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Crush Syndrome Patient Care in Intensive Care Unit

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Abstract

Crush syndrome is a systemic picture that develops as a result of prolonged compression, immobilization, and crushing of muscle groups after trauma and collapse. It affects numerous physiological systems and lays the groundwork for surgical and medical issues. After direct trauma, crush syndrome is the second most common cause of death in large-scale disasters like earthquakes. Rhabdomyolysis, which develops with loss of perfusion owing to compression of the limb muscles, is the primary initiator of crush syndrome.Rhabdomyolysis has a systemic effect whereby intracellular products including electrolytes, enzymes, and myoglobin rise quickly in the bloodstream and result in potentially fatal acute kidney injury and electrolyte imbalances. The 2 main factors that contribute to this syndrome's mortality are hyperkalemia and acute tubular necrosis. Infections, compartment syndrome, hemorrhage, hypovolemic shock, heart failure, respiratory failure, and other problems are also brought on by it.

The management of electrolyte imbalances and associated arrhythmias, the successful treatment of compartment syndrome, the avoidance of infections, and the prevention of potential consequences are all important tasks for intensive care nurses. The administration of the care and treatment process for a trauma patient admitted to intensive care depends heavily on the knowledge, abilities, and experience of nurses.

Keywords: Crush syndrome, intensive care units, patient care, patient care management

Introduction

About 75%-80% of fatalities in large-scale disasters like earthquakes are brought on by penetrating injuries to important organs during shaking. Crush syndrome and problems brought on by muscle-related physical trauma are additional causes of death.[1,2]

"Crush" refers to various crushing, squeezing, compression, and pressure actions. Crush injury only refers to compression-related injuries, whereas crush syndrome includes all of the systemic harm this trauma causes to the body. Rhabdomyolysis and other surgical/medical signs and symptoms add complexity to the picture.[3,4]

A clinical disorder known as rhabdomyolysis, which most commonly affects limb muscles, is characterized by the release of intracellular contents into the bloodstream after perfusion is lost or reduced as a result of compression. Muscle deterioration and the discharge of cellular contents are both influenced by the amount of time spent under debris.[4,5,6]

The disaster victim waiting to be rescued under the rubble experiences continued pressure on their extremities, preventing the harmful compounds generated from their muscle cells from reaching their systemic circulation. This barrier is removed when the victim is saved, and the systemic circulation is then exposed to the electrolytes (K-phosphate), enzymes, myoglobin, and poisonous chemicals released from damaged muscle cells. These drugs induce hazardous and deadly effects, and the patient may pass away suddenly as their blood levels rise.[2,4,7,8]

Complications of crush syndrome include acute tubular necrosis, electrolyte imbalances (particularly hyperkalemia), compartment syndrome, infections, hemorrhage, heart failure, and respiratory failure.[6] It is crucial to assess the symptoms, make a correct diagnosis, and take the required precautions, especially in patients with severe traumatic damage, as these consequences raise mortality and morbidity rates.[1]

The ideas of approach to the patient who has experienced trauma are part of the treatment and care for crush syndrome. The goal of treating traumatized patients is to provide awareness; offer prompt, accurate treatment and care that takes the patient and his or her family into account; help lessen the harm; hasten the healing process; avoid problems; and guarantee a quick and safe transfer of the patient.[9]

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Acute Kidney Injury

One of the most significant side effects of crush syndrome is acute kidney injury (AKI). Myoglobin generated as a result of RM is the first factor that comes to mind in renal injury caused by crush syndrome. Trauma causes myoglobin, a substance ordinarily present in muscles, to leak into the blood and block the renal tubules, leading to acute tubular necrosis and subsequent acute renal failure.[2,4,6]

Hypovolemia and hypotension are additional significant factors in AKI. As a result, renal tubular ischemia develops and renal perfusion is compromised. Renal hypoperfusion is also a result of a decrease in heart stroke volume brought on by electrolyte abnormalities.[4,7,10,11]

Nursing Care

- The prevention of AKI is greatly aided by fluid resuscitation. Rapid initiation of an efficient and dynamic intravenous fluid resuscitation is necessary. Renal blood flow, glomerular filtration rate, and urination will all rise with volume replacement.[2,9,11]
- In the first 24 hours, 10-20 L of fluid may be required, depending on the severity of the rhabdomyolysis. Therefore, appropriate goals for a patient weighing 70 kg are 200-300 mL/h or 2.5-3 mL/kg/h of urine production.[2,11]

- In general, patients should desire a positive fluid balance. since there is an excessive accumulation of fluid between the injured muscles.[10]
- Wide arterial access is necessary for fluid replacement, and extravasation and infiltration should be avoided during infusion.[12]
- To provide objective guidelines for fluid therapy, central venous catheterization should be used.[12]
- Patients' vital signs and electrolyte levels should be closely watched.[12]
- Hemodynamic stability should be ensured in these patients receiving early aggressive fluid therapy, and volume overload should be avoided.[2,11]
- To titrate the amount fluid administered and to keep track of urine output, a urinary catheter should be placed. Monitoring fluid intake and output, tracking urine production and color on an hourly basis, and computing balance are all recommended.[8,12]
- Myoglobinuria should be checked in the incoming urine. Urine with a macroscopic dirty-brown hue should indicate myoglobin is present.[8,10,11]
- Edema and dehydration condition of the patient should be assessed, and daily weight monitoring should be done. The turgor of the skin should be checked.[12,13]
- Generally speaking, oliguria is a sign of a poor prognosis. To avoid deadly complications, it is crucial to administer fluids carefully while closely monitoring the electrolyte and acid–base balance during the oliguric/anuric phase.[8]
- Kidney replacement therapy is the only effective treatment for developing kidney injury.[11]

Electrolyte Changes

Hyperkalemia

Hyperkalemia is the primary laboratory finding in crush syndrome. The most serious issue that poses a threat to life immediately following rescue from the debris is hyperkalemia. During rhabdomyolysis, the blood's normal potassium level, which is between 3.5 and 5 mEq/L, rises to above 6 mEq/L, and the resulting arrhythmia and heart failure are 2 of the conditions that can lead to mortality in crush syndrome.[6,7,8,11,13]

Hyperkalemia develops as a result of several reasons. The causes of hyperkalemia include dehydration, medical treatments (transfusion), surgical interventions, and increased catabolism. The release of potassium, an intracellular ion, from damaged muscle tissue, decreased potassium excretion due to concurrent ABI, development of metabolic acidosis, H^+ ion passing into the cell and potassium leaving the cell, and metabolic acidosis are the main causes.[11]

Hyperphosphatemia

Due to the release of phosphate from injured cells, hyperphosphatemia is seen in rhabdomyolysis. Phosphate and calcium combine to generate $CaPO_4$, which calcifies soft tissue and lowers calcium levels.[11]

Hypocalcemia

Crush syndrome occurs when pressure-induced muscle damage stretches muscle cells, allowing Ca^{3+} to enter the cell through open (Ca^{3+}) channels. Other than this, the primary causes of hypocalcemia in the early stage are the direct effects of hyperphosphatemia and the precipitation of Ca^{2+} by crystals in the injured muscle tissue.[4,7,11]

Nursing Care

- Protecting the patient from lethal cardiac arrhythmias is the main goal of hyperkalemia treatment. Electrocardiography (ECG) analysis is therefore the initial step in determining the impact on the heart.[4,8,14]
- When found on an ECG, the symptoms of hyperkalemia include P wave flattening, longer PR interval, thin pointed T waves, ST depression, and QRS widening.[8,14]
- Insulin-dextrose (buffered) solutions are frequently used in the treatment of hyperkalemia to ensure K^+ entrance into the cell. Fluid overload and peripheral vascular injury should be assessed in the patient before administering hypertonic fluids. Ten percent dextrose solutions can be administered via peripheral vascular access, but a central catheter should be used for greater hypertonic solutions (20%, 30%, and 50%).[8,13]
- The most efficient treatment for hyperpotasemia is hemodialyzation, which quickly eliminates K^+ from the body.[8]
- Potassium-containing solutions shouldn't be administered unchecked.[10]
- When used to treat hypocalcemia, calcium glubionate (10%), calcium gluconate (10%), and calcium chloride (10%) significantly raise serum calcium levels. However, due to their concentration and irritating nature, caution should be exercised when administering intravenous (IV) medications to prevent phlebitis and infiltration. It is important to keep an eye out for erythema, temperature rise, and pain along the vascular access line.[10]
- It should be remembered that calcium administered quickly can result in arrhythmia and hypotension.[13]
- Calcium cannot be administered intravenously to digoxin-using people.[10]
- It should be remembered that the citrate-calcium binding effect of massive transfusions of stored blood may result in hypocalcemia.[10]
- The patient needs to be regularly watched for hypocalcemia symptoms (cardiac arrhythmias and tetany).[12]
- Vital signs should be collected and assessed every hour. Electrocardiography tracing should be closely watched during monitoring since heart rhythm alterations may occur.[9,13]
- Electrolyte levels in the serum should be checked, and any deficiencies should be corrected.[13]

Compartment Syndrome

A variety of factors might cause the "closed fascial compartment," where the muscles are extended, to experience compartment syndrome, which is an increase in interstitial pressure. The pressure inside the compartments is often relatively low (0-20 mmHg). This extremely low pressure begins to rise when the muscles swell and become edematous. Fractures, crush injuries, intramuscular hemorrhages, and closed spontaneous hemorrhages are the most frequent causes.[2,6,15]

The increase in compartment pressure causes an increase in capillary perfusion pressure, a reduction in microvascular circulation, and ischemic damage to nerve and muscle cells. When the pressure is greater than 30 mmHg, clinically significant muscular ischemia ensues.[6,11]

Fasciotomy is carried out under anesthesia when the pressure is greater than 50 mmHg or greater than 30 mmHg for 6 hours.[8,10,11,14]

Nursing Care

- With the early diagnosis of compartment syndrome and neurovascular diseases, nurses play crucial roles. The wounded or at-risk extremity's peripheral circulation, oxygenation, and nerve function should be assessed.[9]
- Diagnoses should be made based on color, warmth, feeling, movement, capillary refill, pulse, discomfort, and edema. The capillaries should refill in 3-5 seconds, and the skin should be warm and pink.[9]
- Pathological signs that should be carefully considered include changes in skin color and warmth, tingling, impaired motor function, increasing pain—especially with passive stretching—increased body temperature, edema, and a sense of pressure or strain.[9]
- The injured extremity needs to be raised and kept above the heart.[9]
- The patient needs to be ready for surgery if a fasciotomy is going to be conducted.[9]
- Fasciotomy will convert a closed wound into an open wound, increasing the risk of infection and possibly resulting in sepsis.[10]
- The wound care of patients with fasciotomy is crucial for preventing infection and ensuring proper tissue feeding, and it should be done under strict operating room conditions and in compliance with aseptic standards.[2]
- Surgical debridement may need to be performed frequently and forcefully on infected wounds.[10]
- Application of dressings and debridement should be done under analgesia and, if required, sedation.[8,9]
- It is advised to utilize the "Quantitative Pain Scale" in the management of pain in patients who are conscious and have verbal communication. The "Intensive Care Pain Observation Scale" or the "Behavioral Pain Scale" can be used on patients who are unconscious, unable to communicate verbally, and receiving mechanical ventilation.[16]
- Before invasive treatments like debridement that could be quite painful, it is routinely advised to use analgesic medications.[16]
- It has been said that the best method for treating pain is patient-controlled analgesia. Additional medication possibilities include opioids (IV morphine), paracetamol, nonsteroidal anti-inflammatory medications, and ketamine.[8,9]

Infection Control

Mortality in crush syndrome is either directly or indirectly caused by infections, particularly in the late stage. It causes a 3-fold increase in mortality and occurs in patients with blunt and penetrating injuries 30%-86% of the time.[2,4,17]

As a result of treatments like debridement, fasciotomy, and amputation that are not carried out under optimal conditions, wound-site infections resulting from the trauma itself and surgical wound infections are more frequent in the early stages. Due to intrusive treatment procedures, health-care-associated infections are now at the forefront of the situation (catheterization, intubation, etc.).[9,17]

The most common infections found in patients monitored in an intensive care unit following trauma include sepsis, wound infections, pneumonia, urinary tract infections, empyema, and catheter infections.[2,4,10,17]

Nursing Care

- Local and systemic infection findings in the patient should be evaluated.[9,12,17]
- Dressing and wound site cleaning should be performed under appropriate conditions. Incision sites should be observed for signs of infection such as redness, swelling, pain, and temperature.[12]
- Hand washing instructions must be followed in patient care.[12]
- The most common infection in patients is sepsis. Wound infections are responsible for a significant portion of sepsis cases. Therefore, wound dressings should be performed at regular intervals and in accordance with aseptic principles. Wound dressings should be performed routinely every day and in some patients several times a day.[9,10]
- In infected wounds, appropriate antibiotics should be given according to the doctor's order after surgical debridement is performed and blood and wound culture samples are taken.[10]
- Hand hygiene, standard precautions and isolation precautions must be followed in the prevention of infections. Environment cleaning, disinfection and sterilization of devices and equipment are very important.[18]
- Patients who are intubated and mechanically ventilated will have an increased risk of ventilator-associated pneumonia:
  - The need for intubation should be assessed every day and extubation should be planned as soon as appropriate.[19]
  - Noninvasive mechanical ventilation (NIMV) should be preferred if possible.[19]
  - Deep sedation should be avoided in patient monitoring, daily sedation holiday should be applied.[19]
  - In the absence of contraindications, the head of the bed should be kept at 30-45° (semisitting position).[19]
  - Daily oral cavity should be evaluated; oral care should be performed with sterile water and toothbrush.[19]
- Urinary tract infections are also common in patients. To prevent urinary tract infections:
  - The aseptic technique must be observed during urinary catheter insertion.[10]
  - The probe should be removed as soon as the need no longer exists.[10]
  - Urinary catheter care should be performed properly and care should be taken to keep the catheter drainage system and bag below the bladder level and off the floor.[19]
- To prevent central catheter-related bloodstream infections in trauma patients with central catheter insertion:
  - Guidelines on hand hygiene, adherence to aseptic technique, use of maximum sterile barrier measures, skin washing, proper catheter type, and site selection should all be taken into account when inserting central catheters.[18]
  - Appropriate access site covers and dressing materials should be selected for catheter care.[18]
  - Blood transfusions, medicine applications, and infusion guidelines should all be adhered to. The frequency of infusion sets and connection connector replacement should be taken into consideration.[18]

Pulmonary Complications

Respiratory issues are greatly increased after disasters. Airway blockage due to trauma, hemopneumothorax, etc.; bronchitis; pneumonia; and asthma attacks stand out in particular. The most frequent of these consequences is acute respiratory distress syndrome (ARDS). In addition to being common, ARDS is significant because it is a significant cause of mortality in this patient population.[2,4,10,14]

About 6-12 hours after trauma, an initial, physiological inflammatory reaction appears. This inflammation is mediated by several endogenous mediators, including cytokines. The likelihood of developing sepsis, septic shock, and multiple organ dysfunction is significant as a result of the systemic inflammatory response. It is fairly typical for ARDS to develop as part of this scenario.[2]

Nursing Care in Acute Respiratory Distress Syndrome

- Respiratory rate, rhythm and depth should be monitored for early recognition of hypoxemic respiratory failure. Particular attention should be paid to chest movement, symmetry, use of auxiliary muscles and intercostal muscle retractions.[12,20,21]
- The patient should be monitored for hyperventilation, dyspnea, and cyanosis.[12,21]
- Deep breathing and coughing exercises should be taught to the patient and spirometry should be encouraged.[12,21]
- Oxygen saturation and blood gas monitoring should be performed.[12]
- The patient should be given the appropriate position so that the ventilation level is optimum.[21]
- In cases where oxygenation cannot be corrected, high-flow nasal oxygen therapy may be initiated.[20]
- In severe cases of ARDS, prone position can be tried to prevent consolidation in the lung fields due to gravity.[20]
- The patient's pressurized areas should be assessed in the prone position and hydrocolloid dressings should be applied to the face, chest, iliac crests, and knees.[16,22]
- Mechanical ventilation should be considered in patients with deepening hypoxemia and increasing respiratory distress.[20]
- Noninvasive mechanical ventilation should be the first choice, and a mask (helmet, full face mask, oronasal mask) appropriate to the patient's condition and face should be used.[16,20]
- Masks should fit the patient's face perfectly, air leakage should be prevented.[16,20]
- The straps of the masks should not be too tight and should be tight enough for 2 fingers to pass through. Pressure-reducing dressings can be applied to reduce pressure on the root of the nose.[16,20]
- Patients who cannot control their secretions, who are at risk of aspiration, who have hemodynamic impairment, and who have altered consciousness are risky patient groups in terms of NIMV.[20]
- Intubation and invasive mechanical ventilation (IMV) should not be delayed in patients with severe respiratory failure.[20]
- In patients on IMV, airway patency should be maintained, effective airway cleaning should be provided by endotracheal aspiration, and the amount and consistency of secretions should be evaluated.[16,22]
- The mechanical ventilator circuit should not be disconnected unless necessary, closed system aspiration method should be used.[20]
- Oral hygiene should be maintained in patients and traumas that may occur in the mouth, lips and tongue due to compression of the intubation tube should be prevented.[22]

Impairment of Physical Mobility

Mobility is restricted by posttraumatic compartment syndrome, invasive catheters, sedatives, stress, sleep difficulties, pain, and bandages.

Muscle atrophy, pressure sores, atelectasis, and bone demineralization are all effects of prolonged bed rest. Edema or dehydration also increases the chance that the integrity of the skin and mucous membranes will be compromised. Thus, in order to protect the integrity of the skin, planning mobilization and position changes for trauma patients monitored in the intensive care unit is crucial.[13]

Nursing Care

- The patient should be mobilized to the extent tolerated and activity intolerance should be assessed.[9]
- The patient's motor functions such as muscle strength, muscle tone, and the ability to move in bed should be evaluated and recorded.[9,16]
- In-bed active and passive exercises should be performed and the patient should be trained on this subject.[9]
- The position should be changed every 2 hours in accordance with the clinical condition of the patient.[16]
- In the patient who cannot tolerate frequent major changes in body position, more frequent and minor changes in position to allow some perfusion may be considered.[9,16]
- The skin should be evaluated for erythema and redness at each position change and appropriate skin care should be provided.[9,16]
- Active or passive range of motion should be performed to prevent joint contractures.[16]
- Pressure injury risk assessment should be made, pressure points should be closely observed and supported with appropriate materials.[16]
- In order to ensure perfusion of the crushed area and the extremity on the crushed side, positions, tight clothing, and interventions that will put pressure on this area should be avoided.[9]

Conclusion

In intensive care, managing a patient with crush syndrome is difficult and necessitates a multidisciplinary team approach. This condition is a side effect of significant physical trauma and has the potential to be lethal.

This article discusses the challenges and nursing interventions that will be used in the management of the patient with crush syndrome in the critical care unit. Among these strategies are maintaining fluid electrolyte balance, preventing potential arrhythmias, treating compartment syndrome successfully, monitoring renal function, and preveinfection.

Hemodynamic monitoring, particularly ECG monitoring and monitoring of patients using mechanical ventilators, is a part of patient follow-up. Also, it is important for patients to receive wound care, dressings, posture, and pain management.

In summary, managing patients with crush syndrome in intensive care can save lives and improve survival rates. As a result, adequate resources should be made available for patient care and treatment, and medical staff should receive training on patient care in emergencies.

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