LITERATURE REVIEW

Bronchial Toilets in Sepsis Patients Treated in The Intensive Care Unit (ICU): A review On Indications and Complications

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ABSTRACT

The respiratory system is very important for human life. Its performance determines the quality of life. Physical exercise helps patients suffering from various diseases to build physical fitness, improve respiratory mechanisms, and reduce secretions. It is important to choose the right technique for such patients, using fitness and strength training, breathing exercises, bronchial cleansing. Bronchial clearing aims to remove respiratory tract secretions that contribute to recurrent inflammation and respiratory distress. This is based on the position which facilitates the removal of dense secretions due to the influence of gravity. Pharmacological measures to reduce the secretions in the respiratory tract and facilitate coughing, should be administered prior to drainage. Tracheo-bronchial toilet is a method used to clear mucus and secretions from the airways. The benefits of a tracheo-bronchial toilet include preventing infections such as pneumonia and improving drainage of secretions. Methods used in tracheo-bronchial toilets include temporary naso-tracheal intubation with small tubes, percussion, positioning, and coughing. A tracheotomy can also be performed for lung clearance. Toilet bronchoscopy is a potentially therapeutic intervention to aspirate retained secretions in the endotracheal tube and airway and restore atelectasis.

Keywords: bronchial toilet; intensive care unit; morbidity; respiratory system; sepsis

INTRODUCTION

Bronchial toilets, also known as pulmonary hygiene, are a set of methods used to clear mucus and secretions from the airways. One method of bronchial toilet is tracheobronchial lavage, which assesses upper airway exudate and cellular population, whereas bronchoalveolar lavage concentrates on the structure of the lower airway. Toilet bronchoscopy is a potentially therapeutic intervention to aspirate secretions retained in the endotracheal tubes and airways and restore atelectasis. Toilet bronchoscopy is used in lobar and total lung collapse in mechanically ventilated patients who fail to respond to treatment such as physiotherapy or maneuvers.[1]

Other methods of bronchial toilet include percussion, which loosens secretions and allows airway cilia to expel material, and position, which encourages secretion drainage by placing the patient in a prone position.[2]

Sepsis is an overreaction to infection accompanied by high morbidity and mortality, requiring immediate intervention to improve outcomes with some specific diagnostic and therapeutic measures, such as the use of fluid resuscitation and antibiotics. According data published by World Health Organization (WHO), in 2020 there were 48.9 million cases and 11 million sepsis-related deaths worldwide, representing 20% of all global deaths.[3]

A lung abscess is a necrotic cavity lesion of the pulmonary parenchyma. They are usually caused by anaerobic bacteria or mixed flora and usually occur after aspiration. The average annual incidence of lung abscesses, including gangrene or necrosis of lung, was 35.7 per million. Globally, the mortality rate of lung abscesses varies from 1% to 20% depending on study periods and patients' history. Primary lung abscesses occur in previously healthy patients with no underlying medical impairment and are usually solitary. Secondary lung abscesses occur in patients with underlying or predisposing conditions and may be multiple.[4]

Initial diagnosis for lung abscess is usually made with chest radiographs that show the lung cavity with air-fluid levels. Usually, the cavity wall is thick and irregular, and there is often lung infiltration around it. The differential diagnosis of pulmonary cavitation is extensive, including various types of possible infections, neoplasia, and bronchial tree malformations.[4]

Management is usually based on prolonged antibiotic treatment. Failure of conservative management, manifested by persistent sepsis and/or other complications of abscesses, may require drainage by invasive techniques (percutaneous, endoscopic or surgical) or surgical removal of lung lesions in patients with good performance status and adequate respiratory reserve.[4] In conscious patients, temporary naso-tracheal intubation with a small tube is a well-tolerated alternative treatment for tracheobronchial toilet if mucus is retained in lung abscess.

DISCUSSION

Anatomy and physiology

Before performing actions it is important to understand the anatomy of the trachea and bronchi. In humans, the trachea arises at the level of cricoid cartilage and extends to the karina of the narrowest part of the airway in adults, where it branches into the right and left main trunk bronchi. The average length of an adult trachea is 12 cm and consists of 18 to 22 C-shaped cartilage rings in the

anterolateral, the ends of which are connected posteriorly by the walls of the superficial membrane and the tracheal muscles. The right main bronchi are located in a more vertical plane, shorter (an average of 1.9 cm in men and 1.5 cm in women) and larger than the left main bronchi. The left main bronchi are located in a more horizontal plane and average about 4.9 cm in males and 4.4 cm in females.[5]

The left lung is 10% smaller than the right lung and consists of 2 lobes, the superior and inferior lobes, while the right lung consists of three lobes - superior, middle and inferior lobes. Each lobe is divided by connective tissue into anatomical compartments known as bronchopulmonary segments, supplied by bronchi and segmental (tertiary) arteries. Each bronchopulmonary segment is functionally and anatomically separate and can be resected (segmentectomy) without affecting each other. In general, each lung has 10 bronchopulmonary segments. Lung ventilation and perfusion are anatomically suited, with the dependent part of the lung receiving greater blood flow (perfusion) due to gravity and greater ventilation due to the gravitational effect of pulmonary compatibility. One lung ventilation (OLV) initiation stops all ventilation to one lung, which creates a mandatory shunt (i.e. the lung is perfused but not ventilated). Because the left lung is smaller, there are fewer shunts when the left lung collapses.[6]

Indications of bronchial toilet

Bronchial toilets are useful for patients with difficult-to-clean bronchial secretions, particularly those using mechanical ventilation. They can help clear secretions from the airways of critically ill patients who struggle with coughing or clearing them due to various conditions. Mechanical ventilation can contribute to the buildup of secretions, making bronchial toilets a valuable intervention. Additionally, bronchial toilets can prevent atelectasis, the collapse of lung tissue caused by secretions blocking the airways. Overall, bronchial toilets are a valuable intervention for patients with respiratory issues.[3]

Individuals suffering from pneumonia or tracheobronchitis, particularly those with difficult-to-clean secretions or mucus blockages: pneumonia and tracheobronchitis can worsen respiratory status and produce copious secretions that are difficult to clear. Bronchial toilets can enhance oxygenation and assist in the removal of these secretions. Pneumonia and tracheobronchitis can worsen respiratory status and produce copious secretions that are difficult to clear. Bronchial toilets can enhance oxygenation and assist in the removal of these secretions. Additionally, by eliminating secretions containing bacteria, bronchial toilets can aid in the prevention of subsequent infection.[3] Indicated in patients who are unable to stop secretions from building up in the tracheo-bronchial due to weakness or pain; it may also be required in the event of incapacitating illnesses, following surgery, or following injuries, particularly to the chest wall.[7,8]

Tracheo-bronchial toilet is a procedure where the patient cannot remove secretions themselves and signs of lung collapse persist even after carbon dioxide inhalation and postural drainage. It involves intubation, a difficult prelude, and cleansing. The active cough reflex, which helps in intubation, can be disadvantageous during initial intubation, causing stress for both the

patient and anesthesiologist. To ensure complete laryngeal anesthesia, laryngeal sprays or toxic drugs like cocaine, nupercaine, or amethoccaine should be used, along with large doses of toxic drugs like cocaine, nupercaine, or amethoccaine.[7,8]

Some indications for performing tracheobronchial aspiration

Foreign body aspiration of the tracheobronchial tract, clearing blockages in the respiratory tract, preventing more serious complications due to foreign body aspiration, overcoming respiratory problems such as local inflammation and infection.[15] Contraindications to drainage are: new ischemic or hemorrhagic stroke, conditions after neurosurgical operations on the skull, aortic aneurysm, unstable coronary heart disease, new heart attack, conditions after esophageal fusion or gastroesophageal reflux surgery, severe arrhythmias, continued insufficiency of bleeding or gastric hemorrhage, history of epilepsy and unstable hypertension, pulmonary edema, ascites, strict immobilization after orthopedic surgery, pregnancy, bleeding from the respiratory tract or gastrointestinal tract, intolerance to the inverted position.[12]

Prevention of ventilator-associated pneumonia (VAP)

Some references highlight the use of bronchial or tracheobronchial toilets as a way to reduce the incidence of VAP in critically ill patients. For example, Blackwood et al. (2016) conducted a systematic review of closed-system suction versus open-system suction in mechanically ventilated adults and found that closed-system suction was associated with a lower risk of VA.[8]

Bronchial or tracheobronchial toilets are especially indicated in critically ill patients to prevent the development of ventilator-associated pneumonia (VAP). VAP is a common complication in patients with mechanical ventilation, and can lead to prolonged hospitalizations, increased health care costs, and even death. Tracheobronchial toilets are an important component of VAP prevention strategies, as they help remove secretions from the airways and reduce the risk of bacterial colonization. Closed-system suction and intermittent drainage of subglottis secretions have been shown to be effective in reducing the incidence of VAP in patients with mechanical ventilation. In addition to VAP prevention, tracheobronchial toilets can also be used to remove excess secretions from the airways, which can improve oxygenation and prevent airway obstruction in critically ill patients. Hess (2007) provides a comprehensive overview of the various techniques and equipment used for tracheobronchial toilets in ICUs.[8,9]

Bronchial toilet method

Toilet bronchoscopy is a potentially therapeutic intervention to aspiration retained secretions in the endotracheal tubes and airways and restore atelectasis, Toilet bronchoscopy is used in lobar and total lung collapse in mechanically ventilated patients who fail to respond to treatment such as physiotherapy or recruitment maneuvers.[1]

Bronchial bleaching obtained by advancing the bronchoscope into the airway, inserting 10 to 20 mL of sterile saline, and then quickly sucking out the inserted saline into the specimen trap. This method is intended to improve secretion drainage and prevent infections such as pneumonia.[16]

Bronchial toilet is the act of removing fluid or mucus from the mouth, nose, or trachea of clients who cannot expel it spontaneously. This action is usually performed in patients who have sputum retention, and children, as well as adults and patients who are admitted to the ICU room with decreased glasgow coma scale (GCS), and have pneumonia.[10] Fiberoptic bronchoscopy is also performed to take sputum samples in patients who cannot remove sputum, with suspected active TB.[17] Flexible fiberoptic bronchoscopy is often the initial technique for the diagnosis of lung and bronchial tumors. Many studies have shown a high degree of accuracy of bronchial clearance in the evaluation of neoplastic and non-neoplastic bronchopulmonary lesions. The purpose of this study was to emphasize the value of bronchial cytology findings for the diagnosis of non-neoplastic bronchopolmonary lesions.[18] One method of bronchial toileting is tracheobronchial lavage, which assesses upper airway exudate and cellular population, whereas bronchoalveolar lavage concentrates on the structure of the lower airway.[13] Temporary naso-tracheal intubation with a small tube, tracheobronchial aspiration, percussion, the next method of evacuating secretions is to apply positive exhaust pressure. By exhaling air to vibrate, the airways vibrate and the secretions are separated. Another therapy option is physiotherapy procedures to support the breathing mechanism, which utilizes vibration massage. Devices such as Aquavibron, Fleximatic, Medex or Vest devices with swing vests can be used to adjust chest pressure, vibration intensity, and vibration frequency. Vibration can also be done manually.[9] Cough: another method of clearing bronchial trees is effective cough exercises. To do this, the patient takes a deep breath through the nose, followed by a long exhale through the mouth, interrupted by episodes of short coughing, thereby facilitating the vibration of the bronchial walls caused by pressure changes in the airways to free the bronchial tubes from clogging. The cough can be triggered by exhaling while saying the word "rrrrrrrr". . . long or "hhhhh. This vocalization of sounds allows additional vibrations, so that secretions can dissolve. The exercise can be performed in the driver's position where the patient sits with his head and torso leaning forward.[9]

Examples of exercises for effective cough: sit upright- inhale- slowly lean towards the coachman when exhaling obliquely- above the exhalation 2-4 cough, sit upright- inhale- slowly lean towards the coachman when 3-4 coughs are tilted and air is exhaled, sit upright- slowly with the driver's position tends to quickly inhale and exhale because of cough-inhalation-cough-inhalation-cough-cough-cough.

Advantages of suction as a bronchial toilet method: suction is a quick and effective method of removing secretions from the airways, it can be done at the bedside, making it a convenient option for patients who cannot undergo more invasive procedures, suction can be used in combination with other bronchial toilet methods, such as chest physiotherapy, to improve results.

Disadvantages of suction as a bronchial toilet method

Suction can cause trauma to the airway, causing bleeding and inflammation, It can also cause hypoxemia, or low oxygen levels, if done incorrectly, suction can be uncomfortable and painful for patients, especially if they are in a conscious state, excessive use of

suction can lead to increased mucus production and airway irritation.

One of the elements of the toilet is drainage. The patient is positioned in such a way that the cleared airway is above the lung cavity (e.g. in the middle of the sternum), allowing secretions to flow unobstructed by gravity. Depending on the installation site, different drainage positions are used. Release of secretions can be achieved e. g. in the trendelenburg position, where the patient lies with his back and head, upper chest and torso under the lower extremities. Drainage is best done in special drainage beds with the possibility of adjusting the patient's position. A simple deck chair can be used where the back legs of the lounger are placed with a washer measuring 20-30 cm or a fixed roller for the patient's hips, so that the head is 10-20° lower. The treatment is carried out several times throughout the day, depending on the amount of retained secretion and the patient's condition. During the stable period with dilation and cystic fibrosis, it is recommended to perform surgery 2 times a day. During the period of infection, the number of treatments should be increased. The duration of a static drainage session is about 30-60 minutes. Where appropriate, 2-3 sessions per day should be held, for sessions longer than 30 minutes, for 30-minute sessions 4-5 times per day. Drainage should be carried out in patients with an unfilled stomach, i.e. before meals, but at least two hours after meals. The patient must wear loose clothing that cannot move.

Contraindications for drainage are: new ischemic or hemorrhagic stroke, condition after neurosurgical operation of the skull, aortic aneurysm, unstable coronary heart disease, new heart attack, condition after esophageal fusion or gastroesophageal reflux surgery, severe arrhythmia, continued insufficiency. Gastric bleeding or hemorrhage, history of epilepsy and unstable hypertension,9 pulmonary edema, ascites, strict immobilization after orthopedic surgery, pregnancy, bleeding from the respiratory tract or gastrointestinal tract, intolerance to the inverted position.

Tracheobronchial aspiration is one of the methods used in the tracheo-bronchial toilet to clear blockages in the respiratory tract. The methods to perform tracheobronchial aspiration are listed below: the patient is placed in a comfortable and stable position. The tool used is a suctioncatheter or suction tube. The tool is inserted into the patient's respiratory tract through the nose or mouth. The tip of the tool is directed to the blockage or mucus you want to suck. Press the button on the tool to suck the blockage or mucus. When finished, clean the tool with antiseptic liquid. Tracheobronchial aspiration should be performed by trained and experienced medical personnel to avoid complications that can occur.

Symptoms indicating the presence of foreign body aspiration in the tracheobronchi are not always typical and may vary depending on the age of the patient, the size and type of foreign body, and the location of the foreign body. Here are some symptoms that can indicate the presence of foreign body aspiration in the tracheobronchial: asphyxia or difficulty breathing, suffocation, paroxysmal cough, respiratory distress, wheezing, tachypnea, choking or vomiting, chest pain, fever, altered breathing sounds, history of foreign body aspiration. If the patient experiences these symptoms, it is necessary to take immediate medical action to prevent more serious

complications. Foreign body aspiration of the tracheobronchial canal is an emergency that requires immediate bronchoscopy to prevent more serious complications.

Complications of bronchial toilet

Airway trauma: endotracheal suction can cause damage to the airway, especially if done too often or with excessive exertion. Rumbak et al. (1999) describe significant cases of tracheal obstruction caused by secretions and not by endotracheal tube malposition, which requires bronchoscopy removal of secretions.[10]

Hypoxemia: during suction, ventilation may be temporarily interrupted, which can lead to decreased oxygen saturation. Li Bassi and Torres (2011) note that closed-system suction and intermittent drainage of subglottis secretions have been shown to be effective in reducing the risk of VAP, but caution that impaired ventilation can lead to hypoxemia.[10]

Hypoxemia also can occur due to impaired ventilation during the suction process. This is especially of concern in patients with pre-existing lung disease or impaired respiratory function. Closed-system suction and intermittent drainage of subglottis secretions can help reduce the risk of hypoxemia, as it allows suction without interfering with ventilation. However, health care providers should closely monitor oxygen saturation levels during and after suction.[11,12]

Increased intracranial pressure: Berra et al. (2004) evaluated the feasibility and safety of the drainage system of subglottis secretion in patients with intracranial hypertension and found that the use of such a system did not increase intracranial pressure. However, it is possible that suction may cause increased intracranial pressure in some patients.[11]

Tracheobronchial toilets may cause increased intracranial pressure in some patients, especially in patients with pre-existing intracranial hypertension. This is a rare complication, but it can be serious and potentially life-threatening. Health care providers should carefully evaluate the need for tracheobronchial toilets in patients with intracranial hypertension and use appropriate techniques and equipment to minimize the risk of increased intracranial pressure.[13] Bronchial or tracheobronchial toilets may be indicated in critically ill patients to prevent VAP and remove secretions from the airways. However, there are potential complications associated with this procedure, including airway trauma, hypoxemia, and increased intracranial pressure. Therefore, it is important to carefully evaluate the need for bronchial or tracheobronchial toilets in each patient and use appropriate techniques and equipment to minimize the risk of complications.[14]

Bleeding: bronchial toilets can cause bleeding due to mucosal irritation, and this risk is especially high in patients with coagulopathy.[10] While bronchial toilets can be an effective way to clear secretions, it can also cause trauma to the airway mucosa, leading to bleeding. Patients with coagulopathy, as in anticoagulant therapy or with liver disease, are at increased risk of bleeding complications. Bleeding: bronchial toilets can cause bleeding due to mucosal irritation, and this risk is especially high in patients with coagulopathy.[10] While bronchial toilets can be an effective way to clear secretions, it can also cause

trauma to the airway mucosa, leading to bleeding. Patients with coagulopathy, as in anticoagulant therapy or with liver disease, are at increased risk of bleeding complications.

Hypoxia: suction during bronchial toilets may cause a temporary decrease in oxygen saturation, especially in patients with pre-existing hypoxemia.[11] Suction during the bronchial toilet can cause a temporary decrease in oxygen saturation as air is expelled from the lungs. Patients who are already hypoxemic or have poor respiratory function are at higher risk of hypoxia during the procedure.

Bronchospasm: patients with reactive airway disease are at higher risk of bronchospasm during bronchial toilet.[14] Bronchial toilets can irritate the airways, causing bronchospasm, especially in patients with pre-existing reactive airway diseases such as asthma or chronic obstructive pulmonary disease.

Nosocomial infections: bronchial toilets can increase the risk of ventilator-associated pneumonia and other nosocomial infections if performed with inadequate aseptic techniques or if excessive suction is performed. Bronchial toilets can introduce bacteria into the lower respiratory tract, leading to infections such as ventilator-associated pneumonia. Proper techniques and precautions, such as aseptic techniques and proper cleaning and disinfection of equipment, are necessary to minimize the risk of infection.[19,20,21]

Health care providers should carefully evaluate the need for tracheobronchial toilets in each patient and use appropriate techniques and equipment to minimize the risk of complications. Close monitoring of the patient during and after suction is essential to detect and treat potential complications that may arise.[10,13,14]

Based on previous research, the morbidity resulting from bronchial toilet, particularly bronchoalveolar lavage, leading to therapy alterations, including respiratory events requiring modifications in respiratory support, is influenced by the type of oxygen therapy received by patients, such as invasive and non-invasive methods ($p < 0.001$). The most frequent adverse event observed is respiratory distress in patients receiving standard oxygen therapy compared to fewer incidences in patients undergoing mechanical ventilation ($p < 0.01$). The success of the bronchial toilet is also contingent upon the experience of the operator performing the procedure on non-intubated patients ($p < 0.04$). Conversely, in intubated patients, the success of bronchoalveolar lavage is not affected by the operator's experience.[22]

In a non-ICU setting, previous research observed complications occurring within 48 hours post-bronchoscopy in 5.6% of the observed sample, with hypoxia/dyspnea being the most common. Deterioration in oxygenation and ventilation parameters leading to mortality within five days post-bronchoscopy was experienced by 14.8% of the observed sample.[23]

CONCLUSION

Overall, while bronchial toilets can be a useful intervention in critically ill patients, it is important to weigh the potential benefits against the risk of complications and perform the procedure with appropriate precautions and monitoring.

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