, Dagnelie PC, Helders PJ. Prediction of postoperative pulmonary complications on the basis of preoperative risk factors in patients who had undergone coronary artery bypass graft surgery. Phys Ther. 2003;83(1):8-16.

7. Borghi-Silva A, Mendes RG, Costa FS, Di Lorenzo VA, Oliveira CR, Luzzi S. The influences of positive end expiratory pressure (PEEP) associated with physiotherapy intervention in phase I cardiac rehabilitation. Clinics. 2005;60(6):465-72.

8. Costa AD, Rieder MM, Vieira SR. Desmame da ventilação mecânica utilizando pressão de suporte ou tubo T. Comparação entre pacientes cardiopatas e não cardiopatas. Arq Bras Cardiol. 2005;85(1):32-8.

9. Consenso Brasileiro de Ventilação Mecânica (III). J Bras Pneumol. 2007;33:(Supl. 2):S137-41.

10. Müller AP, Olandoski M, Macedo R, Costantini C, Guarita-Souza LC. Estudo comparativo entre a pressão positiva intermitente (Reanimador de Müller) e contínua no pós-operatório de cirurgia de revascularização do miocárdio. Arq Bras Cardiol. 2006;86(3):232-9.

11. João PRD, Faria Júnior F. Cuidados imediatos no pós-operatório de cirurgia cardíaca. J Pediatr. 2003;79(Supl. 2):S213-22.

12. Consenso Brasileiro de Ventilação Mecânica (II). J Pneumol. 2000;26(Supl 2):1-68.

13. Ambrozin ARP, Cataneo AJM. Aspectos da função pulmonar após revascularização do miocárdio relacionados com risco pré-operatório. Rev Bras Cir Cardiovasc. 2005;20(4):408-15.

14. Moura HV, Pomerantzeff PMA, Gomes WJ. Síndrome da resposta inflamatória sistêmica na circulação extracorpórea: papel das interleucinas. Rev Bras Cir Cardiovasc. 2001;16(4):376-87.

15. Stayer SA, Diaz LK, East DL, Gouvion JN, Vencill TL, McKenzie ED, et al. Changes in respiratory mechanics among infants undergoing heart surgery. Anesth Analg. 2004;98(1):49-55.

16. Guizilini S, Gomes WJ, Faresin SM, Bolzan DW, Alves FA, Catani R, et al. Avaliação da função pulmonar em pacientes submetidos à cirurgia de revascularização do miocárdio com e sem circulação extracorpórea. Rev Bras Cir Cardiovasc. 2005;20(3):310-6.

17. Akdur H, Polat MG, Yigit Z, Arabaci U, Ozyilmaz S, Gürses HN. Effects of long intubation period on respiratory functions following open heart surgery. Jpn Heart J. 2002;43(5):523-30.

18. Leguisamo CP, Kalil RAK, Furlani AP. Efetividade de uma proposta fisioterapêutica pré-operatória para cirurgia de revascularização do miocárdio. Rev Bras Cir Cardiovasc. 2005;20(2):134-41.

19. Feltrim MIZ, Jatene FB, Bernardo WM. Medicina baseada em evidências: em pacientes de alto risco, submetidos a revascularização do miocárdio, a fisioterapia respiratória pré-operatória previne as complicações pulmonares? Rev Assoc Med Bras. 2007;53(1):8-9.

20. Brooks D, Parsons J, Newton J, Dear C, Silaj E, Sinclair L, et al. Discharge criteria from perioperative physical therapy. Chest. 2002;121(2):488-94.

21. Pelosi P, Rocco PR. Airway closure: the silent killer of peripheral airways. Crit Care. 2007;11(1):114.

22. Patman S, Sanderson D, Blackmore M. Physiotherapy following cardiac surgery: is it necessary during the intubation period? Aust J Physiother. 2001;47(1):7-16.

23. Rosa FK, Roese CA, Savi A, Dias AS, Monteiro MB. Comportamento da mecânica pulmonar após aplicação de protocolo de fisioterapia respiratória e aspiração traqueal em pacientes com ventilação mecânica invasiva. Rev Bras Ter Intensiva. 2007;19(2):170-5.

24. Silva NLS, Piotto RF, Barboza MAI, Croti UA, Braile DM. Inalação de solução salina hipertônica como coadjuvante da fisioterapia respiratória para reversão de atelectasia no pós-operatório de cirurgia cardíaca pediátrica. Rev Bras Cir Cardiovasc. 2006;21(4):468-71.

25. Thomas JA, McIntosh JM. Are incentive spirometry, intermittent positive pressure breathing, and deep breathing exercises effective in the prevention of postoperative pulmonary complications after upper abdominal surgery? A

systematic overview and meta-analysis. Phys Ther. 1994;74(1):3-16.

26. Agostini P, Calvert R, Subramanian H, Naidu B. Is incentive spirometry effective following thoracic surgery? Interac Cardiovasc Thorac Surg. 2008;7(2):297-300.

27. Ueshima K, Kamata J, Kobayashi N, Saito M, Sato S, Kawazoe K, et al. Effects of exercise training after open heart surgery on quality of life and exercise tolerance in patients with mitral regurgitation or aortic regurgitation. Jpn Heart J. 2004;45(5):789-97.

28. Ferreira PEG. Efeito de um programa pré-operatório de reabilitação da musculatura inspiratória na evolução hospitalar de pacientes submetidos a operações cardíacas [Tese de Mestrado]. Ribeirão Preto:Faculdade de Medicina de Ribeirão Preto, Universidade de São Paulo;2007. 90p.

29. Megna RC. Fatores de risco para ventilação mecânica invasiva prolongada em pacientes submetidos à cirurgia cardíaca com circulação extracorpórea [Dissertação de Mestrado]. Ribeirão Preto:Faculdade de Medicina de Ribeirão Preto, Universidade de São Paulo;2007. 67p.

30. Borges VM. Avaliação da musculatura respiratória e dos volumes pulmonares como preditores de complicações respiratórias no pós-operatório de cirurgia cardíaca [Dissertação de Mestrado]. Ribeirão Preto:Faculdade de Medicina de Ribeirão Preto, Universidade de São Paulo;2008. 47p.