Introduction

Chest tube thoracostomy involves placing a hollow plastic tube between the ribs and into the chest cavity to drain fluid or air from around the lungs. The tube is often hooked up to a suction machine to help with drainage. The chest tube usually stays in chest until x-rays show that all the blood, fluid, or air has drained from chest and lung has fully re-expanded ***(American Lung Association, 2012; American Thoracic Society, 2014).***

Chest drainage may be indicated when a lung lesion, chest trauma or cardiac/thoracic surgery punctures the pleura, or when a spontaneous puncture of the pleura occurs. Air or fluid may be drawn into the pleural space by its negative pressure, causing lung recoil and collapse. Appropriate chest drain management is required to maintain respiratory function and haemodynamic stability ***(O'Hanlon-Nicols, 2011)***.

An improper handling of chest tube can lead to many complications. Complications of chest drainage were defined as insertional (visceral or parietal injuries of the intercostal artery or intraparenchymal lung), positional (extrathoracic placement or atypical intrathoracic placement resulting in tube failure and replacement) or infectious (wound infection or empyema) ***(Wallen, Margare and Anne Morriso, 2011)***.

The finding of study conducted by ***Mefire, Fokou and Dika (2013)*** about indications and morbidity of tube thoracostomy performed for traumatic and non-traumatic free pleural effusions in a low-income setting revealed that, the complication rate among the patients with chest tube drainage was 19.35%. The most common complications included tube dislocation and pneumothorax.

The report of ***British Thoracic Society, Guidance for the implementation of local trust policies for the safe insertion of chest drainage for plueral effusions in adults (2008),*** revealed that, the risk of infection of wound is 7.7%. Studies of empyema secondary to tube thoracostomy have reported complication rates as low as 1% and as high as 25%. The most frequent complication associated with chest tubes is chest tube clogging, which is commonly caused by thrombus formation inside the chest tube, and can cause major subsequent complications. After cardiac surgery, chest tube clogging has been observed in 36% of patients. Minor complications of thoracostomy tube placement such as unresolved/ reaccumulation of pneumothorax or misplacement of the tube (too deep/kinked) are common and approach approximately 30%.

The nurses frequently are the professionals who see the full impact of management of chest tube drainage and have the skills that can alter the course of a patient's recovery, it is

important for nurses to have a valuable resource to help them achieve the best possible outcomes ***(Aiken et al., 2012)***.

The nursing intervention guidelines provide the continuing education for nurses which consider one way of closing the gap between an over increasing store of health care knowledge and the application to clinical practice. Continuing education is very important in updating nurses knowledge and their skills, stimulating nursing research and improvement the quality of patients' care. The aim of the nursing intervention guidelines implementation training program is to improve the nurses' knowledge and practice regarding the nursing intervention for management of patients with chest tube drainage. This will subsequently lead to improving the quality of care giving, saving cost and reducing the patients' complications associated with chest tube drainage ***(Nieva and Sorra, 2014)***.

Significant of Study

Chest tubes are routinely inserted post-thoracic and cardiac surgery. All patients after cardiothoracic surgery have placed mediasternal chest tubes ***(Clark, 2009; Tooley, 2011)***. The Ain Shams University Hospital statistic reported that, the cardio thorasic surgeries were performed for 1202 patients in the year 2012-2013. This indicates increasing the number of patients undergoing chest tubes drainage.

Patients who need chest tube are usually seriously ill and require advanced vigilant and expert nursing care to prevent serious complications and decrease the incidence of morbidity. Complications are more likely to occur if nurses caring for these patients do not have the necessary skills and training ***(Williams and Hopper, 2009)***.

Evidence- based nursing guidelines for management of patients with chest tube drainage are designed for prevention of complications and achieving better outcome for such group of patients ***(Maggie, 2010)***. Hopefully this study results will generate attention and motivation for further investigations into this topic as well as the lack of local researches concerned with such a problem necessitate the conduction of this study.

Aim of the Study

This study aimed to evaluate the effect of nursing guidelines for chest drainage management on nurses' performance through the following:

1. Assess nurses' performance (knowledge & practice) regarding chest drainage management
2. Develop and implement the nursing guidelines for chest drainage management based on nurses' needs assessment.
3. Evaluate the effect of nursing guidelines for chest drainage management on nurses' performance.
4. Assess chest tube drainage associated complications pre and post guidelines implementation.

Hypothesis:

1. The nurses' performance (knowledge & practice) regarding chest drainage management will be improved post the nursing guidelines implementation.
2. Patients who received nursing care post the guidelines implementation will have less chest tube drainage associated complications than patients who received nursing care pre the guidelines implementation.

Overview of Anatomy & Physiology of Respiratory System

It is important for the nurse to review normal anatomy and physiology of the thorax with emphasis on the physiology of respiration. This will help them understand where chest tubes are placed, how they work, what can go wrong in the structure and function of the chest and how these problems can be managed ***(American Thoracic Society, 2014)***.

The respiratory system, is situated in the thorax, and is responsible for gas exchange between the circulatory system and the outside world. Air is taken in via the upper airways (the nasal cavity, pharynx and larynx) through the lower airways (trachea, primary bronchi and bronchial tree) and into the small bronchioles and alveoli within the lung tissue ***(Tartora and Derrickon, 2011).***

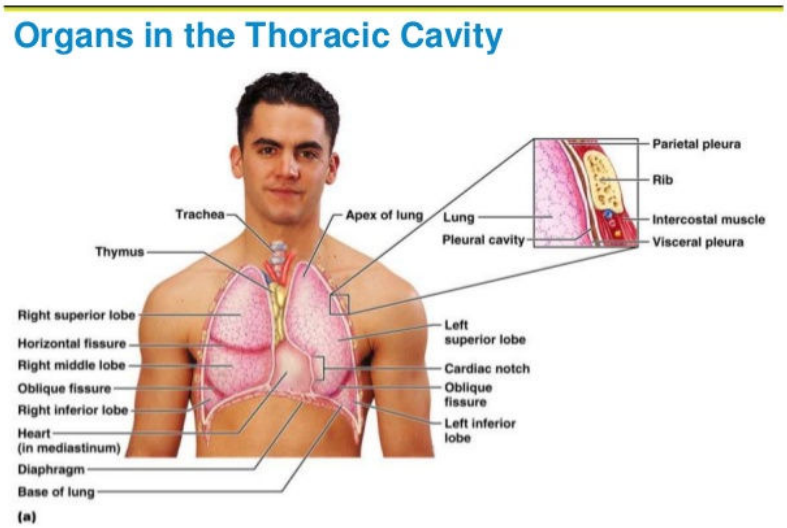

Fig. (1): Thoracic cavity related structure ***(Marieb, 2011).***

The thoracic cavity (or chest cavity), is the chamber of the human body that protected by the thoracic wall (thoracic cage and associated skin, muscle, and fascia). The main structures of thoracic cavity, the pleura, pleural space, mediastinum and lungs. The lungs occupy most of the thoracic cavity. The right lung has three lobs and accounts for slightly over half of the ventilation; the left lung has two lobs and is smaller than the right lung. The lungs are covered by a thin tissue layer called the pleura ***(Marieb and Hoehn, 2011)***.

The pleura, are double-layered serous membranes that surround each lung, attached to the wall of the thoracic cavity, the parietal pleura forms the outer layer of the membrane. The visceral pleura forms the inner layer of the membrane covering the outside surface of the lungs. Between the parietal and visceral pleura is the pleural cavity, which creates a hollow space for the lungs to expand into during inhalation. Serous fluid secreted by the pleural membranes lubricates the inside of the pleural cavity to prevent irritation to the lungs during breathing ***(Durai, Hoque and Davies, 2010).***

The mediastinum is the region between the right and left lungs; it's also covered by parietal pleura. The mediastinum is bordered by the sternum on the front and the thoracic vertebra on the back. The heart, contained in its own pericardial sac, is in the middle of the mediastinum. Also, in the mediastinum are the great vessels that enter and leave the heart, the bifurcation of the

trachea, the main-stem bronchi, most of esophagus, the thymus gland, lymph nodes, and various nerves ***(Yalayyaswamy, 2009)***.

The diaphragm, is a dome-shaped structure that separates the thoracic and abdominal cavities and is the most important muscle of inspiration. When it contracts, it moves downward and because it is attached to the lower ribs, it also rotates the ribs toward the horizontal plane, and thereby further expands the chest cavity ***(Marieb and Hoehn, 2008).***

Mechanics of breathing

Inspiration is the active part of the breathing process, which is initiated by the respiratory control center in medulla oblongata (Brain stem). Activation of medulla causes a contraction of the diaphragm and intercostal muscles leading to an expansion of thoracic cavity and a decrease in the pleural space pressure ***(Marieb and Hoehn, 2008).***

Expiration is a passive event due to elastic recoil of the lungs. However, when a great deal of air has to be removed quickly, as in exercise, or when the airways narrow excessively during expiration, as in asthma, the internal intercostal muscles and the anterior abdominal muscles contract and accelerate expiration by raising pleural pressure ***(Morton and Fontaine, and Hudak, 2009).***

Overview of Chest Tube Drainage System

Definition of chest tube drainage system (chest drain or tube thoracostomy), is sterile a flexible plastic tube that is inserted through the side of the chest into the pleural space. It is used to remove air (pneumothorax) or fluid (pleural effusion, blood, chyle), or pus (empyema) from the intra-thoracic space. They are also used to introduce sclerosing agents into the pleural space, thereby preventing a re-accumulation fluid ***(Kirsch, Roberts and Hedges, 2009).***

Purposes of chest tubes drainage insertion are removal or drainage of accumulated air, fluids, blood, pus, chyle, serous fluids, or solids (blood clots) from the pleural cavity. And to restore and/or maintain negative pressure in the pleural cavity to re-expand a partially or totally collapsed lung. They are also used to introduce sclerosing agents into the pleural space, thereby preventing a re-accumulation fluid ***(Timby and Smith, 2012)***.

Types of chest tube drainage system, there are two types of chest tubes: small-bore and large-bore catheter. Small-bore catheters (7 Fr to 12 Fr) have a one-way valve apparatus to prevent air from moving back into the chest. They can be inserted through a small skin incision. Large-bore catheters, which range in size up to 40 Fr, are usually connected to a chest

drainage system to collect any pleural fluid ***(Smeltzer, Hinkle, Bare and Aheever, 2010).***

The chest tube is connected to the collection water-seal system by a rubber tube that can be up to two feet long. Any drainage system must be sealed so that air or liquid cannot entering the chest tube and thus entering the pleural cavity. Such a drainage system is called a water-sealed (underwater) drainage or a disposable pleural drainage system ***(Eddy Lund and Copass, 2010)***.

Drainage systems use three mechanism to drain fluid and air from pleural cavity; positive expiratory pressure (PEP), gravity and suction. Many types of disposable commercial chest drainage systems are in use, most of which use the water-seal principle. Chest drainage can be categorized into three types of mechanical systems ***(Sorrentino, 2008)***.

A one-bottle water-seal **system,** allows air from the pneumthorax to bubble out of the water-seal and escape through the air outlet while preventing air from reentering the interapleural space ***(Shelli, Saeed, Fukamachi, Gillinov, Cohn, 2009).***

A two- bottle water-seal **system,** consists of the same water-seal chamber, plus a fluid collection bottle. Drainage similar to that of a single unit, except that when pleural fluid

drains, the underwater-seal system is not affected by the volume of the drainage. That system permits liquid to flows into collecting chamber, and air flows into the water-seal chamber ***(Karimov, Gillinov, Schenck, Cook, Kosty and Sweeney, 2013)***.

A three-bottle water-seal **system,** is similar in all respects to the two-bottle system, except for addition of a third bottle to control the amount of suction applied**.** The chest drainage systems currently used in the hospital are single unit, disposable systems and an alternative to traditional glass-bottle chest drainage systems and correlate to the triple-bottle drainage system composed of a collection chamber, a water-seal chamber, and a suction control chamber positioned side by side in a molded plastic disposable unite ***(Karimov et al., 2013).***

The collection chamber, collects any fluid that drains from the chest tube. The chamber is composed of series of graduated columns that fill sequentially. The water-seal chamber allows drainage and air to drain into the collection chamber without air entry the chest tube. The water-seal chamber is filled with sterile water up to the mark identified by the manufacturer. Mild fluctuation in water-seal chamber is normal as the patient breathes. Bubbles in water-seal chamber when a client cough may indicate an intermittent air leak. Continuous bubbling in water-seal chamber indicates an

ongoing air leak and should be reported to physician ***(Lancey, 2011).***

The suction chamber, is partially filled with sterile water and connected to suction. The physician orders the amount of suction to be used (usually 20 cm suction), and the suction chamber is adjusted so that there is gentle bubbling of the sterile water up to the line corresponding to the amount of suction ordered ***(Lawrence, 2005a).***

The inclusion of suction in a chest drainage system establishes negatives pressure to more readily re-inflate a collapsed lung or encourage fluid removal from the pleural space. A chest tube sometimes will be ordered to be disconnected from the suction and attached just to water-seal drainage ***(Morton et al., 2009).***

There is another type of chest drainage system it called (Heimlich valve) contains a one-way flutter valve; air drains out when patient exhales; keep collection device upright and to prevent air buildup ***(Antune, Neville, Deffy and Ali, 2013).***

Dry-seal systems*,* are a one-piece device with three chambers: fluid collection, dry seal, and dry suction control. They do not use water in the suction chamber, relying instated on the mechanical automatic control valve (ACV) and air leak monitor. The valve allows air to pass out of the patient and

prevents it from returning to the patient. The ACV keeps the pressure constant by adjusting to changes in air leaks and fluctuations in the suction source ***(Antune et al., 2013)***.

Portable system or mobile system, consists of a single dry-seal-chamber attached to the patient's chest tube. It drains by gravity, but can be connected to wall suction. Portable system improves ambulation and reduces the risk of deep vein thrombosis and pulmonary embolism. It is thought to decrease the length of time a patient must stay in the hospital. The collection chamber holds a maximum of 500 ml, so portable system is not practical for patients whose drainage is more than 500 ml daily ***(Blak and Hawks, 2009)***.

Sites of insertion, the location of the chest tube indicates the type of drainage expected. Apical (second or third inter-costal space) and anterior chest tube placement are indicated in case of a pneuomothrax. Because air rises, these chest tubes are placed high, allowing evacuation of air from the intera-pleural space and allowing the lung to re-expand. Commonly, a chest tube is inserted at the midaxillary line between the fourth and fifth ribs on a line lateral to the nipple and posterior or lateral to drain fluid ***(Fishman, 2009).***

A mediastinal chest tube is placed in the mediastinum, just below the sternum and is connected to a drainage system this tube drains blood or fluid, preventing its accumulation

around the heart and prevent caridac tamponade can result in cardiac arrhythmias, such as pulsless electrical activities (PEA) and asystole which can cause death. A mediastinal tube is commonly used after open heart surgery. There is no tidaling (fluctuations or rocking) in mediastinal drainage because the tube is not placed in a lung cavity and therefore does not reflect intrapleural changes ***(Gordon, Norton, Guerra and Perdue, 2013).***

Indications for chest tube placement include, pneumothorax, penetrating chest trauma, severe blunt chest trauma, hemothorax, chylothorax, symptomatic pleural effusion, bronchopleural fistula, chemical pleurodesis for benign and malignant conditions, postoperative use in thoracic/cardiac surgery and complicated parapneumonic effusion or empyema ***(Susan and Candice, 2013).***

Indication of chest tubes also may be used to prevent or mitigate postoperative complications. For example, after cardiac surgery or chest trauma, one or more chest tubes may be inserted in the mediastinum to drain blood and prevent cardiac tamponade. In addition, chest tubes can be used to instill fluids into the pleural space, such as chemotherapy drugs or sclerosing agents to treat recurrent pleural effusions (a procedure called pleurodesis) ***(Durai et al., 2010).***

Contraindications of chest tube, in cases of emergency, didn't have an absolute contraindications for tube insertion. The other relative contraindications were included the following: coagulopathy, pulmonary bullae, pulmonary, pleural or thoracic adhesions, loculated pleural effusion or empyema and skin infection over the chest tube insertion site**.** Other, relatives contraindications include a risk of bleeding in patient taking anticoagulant medication or the patient with a predisposition to bleeding or abnormal clotting profiles, refractory coagulopathy, and diaphragmatic hernia ***(Lehwadt & Timmis, 2010).***

Complications of chest tube insertion, these complications include, major complications as hemorrhage, infection, and re-expansion pulmonary edema. Chest tube clogging can also be a major complication if it occurs in the setting of bleeding or the production of significant air or fluid. When chest tube clogging occurs in this setting, a patient can suffer from pericardial tamponade, tension pneumothorax, or infection from site of insertion, an empyema. All of these can lead to prolonged hospitalization and even death. Minor complications include a subcutaneous hematoma or seroma, anxiety, shortness of breath (dyspnea), and cough (after removing large volume of fluid) ***(Hornick, Johne, Wallis, Willkins, Rees and Edmandson, 2010)***.