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FLAIL CHEST FRACTURE OF RIBS 2-9 WITH POST-CTT LUNG CONTUSION AND SUBCUTANEOUS EMPHYSEMA: A CASE REPORT

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ABSTRACT
Flail chest fracture of ribs 2-9 with pulmonary contusion after CTT installation and subcutaneous emphysema is a serious condition that affects the patient's respiratory function and quality of life. Patients often experience difficulty breathing, increased respiratory rate, and severe chest pain. In addition, the presence of a flail chest can increase the risk of complications such as atelectasis, lung infections, and hypoxia. The combination of this disease accompanied by rib fractures 2-9, subcutaneous emphysema, pneumothorax, and hemothorax makes this case unique and rare, so this finding can shed new light on the possible pathogenesis of a disease or its bad effects. The aim of this study is to describe the action in cases of Flail chest fracture of ribs 2-9 with post CTT pulmonary contusion and subcutaneous emphysema. Mr. T, a 23 year old man, was admitted to the Kemuning ICU with various medical diagnoses including flail chest, rib fracture, emphysema subcutis, right pneumothorax, pleural effusion, right hemothorax, right lung contusion, and ARDS. The patient complained of shortness of breath and chest pain after a motorbike accident. Initial actions include GCS monitoring, vital signs, oxygen therapy, fluid therapy, and Chest Tube Thoracostomy (CTT) installation. The patient's condition worsened and required intubation and a ventilator, then a thoracotomy operation and wire installation were performed to stabilize the fracture. After surgery, the patient's condition improved, he was successfully weaned off the ventilator, and pain was managed with intravenous morphine and ketorolac therapy. This case highlights the complexity in flail chest management that requires careful monitoring, interprofessional collaboration, and appropriate treatment strategies to improve the outcomes of patients with this condition.

Keywords: flail chest; nursing care; pulmonary contusion; subcutaneous emphysema

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INTRODUCTION

Flail chest is a serious medical condition that occurs due to multiple fractures of the ribs, leading to rib segmentation and paradoxical movement of the segments during respiration (Divisi et al., 2021a). Flail chest is also defined as one of the most severe forms of injury because it can disrupt chest wall stability and respiratory function (Guo et al., 2020). Flail chest is usually caused by significant blunt trauma, such as a traffic accident or fall from a height. This condition is often accompanied by other complications, including pulmonary contusions and subcutaneous emphysema.The prevalence and incidence of flail chest are quite high in patients with severe chest trauma. Fractures of ribs 2-9 are very common in flail chest cases, considering that this location is in the middle of the chest and is more susceptible to direct trauma (Helkin & Martin, 2020). The incidence of flail chest in thoracic trauma ranges from 5% to 13%, with higher rates in high-risk populations such as motor vehicle drivers and construction workers (Divisi et al., 2021b). Patients with fractures at ribs 2-9 are at greater

risk for serious complications, including respiratory failure and lung infections (Uchida et al., 2020). In addition, these injuries are often accompanied by pulmonary contusions that impair gas exchange, increasing the risk of hypoxemia and hypercapnia. At the circulatory level, chest trauma can cause internal bleeding and subcutaneous emphysema, which increases the workload of the heart and potentially causes shock (Glaser & Rodriguez, 2022).

The thorax consists of several important structures which include the ribs (costa), sternum (sternum), and spine (vertebrae thoracicae). There are 12 pairs of ribs, with ribs 1-7 referred to as "true ribs" because they are directly connected to the sternum via cartilage, while ribs 8-10 are called "false ribs" because they are connected to the sternum indirectly, and ribs 11-12 called "floating ribs" because they are not connected to the sternum at all (Bakir et al., 2022). This structure forms the chest cavity which protects vital organs such as the lungs and heart, and provides attachment points for muscles involved in the breathing process (van Gool et al., 2022).The lungs are an organ that functions to exchange vital gases, namely oxygen and carbon dioxide. Lung function relies heavily on the integrity of the chest structure to expand and contract efficiently during inspiration and expiration (Chudzik et al., 2023). Trauma to the ribs, such as a fracture, can disrupt this breathing mechanism by causing severe pain and abnormal chest movements. Rib fractures can affect the lung's ability to fully expand, potentially leading to decreased tidal volume and vital lung capacity (van Gool et al., 2022). In addition, severe trauma to the ribs can cause direct injury to lung tissue, such as pulmonary contusion, which results in impaired gas exchange and increases the risk of hypoxia.

Fractures of ribs 2-9 have significant specificity and impact in flail chest cases due to their location and vital role in the chest structure. Ribs 2 through 9 are in the center of the chest, which is the largest area and is vulnerable to direct trauma from the front or side. Fractures of the ribs are often caused by hard impacts, such as motor vehicle accidents or falls from heights, which put great pressure on the ribs and cause structural damage (Keene et al., 2019). The impact of fractures at ribs 2-9 on chest structure is very significant. This instability reduces the efficiency of pulmonary ventilation, impairs gas exchange, and can lead to acute respiratory insufficiency (Rajan et al., 2017). In addition, rib fractures are often accompanied by surrounding soft tissue injuries, including pulmonary contusions and subcutaneous emphysema, which further worsen respiratory function and increase the risk of serious complications.

Subcutaneous emphysema generally occurs due to chest trauma which causes air from the lungs or airways to leak into the subcutaneous tissue. Subcutaneous emphysema can also occur after medical procedures such as Chest Tube Thoracostomy (CTT), where improper placement of the chest tube or complications of the procedure can allow air to enter the subcutaneous tissue (Brenton, 2018). The impact of subcutaneous emphysema on the patient's clinical condition can vary from mild to severe. Extensive air accumulation can cause pressure on important structures within the chest, including blood vessels and vital organs, which can disrupt cardiovascular and respiratory function (Saleh & Alratroot, 2020). Patients with severe subcutaneous emphysema may experience difficulty breathing, chest pain, and neck or facial swelling, which may be an indication of more significant air buildup in the subcutaneous tissue (Zantah et al., 2020).Pulmonary contusion is the result of blunt trauma to the chest, which results in bleeding and edema in the lung tissue without any tears or open wounds in the tissue (van Gool et al., 2022). This injury usually occurs when the chest experiences a hard impact, such as in a motor vehicle accident, fall from a height, or injury due to a blunt object. When trauma occurs, a strong force applied to the chest causes small blood vessels in the lungs to rupture, resulting in the accumulation of blood and fluid in the

alveoli, which is the main site of gas exchange in the lungs (Liu et al., 2019). Pulmonary contusions can reduce the efficiency of the respiratory system, result in significant breathing difficulties, and require immediate medical intervention to avoid more serious complications.

Nurses have an important role in treating cases of flail chest with pulmonary contusion post CTT and subcutaneous emphysema. These conditions are interrelated and can together worsen the condition of patients with chest trauma. Additional complications such as pulmonary contusions can worsen gas exchange due to bleeding and edema in the lung tissue, while subcutaneous emphysema can add to the difficulty by causing accumulation of air under the skin, compromising the integrity of chest structures and breathing (Glaser & Rodriguez, 2022). A multidisciplinary approach in diagnosis, management and rehabilitation is necessary to ensure holistic and comprehensive treatment. The involvement of various specialists such as thoracic surgeons, pulmonologists, radiologists, as well as nursing and physical rehabilitation teams is essential to manage every aspect of this condition. The aim of this study is to describe a case study related to Flail chest fracture of ribs 2-9 with post-CTT pulmonary contusion and subcutaneous emphysema.

METHOD

This study used a case study approach with a sample of one patient who was diagnosed with flail chest fracture of ribs 2-9, pulmonary contusion, and subcutaneous emphysema after CTT (Rashid et al., 2019). Data collection is carried out comprehensively through the nursing care process which includes the assessment, planning, implementation and nursing evaluation stages. Nursing care is provided in the Cardiac Intensive Care Unit (CICU) room at a hospital in Bandung. The assessment involves collecting patient data which includes medical history, physical examination results, and supporting examinations such as chest radiography and blood gas analysis. The planning stage focuses on developing a nursing plan specific to the patient's needs, including pain management, optimization of ventilation, and prevention of further complications. Implementation involves carrying out nursing interventions according to plan, such as close monitoring of respiratory function, administering oxygen therapy, and educating the patient's family. Nursing evaluations are carried out periodically to assess the effectiveness of the interventions that have been provided and make adjustments if necessary. Data analysis was carried out descriptively to describe and discuss case findings in detail, with the aim of providing an in-depth understanding of the clinical management of flail chest with associated complications and the final results of the nursing care provided.

RESULTS

The patient is a 23 year old man with the name Mr. T, was treated in the Kemuning ICU with a medical diagnosis of flail chest in rib fractures 2,3,4,5,6,8,9 with segmental right hemithorax on the posterior aspect, and 6,7,8 on the lateral aspect, accompanied by subcutis emphysema , right pneumothorax, pleural effusion, right hemothorax, right lung contusion, as well as blunt thorax trauma, post Chest Tube Thoracostomy insertion, and ARDS. The patient complained of right chest pain and shortness of breath. This incident occurred when Mr. T was riding a motorbike with a helmet in the Cipamokolan area, where he fell after trying to avoid a cat crossing, and his right chest hit a telephone pole.The patient complained of shortness of breath and pain in the right chest after the incident. There were no complaints of nausea, vomiting, history of fainting, nose, ear or mouth bleeding. The patient was first taken to Al Islam Hospital and then referred to Hasan Sadikin Hospital. The results of the examination at the RSHS emergency room showed shortness of breath, pain when breathing, GCS E4M6V5, saturation 90-95%, breathing 38 x/minute, paradoxical breathing, right hemithorax crepitus, right VBS less than left, left vocal fremitus higher than right, and sonor

percussion on both sides. Furthermore, on May 7 2024, intubation and Chest Tube Thoracostomy insertion surgery were carried out, and the patient was treated in the Kemuning ICU.

On May 14 2024, before surgery, the patient complained of right chest pain, with pain scale CPOT 2, GCS E4M6VT, RR 20 x/minute with CPAP PS 5 mode ventilator, BP 125/70 mmHg, pulse 80 x/minute, installed WSD in the right chest with a production of 200 cc/8 hours, a catheter installed with a urine output of 140 cc/hour, an infusion of RL 2000 cc/24 hours and fentanyl 30 mcg/hour via a syringe pump, good turgor, and CRT 2 seconds. On May 15 2024, a thoracostomy operation and wire installation were performed, and the patient was picked up from the operating room at 13.30 with a PS 5 CPAP mode ventilator installed. On May 7, 2024 at 03:34, Mr. T, a 23 year old man, was admitted to the Kemuning ICU with complaints of shortness of breath and chest pain. The patient's oxygen saturation at that time was at 90-95%, blood pressure (BP) 140/90 mmHg, pulse 100 x/minute, respiratory rate (RR) 38 x/minute, temperature 38°C, with compos mentis consciousness (GCS 15). Initial medical diagnosis included fracture of ribs 2-9 and pulmonary contusion. Initial actions taken include monitoring GCS, vital signs (TTV), and signs of bleeding, oxygen therapy to treat hypoxemia, and fluid therapy to maintain hemodynamic stability. At 08.00, the patient's condition worsened with blood pressure dropping to 80/53 mmHg, pulse increasing to 110 x/minute, RR 33 x/min, temperature 36°C, and oxygen saturation dropping to 81%. To overcome this, Chest Tube Thoracostomy (CTT) is installed to treat pneumothorax and hemothorax, as well as fluid resuscitation to treat hypovolemic shock.

Although the patient's blood pressure improved to 95/53 mmHg, pulse 90 x/minute, RR 33 x/min, temperature 36°C, and oxygen saturation increased to 94%, the patient experienced a decrease in consciousness. To ensure the airway is open and adequate, intubation is performed and a ventilator is installed to support mechanical breathing. The patient was then transferred to the ICU for intensive care. The intervention was successful in overcoming shortness of breath and hypovolemic shock, but the patient's respiration remained poor and he experienced decreased consciousness. Intubation and ventilator placement help support breathing and maintain oxygenation. During follow-up treatment in the ICU, the patient showed improvement in consciousness and respiration, although he remained ventilator dependent. The severe pain felt by the patient was managed by administering fentanyl.On May 15 2024, a thoracotomy operation was performed and 8 wire plates were installed to stabilize the costal fracture. After surgery, the patient's condition improved with reduced pain. On the first day after surgery, the patient was successfully weaned off the ventilator and morphine therapy was continued for pain management.Patients experience ineffective breathing patterns due to flail chest and pneumothorax which disrupt normal breathing patterns, so A-Diaphragm breathing exercises and intermittent pressure breathing (IPPB) are needed to improve lung expansion and increase oxygenation.On the second day, the patient regained consciousness and the pain began to decrease. Pain therapy was replaced with intravenous ketorolac administration for further pain management.

Comprehensive and timely intervention successfully improved the patient's condition, although it required intensive care and continued therapy for full recovery.Patients are also at risk of falls due to weakness, pain, and medication side effects that affect balance and coordination, so close monitoring and the use of mobility aids are essential. A combination of pharmacological therapies to manage pain, infection, and inflammation as well as non-pharmacological interventions such as breathing exercises and secretion mobilization techniques helps maximize lung recovery and overall patient health. Acute pain caused by

severe chest injuries and rib fractures requires pain management with the administration of morphine and Paracetamol to enable the patient to perform breathing and mobilization exercises more comfortably, and prevent complications such as hypoventilation. Overall, this nursing intervention is designed to overcome problems identified from the results of the assessment, reduce the risk of complications, speed up recovery, and improve the patient's quality of life during the period of treatment in the ICU.

DISCUSSION

The results of the assessment in this case showed the presence of various abnormalities consistent with the medical diagnosis made. The patient showed symptoms of shortness of breath, chest pain, and signs of thorax trauma such as paradoxical breathing, crepitation in the right hemithorax, and decreased ventilation on the affected side. These findings are in line with previous studies that describe the clinical characteristics of flail chest and rib fractures involving impaired respiratory function and significant chest pain (Peek et al., 2021). In addition, the presence of subcutaneous emphysema, pneumothorax, as well as effusion and hemothorax are also typical findings in serious thoracic trauma (Divisi et al., 2021a; Suzuki et al., 2021). Factors that influence the results of this assessment include the mechanism of injury, the speed and force of the impact of the trauma, as well as the patient's premedical conditions such as age, physical fitness, and possible comorbidities (Glaser & Rodriguez, 2022). The results of this assessment provide important information for planning appropriate treatment interventions to minimize complications and improve the patient's prognosis.The condition of flail chest fracture of ribs 2-9 with pulmonary contusion post CTT and subcutaneous emphysema is influenced by various factors including the mechanism of injury, speed and strength of the impact of the trauma, as well as the patient's pre-medical condition. The mechanism of injury, such as a motorcycle accident involving a collision and direct impact to the chest, can cause significant rib fractures and lung tissue damage (Marasco & Abraham, 2022). The speed and force of the traumatic impact also play an important role in determining the severity of the injury, with high-speed crashes or forceful impacts tending to result in more serious chest injuries (Deng et al., 2022; Bakir et al., 2022). In addition, the patient's premedical conditions such as age, physical fitness, and the presence of comorbidities also influence the body's response to injury and the patient's overall recovery (Gool et al., 2022).

The medical diagnosis of flail chest fracture of ribs 2-9 with pulmonary contusion post CTT and subcutaneous emphysema in this patient can be caused by several factors that contribute to the severity and complexity of the injury. One of the main factors is the mechanism of injury experienced by the patient, which in this case involved a motorbike accident with a direct impact on the patient's chest (Apampa et al., 2022; Chudzik et al., 2023). The accident caused significant segmental fractures of ribs 2-9, as well as lung damage due to blunt trauma. Another factor that worsens the condition is the use of a helmet which may amplify the impact of trauma on the patient's chest (Alanwer et al., 2023). In addition, the insertion of a Chest Tube Thoracostomy (CTT) to treat pneumothorax and pleural effusion can also contribute to the development of subcutaneous emphysema, which may be caused by damage to the pleural wall and air trapped under the skin (Marasco et al., 2023).The medical diagnosis of flail chest fracture of ribs 2-9 with pulmonary contusion post CTT and subcutaneous emphysema in patients has a significant impact on the clinical condition and overall prognosis. One of the main impacts is impaired respiratory function, caused by segmental costal fractures and lung contusions which reduce the ability of the lungs to exchange gases effectively (Li et al., 2023). These disorders can result in hypoxemia, increased work of breathing, and decreased lung capacity, all of which can threaten the patient's life (Hoepelman

et al., 2023). In addition, subcutaneous emphysema that develops as a result of thoracic trauma and CTT procedures can also cause an increased risk of infection and tissue complications around the area of injury (Ferreira et al., 2023).

One of the relevant nursing diagnoses is impaired gas exchange related to structural damage to the lungs due to rib fractures and pulmonary contusions. Required interventions include monitoring the patient's oxygenation level, administering oxygen as needed, and periodically monitoring breathing and lung function to detect possible changes (Chudzik et al., 2023). In addition, acute pain associated with tissue trauma and secondary reflex muscle spasm are also relevant nursing diagnoses, where interventions such as administration of analgesics, relaxation techniques, and comfortable positions can help manage the patient's pain effectively (Helkin & Martin, 2020). Other nursing diagnoses include risk of hypovolemic shock and risk of infection, which require close monitoring of vital signs, fluid status, and wound cleanliness to prevent possible complications (Divisi et al., 2021b). Several nursing interventions can be carried out to manage the patient's condition effectively. Interventions to optimize the patient's respiratory function include monitoring oxygenation levels using a pulse oximeter, administering oxygen according to the patient's needs, and regularly monitoring breathing frequency and patterns (Uchida et al., 2020). In addition, nurses can also provide support in proper breathing techniques, such as deep breathing exercises and effective coughing to help improve lung ventilation (Beks, Peek, & Jong, 2019). Another intervention is pain management which includes giving analgesics according to the patient's pain scale, providing a comfortable position, and applying relaxation or distraction techniques to help reduce pain (Liu et al., 2019; Lodhia et al., 2019). Furthermore, interventions to prevent complications such as hypovolemic shock and infection involve regularly monitoring vital signs, monitoring fluid and electrolyte status, and maintaining cleanliness of the wound and injured area (Ingoe et al., 2019).

In cases of flail chest fracture of ribs 2-9 with post-CTT pulmonary contusion and subcutaneous emphysema, nursing interventions such as diaphragmatic breathing exercises can be an important strategy in improving the patient's respiratory function. This exercise aims to strengthen the respiratory muscles, especially the diaphragm, so that the patient can achieve optimal lung ventilation (Dehghan et al., 2018). Patients learn to breathe deeply and effectively, optimizing the use of the diaphragm to expand chest space and facilitate more efficient expiration. Research has shown that regular diaphragmatic breathing exercises can increase lung capacity, reduce respiratory fatigue, and speed recovery of lung function in patients who have experienced thoracic trauma (Pieracci et al., 2018).Thoracotomy operation and installation of 8 wire plates to stabilize rib fractures in Mr. T is a very necessary action considering the flail chest condition he is experiencing. Flail chest is a serious condition in which multiple ribs are broken in more than one place, causing the chest segments to become unstable and move paradoxically with respiration (Coughlin et al., 2016). This procedure is important to restore mechanical stability to the chest wall, which will reduce pain and allow the lungs to function more effectively. Studies show that surgical stabilization with plates and wires in patients with flail chest can reduce the need for ventilators, speed recovery of lung function, and reduce ICU stay (Dehghan et al., 2014). This intervention succeeded in improving respiratory conditions and reducing pain significantly, as demonstrated by the patient's successful release from the ventilator on the first postoperative day and reduction in pain which was managed with intravenous morphine and ketorolac therapy. Stabilization of costal fractures also reduces the risk of complications such as pneumonia and ARDS, improving the patient's overall prognosis (Beks, Peek, Jong, et al., 2019).

Nursing interventions such as Intermittent Positive Pressure Breathing (IPPB) can be an important strategy in improving a patient's respiratory function. IPPB is a mechanical breathing technique used to treat respiratory disorders associated with chest trauma, such as rib fractures and lung contusions. This technique works by applying positive pressure into the respiratory tract during the inspiratory phase, which helps open the alveoli and improve lung ventilation (Divisi et al., 2021a; Guo et al., 2020). Patients can achieve optimal respiratory volume, reduce airflow resistance, and improve gas exchange within the lungs. Research has shown that IPPB can effectively increase lung vital capacity and improve symptoms of shortness of breath in patients with thoracic injuries (Glaser & Rodriguez, 2022; van Gool et al., 2022).Secretion mobilization techniques are important in facilitating the management of excessive secretions and improving the patient's respiratory function. This technique includes several strategies, including chest wall percussion, chest wall vibration, and the use of an incentive spirometer, which aim to help displace trapped secretions within the patient's respiratory tract, encourage their expulsion, and reduce the risk of complications such as atelectasis or pneumonia(Apampa et al., 2022). By performing percussion and vibration on the patient's chest wall, nurses can help break up and loosen secretions trapped in the respiratory tract, making it easier for the patient to expel them through coughing or sucking mucus. In addition, the use of an incentive spirometer can help patients train their breathing, increase lung capacity, and prevent lung collapse due to secretion stasis.(Helkin & Martin, 2020).

CONCLUSION

In the case of Mr. T, a 23 year old man with a flail chest fracture of ribs 2-9 with post CTT pulmonary contusion and subcutaneous emphysema, there is significant complexity in the management of this serious thoracic injury. Patients experience shortness of breath, chest pain, and decreased oxygen saturation. Various nursing interventions have been implemented, including diaphragmatic breathing exercises, Intermittent Pressure Breathing (IPPB), and Secretion mobilization techniques, to help improve respiratory function and facilitate the recovery process.The nursing implications of this case emphasize the importance of careful monitoring of the patient's respiratory function and adjustment of interventions according to individual response. Interprofessional collaboration is also important in creating a holistic and coordinated care plan. Future research is recommended to conduct a larger prospective study to evaluate the effectiveness of various nursing interventions in the management of serious thoracic injuries.

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