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Pediatric Critical Care Approach for Children Exposed to Earthquakes

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ABSTRACT

Earthquakes are natural disasters that pose significant risks to children, who are particularly vulnerable to trauma and injuries. For a critical care approach to children exposed to earthquakes, rapid triage, and initial evaluation, proper management of Crush syndrome, electrolyte disorders, compartment syndrome, hypothermia, and infection control are important. In addition to these clinical management maneuvers, psychological support, family-centered care, staff training, and community preparedness are other significant issues in earthquakes. A well-prepared and coordinated approach is essential to meet the immediate and long-term medical and psychological needs of earthquake-affected children, thus increasing their chances of recovery and resilience. In this article, we discussed a critical care approach for pediatric patients exposed to earthquakes as a life-saving intervention.

Keywords: Earthquake, children, Crush syndrome, critical care approach

Introduction

Earthquakes are natural disasters that threaten human life and cause loss of life and property in a very short time. These natural disasters, which are common all over the world, can cause great destruction and loss of life (1). In Turkey, where a large part of the population faces the risk of earthquakes, destructive earthquakes are frequent. Most recently, more than 50 thousand lives were lost in the earthquakes centered in Kahramanmaraş on February 6, 2023, affecting 11 provinces and a population of approximately 13 million, and described by geoscientists as the most destructive terrestrial "double" earthquakes of the century (2).

Children are one of the most vulnerable groups during earthquakes. Children constitute a group that requires special attention in terms of trauma, injury, and emergency medical care needs caused by earthquakes (3). In this article, we provide important information about the approach to pediatric intensive care patients in earthquakes.

Evaluation of Children in the Earthquake

Earthquakes carry serious risks of building collapse, debris, injury, and trauma. During an earthquake, a large-scale mass fatality event, paradoxically, medical resources dwindle while the number of disaster victims presenting to hospitals for treatment

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increases at the same rate. Critical care services must continue to function efficiently to provide care for many patients when injuries or illnesses affect the local population in disaster events. Intensive care units and emergency departments play a key role in disasters and mass casualty events (4). Children injured or severely traumatized by earthquakes may require intensive care units (5).

In mass disaster situations, critical care service function differently compared with their routine functioning. The purpose of critical care in a disaster situation is to establish a triage system to assess and prioritize the medical needs of children. By classifying patients according to different levels of severity, triage ensures immediate intervention for those in critical condition and saves as many lives as possible. Effective triage ensures that patients receive the care they need in the right place, at the right time, and with the right resources. This will prevent the misuse of critical care resources and labor for patients who would have survived without these resources (4,5).

Early and rapid identification of fatal earthquake-related trauma and provision of optimal care are crucial for reducing mortality in pediatric patients. The most common cause of death in earthquakes is penetrating and blunt trauma to vital organs (5,6). All patients extracted from the rubble should be considered to have multiple traumas and should be treated. In the first moments of the disaster, death frequently occurs due to organ injuries related to head, thorax, and abdominal trauma, while asphyxia, hypovolemia, and hypothermia are the leading causes of death in the following hours (3). Crush syndrome and related acute kidney injury (AKI) and compartment syndrome are at risk of developing in all patients who have been under debris for long hours and days, who are rescued alive from the rubble, but who have different levels of muscle trauma (7). Patients who develop compartment syndrome may require fasciotomy and amputation (8).

The initial evaluation of pediatric patients in the emergency department is critical in terms of the type and severity of injuries. The main objectives in the initial evaluation can be generalized as ensuring airway patency, stabilizing circulation, and treating existing injuries. Regarding treatment in the pediatric intensive care unit, the main objectives are maintaining airway patency, appropriate fluid replacement, bleeding control, providing appropriate analgesia, prevention, and management of hypothermia, and management of Crush syndrome and related renal and systemic complications (4,6,7).

Opening the Airway

The patient's airway should be opened by cervical stabilization and oxygen support should be provided. Advanced airway support should be provided when necessary (9).

Crush Syndrome

Crush syndrome is a medical emergency caused by prolonged pressure on an area of the body. This pressure can occur during events such as an accident, building collapse, or natural disaster. Compressed or crushed tissue in the body causes harmful substances to be released into the bloodstream. One of these harmful substances is myoglobin. Myoglobin is a protein found in muscle tissue that can leak into the blood when muscles are damaged or crushed. Other dangerous substances, such as potassium, can also be released from damaged muscle cells (7,10).

Crush syndrome occurs after rhabdomyolysis due to muscle trauma. The most practical method for the diagnosis of rhabdomyolysis is a serum creatine kinase level more than 5 times higher than the laboratory normal. In rhabdomyolysis, substances such as lactic acid, thromboplastin, creatinine kinase, nucleic acids, phosphate, creatinine, myoglobin, and potassium in the striated muscle cells (myocytes) pass into the bloodstream; substances such as calcium, water, and sodium enter the muscle cells (10). These events predispose patients to Crush syndrome and AKI, which is one of the most important elements of this picture (7,11).

Clinical findings in patients with Crush syndrome are analyzed under the headings of local symptoms in the crushed muscles and systemic findings related to the substances released from these muscles (Crush syndrome findings) (10). A typical local finding in patients is compartment syndrome (8). Systemic findings vary greatly depending on the organ and system primarily affected by the condition. The most common findings are hypotension/shock, cardiac and respiratory failure, and AKI. Therefore, timely and appropriate management is vital to prevent these complications (12).

Crush syndrome is a clinical entity that affects not only muscle destruction and multiple organs and systems. It may present with AKI, hypovolemic shock, electrolyte disturbances, sepsis, and disseminated intravascular coagulation. The primary treatment approach is fluid resuscitation as early as possible to correct hypovolemia. Hydration increases renal perfusion and prevents obstruction in the tubules. The most important step for treating Crush syndrome is fluid therapy (12,13).

If possible, starting fluid therapy from the first extremity that can be reached while the patient is still under the rubble will reduce mortality and morbidity. Isotonic NaCl is recommended for fluid therapy because it is the most readily available fluid (12). Isotonic NaCl should be administered at an infusion rate of 15-20 mL/kg/h in children. In patients who stay under debris for a long time, a hypotonic NaCl + bicarbonate mixture may be preferred if it can be found. This solution was prepared by mixing 50 mEq/L bicarbonate into 0.45% NaCl +5% dextrose (1/2 SF) solution to prepare an alkalized solution. The rationale for administering bicarbonate solution for fluid resuscitation is to raise the urine pH above 6.5 to prevent Tamm-Horsfall protein and heme protein precipitation, intratubular plug formation, and uric acid precipitation. This will reduce metabolic acidosis and hyperkalemia; however, bicarbonate supply may be difficult in disasters with mass impact. In such cases, the preferred fluid is an isotonic sodium chloride solution. The infusion rate of fluid therapy should be decreased and adjusted to 10 mL/kg/h as the time to extract the patient from the debris increases. In patients in whom intravenous access cannot be established, intraosseous access should be open and fluid therapy should be started in the early period (14,15,16).

In patients with Crush syndrome who reach the hospital, maintenance fluid therapy can be continued on 3000 cc/m^2/day if there is urine output. Patients undergoing fluid replacement should be closely monitored for complications such as signs of overload and metabolic acidosis. However, if the patient is anuric, classical AKI treatment principles should be followed. Daily fluid therapy should be calculated as 400 cc/m^2+ insensible loss, and the patient should be closely monitored for dialysis indications (16,17).

Dialysis has an important place in treatment. Intermittent hemodialysis, continuous renal replacement therapy, and peritoneal dialysis can be used; however, intermittent hemodialysis is the most effective and will be preferred in the aftermath of an earthquake when medical and logistical considerations are considered (18,19,20). Timely and appropriate treatment of Crush syndrome can increase patients' chances of survival and improve long-term health outcomes.

Electrolyte Imbalances

In particular, hyperpotassemia stands out as the most important laboratory finding in patients with Crush syndrome recovered from the rubble. Because earthquake conditions are such that elective diagnostic approach cannot be performed, the treatment plan should be organized empirically. According to the assumptions, many survivors of earthquakes die from hyperpotassemia. Performing laboratory tests or waiting for the results for initiation of treatment may cause acute loss of the patient who is extracted alive from the rubble due to electrolyte imbalance. Therefore, care should be taken to ensure that potassium is not present in the fluid to be administered and that potassium-containing fluids such as Ringer lactate are not given. Hyperphosphatemia, hypocalcemia, and hypoalbuminemia are also frequently observed in these patients (19,21).

Compartment Syndrome

This is the name given to the increase in the normally very low (0-15 mmHg) pressure of the closed spaces (compartments) surrounded by rigid fascia in which the muscles are located (22). Clinical findings and intra-compartmental pressure measurements are useful in the diagnosis of compartment syndrome. The simplest and most effective treatment for this syndrome is surgical opening of the fascia (or fasciotomy). Prophylactic fasciotomy is not recommended in all patients with Crush syndrome to prevent the development of compartment syndrome. Fasciotomy is particularly indicated if there are progressive clinical signs of acute compartment syndrome associated with the absence of mediastinal pulses or confirmed elevation of compartment pressures (8,23).

Amputation is recommended when a limb is unsalvageable and the injury causes sepsis, systemic inflammation, or uncontrollable bleeding. Patients who develop compartment syndrome and require amputation should be closely followed by the orthopedics and traumatology and physical therapy and rehabilitation branches (24).

There is limited evidence that hyperbaric oxygen therapy may improve perfusion, accelerate wound healing, and reduce surgical interventions by reducing oxidative stress and inflammation in patients with compartment syndrome (25).

Hypothermia

Hypothermia is defined as an involuntary decrease in the central body temperature below 35 °C. Patients with multiple and central nervous system trauma are prone to hypothermia. Hypothermia causes severe coagulopathy, complicates bleeding control, increases the need for transfusion, and is associated with serious mortality and morbidity. Appropriate central temperature measurements are required for the diagnosis of hypothermia. Treatment of systemic hypothermia and maintenance of local frostbite with general supportive therapies and rewarming applications are required (26).

Infection Control

It is critical to maintain strict infection control protocols to prevent the spread of diseases, especially in pediatric intensive care units. Adequate sanitation, hand hygiene, and isolation of infectious patients are essential measures for infection control. However, after an earthquake, it becomes difficult to maintain proper infection control measures because of limited resources and overcrowded conditions. In particular, wound infections are common. Therefore, wound care and debridement of contaminated wounds are essential for infection control. Antibiotherapy administered without source control not only is not therapeutic but also creates problems in terms of antibiotic resistance and the growth of resistant microorganisms. If the patient has signs of systemic infection, culture samples should be taken, and antibiotherapy with the appropriate spectrum should be started (27).

Emotional Trauma

Earthquakes are emotionally traumatic for children and can cause anxiety, fear, and distress. It is necessary to create a pediatric intensive care environment in which children affected by earthquakes feel safe. Both children and their families may need psychosocial support to cope with the serious psychological effects and stress of the earthquake. Therefore, it is essential that psychologists and psychiatrists participate in the treatment team (28,29).

Family-centered Patient Care and Communication with the Family

Families of patients hospitalized in pediatric intensive care for earthquake or other reasons are under great stress. There may be deaths or missing family members due to the earthquake. The extent of the impact on the family is directly reflected in the patient being treated in pediatric intensive care. The pediatric intensive care team should establish effective communication with families, provide up-to-date information about the child's health status, and, if possible, involve the family in the treatment process (30).

Training

Pediatric intensive care and hospital staff should be trained in disaster medicine at regular intervals. If necessary, drills and simulations should be conducted to ensure that the team is prepared for any disaster situation (31).

Coordination

Effective communication and coordination among healthcare providers, government agencies, and non-governmental organizations in a hospital under disaster conditions is a key component of a successful pediatric intensive care approach. Establishing continuous lines of communication and collaboration ensures the efficient use of available medical resources and rapid provision of depleted resources. Communication will also ensure that children who cannot receive the treatment they need under the current disaster conditions can access the care they need through an effective referral chain (32).

Conclusion

In conclusion, earthquakes are natural disasters that can have devastating consequences for children. It is essential to prioritize the health of pediatric patients, our most vulnerable patient group, in times of crisis. The timing of major disasters such as earthquakes is unpredictable, but it is necessary to be prepared in every aspect to minimize the devastating effects. Crush syndrome is a clinical picture that all physicians should be aware of, and early and appropriate intervention can life-save. A well-prepared pediatric intensive care approach is essential to meet the immediate and long-term medical and psychological needs to survive children. Rapid intervention in pediatric intensive care patients with a trained and coordinated healthcare team, access to effective treatment methods requiring advanced equipment, infection control, family-centered care, and psychosocial support will significantly increase the chances of recovery and resilience of children exposed to earthquakes. The most important step to prevent children from being exposed to earthquake trauma is to increase earthquake preparedness in the community and take the necessary measures to ensure that children remain safe.

Ethics

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: N.A, Concept: N.A, Design: N.A, Data Collection or Processing: N.A, Analysis or Interpretation: N.A, Literature Search: N.A, D.Y., Writing: N.A, D.Y.

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