The research progress of brain natriuretic peptide in evaluation of weaning from mechanical ventilation

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Abstract

Mechanical ventilation provide important support organ function in critical ill patients. However, mechanical ventilation can produce many complications. Patients should be weaned from mechanical ventilation promptly. It is difficult to identify which patients are suitable for weaning, and studies show that 4%-23% of patients who have passed SBT can not be successfully weaning. There is many reasons for weaning failure. Cardiac function may play a key role. Brain natriuretic peptide (BNP) is a powerful biomarker for the diagnosis of heart failure. BNP has been shown to help determine whether weaning failure is caused by cardiovascular dysfunction.

1. Introduction

Mechanical ventilation was first proposed by Vesalius in the 16th century and was used to treat acute respiratory failure. In the 20th century, the application of mechanical ventilation has been greatly developed, and in 1951 for the first time in the operating room. Bjorn Ibsen has also suggested that the use of positive pressure ventilation in poliomyelitis patients can significantly improve their survival rate, positive pressure ventilation in the global context for the treatment of acute respiratory failure. Mechanical ventilation provides maintenance of the gas exchange between the body and the outer environment as well as stable acid-base balance, so it can be used not only for respiratory failure treatment and surgical support, but also for chronic neuromuscular disorders, chronic heart failure, systemic disease and other treatment. With the deepening understanding of respiratory physiology, the current mainstream view that: MV itself is not a fundamental treatment, but for the existence of potential causes of respiratory failure recovery to provide the required time and conditions, and to ensure that it is optimized Applications.

In fact, MV in the treatment at the same time will produce non-application purposes and even endanger the impact of life. The incidence of complications is mainly related to tracheal intubation, positive pressure ventilation, non-physiological respiratory mode, and so on. Among them, barotrauma is the most common and the earliest raised, including interstitial emphysema, secondary emphysema, mediastinal emphysema and pneumothorax, etc. These lesions are mainly associated with high ventilation pressure or excessive regional lung capacity. At the same time, the pressure to produce barotrauma can also change with the evolution of the disease process, resulting in early disease can be well tolerated in the late stages of disease showed excessive pressure. At present, another concern about the MV complication is ventilator-associated pneumonia (VAP), The International Nosocomial Infection Control Consortium (INICC) data confirm a total VAP incidence of 13.6/1
000 mechanical ventilation, the associated mortality rate of 24%-76%. The occurrence of ventilator-associated pneumonia is related to pathogens in the external environment with the artificial airway into the respiratory tract, cough reflex and mucus cilia system damage and pharyngeal secretions carrying pharyngeal colonization through the tracheal cuff into the trachea and others.

At the same time, with the development of medical support level, the number of elderly patients increased, most of which existed in the past, the basis of heart disease, in the mechanical ventilation, excessive inspiration, exhaled too little or high level of positive end expiratory pressure (PEEP) can be squeezed on the heart, so that left and right ventricular anterior load reduction, compliance decreased, the corresponding reduction in cardiac output. If the lung hyperinflation time is too long, the coronary artery can be sustained by mechanical compression and cause myocardial ischemia. On the other hand, MV positive pressure can also inhibit pulmonary circulation and systemic circulation, thus affect the intra-abdominal organ arterial infusion and venous return, aggravate the systemic circulation congestion, especially in the right heart failure, and then cause cardiovascular complications. And cardiac output reduction, will also cause decreased renal parenchymal perfusion, renal blood flow redistribution, increased antidiuretic hormone, atrial natriuretic peptide decreased glomerular filtration rate decreased renal dysfunction. Of course, when in response to mechanical ventilation patients "man-machine confrontation", the sedation, muscle relaxation and other treatment can also cause blood vessels to dilate, blood pressure, cardiac output and muscle wasting atrophy and other complications. It can be seen that effective reduction of mechanical ventilation complication is one of the important aspects of ICU quality control. Studies have shown that delayed off-line and off-line failures will lead to increased mechanical ventilation time and increased ICU mortality, "shortening the mechanical ventilation time" is one of the key points to reduce the incidence of complications.

2. Materials and methods

Weaning refers to the process of stopping mechanical ventilation, weaning failure usually refers to the failure of the spontaneous breathing test (SBT) or the need for ventilation within 48 h after extubation (including noninvasive mechanical ventilation). The current study shows that: cannot weaning patients, discontinuing the ventilator, almost all of the respiratory rate or tidal volume reduction (shallow breathing); and weaning patients are still about 25% of severe respiratory distress. Need to rebuild ventilating support. In the past, weaning methods included "T-tube test", Intermittent Mandatory Ventilation (IMV) and Pressure Support Ventilation (PSV). However, due to excessive human consumption or difficult to obtain accurate judgment parameters resulting in limited clinical using. At present, SBT is the most accurate way to predict weaning results. However, even through SBT, extubation failure rate can be as high as 15%-20%. It can be seen that weaning is a difficult process, which has a certain relationship with the off-line process involving multiple factors and its complex changes in pathophysiology.

Clinically, due to artificial airway and/or tracheal injury (such as: narrow, tracheal softening, granulation tissue, etc.) will cause increased airway resistance. COPD or asthma (due to increased small airway resistance), ARDS (due to bronchial wall edema) and other patients will also appear to increase bronchial resistance, expiratory flow is limited, resulting in endogenous PEEP (PEEPi). From the perspective of pathophysiology, respiratory resistance increases, compliance and PEEPi exist, the increase in respiratory function, if the patient can not complete the respiratory muscle respiratory function, can lead to weaning failure. And then serious disease will affect the structure and function of respiratory muscles have a great impact, critically ill patients with invasive mechanical ventilation the diaphragm strength will be weakened after 5-6 d. Thus, how to conduct an effective assessment in the MV process off-line is one of the industry's focus.

3. Results

The lung and heart are functionally and anatomical coupling, respiratory arrhythmia is the reaction of the two coupling sensitivity. In the process of mechanical ventilation, from assisted breathing to spontaneous breathing, the serious impact on the cardiovascular system can cause an offline failure. When the ventilator is disengaged, the pressure in the thoracic cavity changes abruptly, the venous return increases significantly, the left ventricular preload increases rapidly with the postload, and then the pulmonary edema may occur quickly, resulting in an offline failure. Thus, the relevant checks based on cardiovascular diagnosis and their interventions may help patients to assess weaning. Some traditional methods (such as: heart color Doppler ultrasound, pulmonary artery catheterization, etc.) there is difficult to detect cardiovascular dysfunction, too much dependence on the level of operation, lack of sensitivity, difficult to bed commonly used and other issues. B-type natriuretic peptide (BNP) and N-terminal prohormone BNP (NT-pro BNP) were evaluated as the sensitivity and specificity of heart failure diagnosis, and now become a possibility indicator of evaluating weaning.

In 1980, Bold et al. discovered, and in 1984, was purified, named
as atrial natriuretic peptide. In 1988 Sudoh T et al. found a peptide in the brain of porcine cerebral and similar physiological role of the ANP, named brain natriuretic peptide, after being confirmed by ventricular myocytes produced. When the ventricular volume is expanded and the pressure load increases, BNP begins to secrete, and its inactive precursor form (proBNP) is cleaved into the signal peptide and proBNP in the ventricular myocytes and released into the bloodstream, which is cleared under the action of furin NT-proBNP and biologically active carboxy terminal fragment BNP. Natriuretic peptides have diuretic, liner maintain water and electrolyte balance, regulate blood pressure, keep the cardiovascular, kidney and other organs function steady state. In the kidney side, BNP has increased glomerular filtration rate, inhibition of renal tubular and collecting tube of sodium reabsorption, so that urine water and sodium excretion increased; inhibition of renin release and aldosterone secretion, indirect sodium. In the cardiovascular side, BNP can relax blood vessels, lower blood pressure, inhibition of coronary artery spasm. In addition, the study found that BNP can be involved in the proliferation of vascular endothelial cells and cardiac fibroblasts by regulating cell proliferation, which is an important pathologic segment of cardiac fibrosis and cardiac remodeling.

However, the secretion of BNP will be affected by age, sex, body mass index, primary disease and other factors. In ICU patients, age and gender are important factors affecting BNP, there is a 30% mutation rate. Plasma BNP concentration increased with age, female BNP levels higher than men 20%-50%, this difference is related to estrogen secretion. At the same time, differences in plasma BNP concentrations between healthy and heart failure patients were associated with body mass index, due to the regulation of fat content and BNP synthesis by steroid hormones, and thus the concentration of BNP was lean body weight. Studies have confirmed that androgen stimulates weight gain and inhibits the synthesis of natriuretic peptides, whereas estrogen acts. Sepsis is one of the main reasons for occupying ICU. At this time, the release of cytokines will increase the plasma BNP content, which is related to sepsis induced cardiac function inhibition.

In right heart disease, BNP secretion is due to increased ventricular stress, COPD, pulmonary embolism, idiopathic or pulmonary embolism-related pulmonary hypertension can affect the right ventricular function, leading to elevated plasma BNP levels. Under the condition of mechanical ventilation, the patient's intrathoracic pressure changes from normal physiological pressure to positive pressure, right ventricular preload, left ventricular postload pressure gradient, reduced venous return, cardiac hyperemia, BNP may be at a low level. It can be seen that the right heart load abnormality is one of the important causes of BNP changes when off-line.

In patients with decompensated COPD, the use of noninvasive mechanical ventilation can reduce plasma BNP levels indirectly. In addition to the above pathophysiological factors, we cannot ignore the mechanical ventilation caused by the expansion of lung volume, alveolar pressure and intrathoracic pressure changes on the cardiovascular system. When receive mechanical ventilation, alveolar passive expansion, increased lung volume will occur on the mediastinal heart squeeze. And chest pressure due to the impact of mechanical ventilation and external pressure gradient increases, but also cause decreased right ventricular compliance. Thus, when the mechanical ventilation is evacuated, if at this time already exists or the potential left ventricular dysfunction, cardiovascular function will be compensated, will lead to weaning failure. It can be seen that assessing weaning from the perspective of cardiovascular dysfunction may be a new attempt.

4. Discussion

In the study of the weaning process, Mekontso-Dessap et al. found that the baseline BNP level was an independent risk factor for weaning failure, with the best predictive value at BNP = 275 pg / ml. There was no significant difference in baseline BNP level between Cheng Long et al., and the rate of change of BNP (SBB) before and after SBT was significantly different. The study showed that the critical value of BNP% was 13.4% with the best predictive value. In the study of Ouanes Besbes L et al., NT-pro BNP was an independent predictor of predisposing respiratory distress after extubation. When NT-pro BNP> 1 000 pg/mL, the diagnostic value was also excluded. In patients with cancer who were associated with non-cardiac surgery, Gang Ma et al. also demonstrated that NT-pro BNP predicts that the patient is successfully weaning, with a best predictor of less than 448 ng/L at the end of the SBT. But for those who are difficult to weaning, due to evacuation of the ventilator, the rapid increase in cardiac load, cardiac function is not enough to compensate, resulting in weaning failure. As mentioned earlier, BNP can be used to predict and diagnose cardiogenic weaning failures. A clinical trial by Mekontso-Dessap et al. confirmed that the liquid management group under the guidance of BNP would form a more liquid balance during off-line, shortening the time of successful extubation significantly.

In summary, BNP and NT-pro BNP can be used to screen and predict the likelihood of a successful weaning patient, as well as help clinicians exclude whether weaning failures are associated with cardiac factors, thereby assisting in such as improving body fluid load clinical treatment to promote successful patient weaning.
Reference


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