Chain of Survival and Emergency Medical Services for Children

Case Study

A 3-year-old is found floating face down in the family pool. The child’s distraught mother says she last saw the child about 15 minutes ago. Mom removed the child from the pool and then called 9-1-1. She is performing cardiopulmonary resuscitation (CPR) per the emergency medical services (EMS) dispatcher’s instructions via the telephone. Police officers are the first to arrive on the scene. They begin CPR after confirming that the child is unresponsive, apneic, and pulseless.

What prevention measures could have been implemented to prevent this tragic situation?

Objectives

1. Identify the links in the Pediatric Chain of Survival.
2. Explain the purpose of the emergency medical services for children (EMSC) program.
3. Define the terms primary prevention, secondary prevention, and tertiary prevention as they relate to injury prevention.

Pediatric Chain of Survival

In adults, sudden nontraumatic cardiopulmonary arrests are usually the result of underlying cardiac disease. In children, causes of nontraumatic cardiopulmonary arrest include bronchospasm, congenital cardiac abnormalities, dysrhythmias, foreign body aspiration, gastroenteritis, seizures, sepsis, drowning, sudden infant death syndrome (SIDS), and upper and lower respiratory tract infection, among other causes.

The Pediatric Chain of Survival represents a sequential series of events to assess, support, or restore effective ventilation and circulation to the infant or child experiencing a respiratory or cardiorespiratory arrest. The sequence consists of five important steps:
Prevention of illness and injury
- Early CPR
- Early EMS activation
- Rapid Advanced Life Support (ALS)
- Integration of post-cardiac arrest care

Note that activating EMS is delayed until after a trial of early CPR. This is based on the higher likelihood of respiratory conditions and lower likelihood of ventricular fibrillation as the cause of cardiopulmonary arrest in the pediatric patient.

It is estimated that about 6% of the children who experience an out-of-hospital cardiac arrest and 8% of those who receive prehospital resuscitation survive. Survival rates can be improved with prompt bystander CPR.

The Role of Emergency Care Professionals in Caring for the Ill or Injured Child

Emergency care of children and families requires specific knowledge, equipment, skills, and resources. A child’s physiologic response to a critical illness or injury differs from an adult’s for such conditions as shock and prolonged respiratory distress. The etiologies of catastrophic events, such as cardiopulmonary arrest, are different from those in adults. In children, the signs and symptoms of distress may be subtle.

The impact of an injured or acutely ill child is devastating not only for the child, but also for the child’s family and the emergency care provider. When treating the child, we must remember to treat the family. Psychological and emotional management of the family is important at this critical time.
Early EMS systems (mid to late 1960s and early 1970s) focused on providing rapid intervention for sudden cardiac arrest in adults and rapid transport for motor vehicle crash victims. Because these systems focused on adult care, outcomes for adults in emergencies improved dramatically, whereas the specialized needs of children experiencing a medical emergency went largely unrecognized. As a result, the equipment, training, experience, and expertise of prehospital personnel were often less developed to meet the needs of children.

In the mid-1970s, this weakness in the EMS system began to be recognized. Healthcare professionals including pediatric surgeons, pediatricians, emergency physicians, and other concerned groups worked to ensure that the special needs of children were integrated into the EMS system. Their efforts remained unfunded until Congress enacted legislation in 1984 (Public Law 98-555) authorizing the use of federal funds for EMSC. EMSC efforts have improved the availability of child-size equipment in ambulances and emergency departments (EDs). EMSC has initiated hundreds of programs to prevent injuries and has provided thousands of hours of training to emergency medicine technicians (EMTs), paramedics, and other emergency medical care providers.

The EMSC program is designed to reduce child and youth mortality and morbidity sustained due to severe illness or trauma. It aims to:

- Ensure state-of-the-art emergency medical care for the ill or injured child and adolescent
- Ensure that pediatric service is well integrated into an EMS system backed by optimal resources
- Ensure that the entire spectrum of emergency services, including primary prevention of illness and injury, acute care, and rehabilitation, is provided to children, adolescents, and adults.

The EMSC program is responsible for a broad spectrum of services including prevention, early recognition of problems, initial stabilization of infants and children, and rehabilitative care.

EMSC encompasses seven phases of child and family services:

1. Prevention
2. System access
3. Field treatment (prehospital response)
4. Transport
5. Emergency department (ED) (stabilization) care
Pediatric injuries are a major public health concern. Toddlers are at greatest risk for burns, drowning, falls, and poisonings. Young school-aged children are at risk for pedestrian injuries, bicycle-related injuries, motor vehicle occupant injuries, burns, and drowning. Teenagers are at risk for motor vehicle occupant trauma, drowning, burns, and intentional trauma.

Two criteria by which the significance of childhood injuries can be measured are death and morbidity. Although death is the worst possible outcome, injuries cause widespread morbidity, which results in the need for medical care and an inability to perform normal daily activities.

The type, number, and severity of pediatric injuries in a given area depend partly on regional characteristics.

- Geography (type of terrain, average response times for emergency care)
- Climate and weather conditions (temperature extremes, violent storms)
- Population density (crime rates, 9-1-1 coverage, availability of medical services)
- Population traits (ethnic backgrounds, education levels)
- Age also influences injury rates and patterns

Successful injury prevention requires an approach that incorporates the ‘Four E’s’: education, enforcement, environmental modification, and engineering.

- Education attempts to bring about positive behavioral changes by informing various groups about the existence of hazards and explaining ways to reduce or prevent the injuries these hazards may cause.
- Enforcement attempts to reduce dangerous behaviors through legislation that requires individuals, manufacturers, and local governments to comply with certain safety practices. Examples include mandatory seat belt and helmet laws, handgun control, zoning codes that require fences around private swimming pools, and safety regulations governing the manufacture of children’s toys.
- Environmental modifications target social issues and physical features within a community that contribute to injury patterns. Examples include providing free smoke detectors or bike helmets to low-income families.
- Engineering involves technological changes that make products or the environment safer. Examples include childproof caps for medications and household solvents.

Epidemiology of Pediatric Illness and Injury

Use of the term accident, which implies an unpredictable or unavoidable event, is being replaced with the term injury to more accurately reflect the nature of the problem.

Unintentional injuries are the leading killer of children ages 14 and under.
The most effective prevention strategies combine methods from multiple categories from the "Four E's." For example, a legislative change might combine environmental modification, enforcement, and education strategies to increase public acceptance.

### Pediatric Equipment

When caring for the pediatric patient, treatment interventions are usually based on the weight of the child. As a result, a range of age-appropriate and size-appropriate equipment (including bags and masks, tracheal tubes, and intravenous catheters) must be readily available for use in pediatric emergencies. The equipment and supplies must be logically organized, routinely checked, and readily available.

Studies have documented unreliability at estimating children's weights, a high rate of errors made when performing drug calculations, and a loss of valuable resuscitation time secondary to computing drug dosages and selecting equipment.

Length-based resuscitation tapes (Figure 1-1) are one example of a system that may be used to estimate weight by length and simplify selection of the medications and supplies needed during the emergency care of children. In the example shown, the tape assigns children to a color zone on the basis of their length. Appropriate resuscitation medication doses and equipment sizes are listed on the tape, as well as abnormal vital signs, fluid calculations, and energy levels recommended for defibrillation. If the child is taller than the tape, standard adult equipment and medication dosages are used.

### Treatment Protocols and Practice Guidelines

Treatment protocols and procedures specific to the pediatric patient are essential and should be developed to guide and maintain consistency in the delivery of emergency care. As protocols are developed, prevention, access, prehospital care, ED care, inpatient services, and rehabilitation must be considered.

#### Prehospital

Prehospital management of the pediatric patient necessitates the development and implementation of protocols for pediatric triage, transport, and treatment. Medical direction guidelines for the management of pediatric patients should exist for basic life support (BLS) and ALS prehospital providers. These guidelines may exist in off-line protocols or online.
Figure 1-1  A length-based resuscitation tape is used to quickly estimate a child’s height and determine equipment needs and medication doses.

medical direction.

Appropriate prehospital triage of the pediatric patient requires knowledge of community levels of pediatric care, available transport methods, and skill in pediatric assessment. Pediatric triage protocols should include hospital bypass criteria. The National Association of EMS Physicians has developed pediatric field treatment protocols for prehospital professionals. These protocols are available online at www.naemsp.org.

Because caregivers often take an ill or injured child directly to the ED, it is essential that EDs and hospitals provide treatment that conforms to the recognized level of care with appropriate equipment, trained personnel, patient care guidelines, and an organized system of care response.

Minimum voluntary requirements endorsed by the American College of Emergency Physicians (ACEP), the American Academy of Pediatrics, and a task force sponsored by the federal EMSC program have been published. These guidelines outline necessary resources for pediatric emergency care in all EDs, and address stabilization and transfer of selected patients to specialized pediatric centers (e.g., pediatric trauma centers, pediatric critical care centers).

Emergency Departments

When a child requires specialized care, agreements should exist between hospitals to facilitate transfer of the child and ensure a smooth and rapid transition. Children who experience a major complication or disability because of their illness or injury should be linked to
rehabilitation services as early as possible.

**Primary Care Providers**

Children should have a designated primary care provider for preventive health services and management of healthcare conditions before they become emergencies. These primary care providers should be prepared to manage potential emergencies in their office setting until prehospital professionals are able to respond.

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**Identifying the Ill or Injured Child**

**Public Information and Education**

Parents and other guardians, such as childcare providers, day care workers, and babysitters need to know how to do the following:

- Distinguish emergent and nonemergent events
- Perform emergency first aid procedures
- Contact the child’s physician
- Access the emergency care system
- Authorize emergency care and provide essential information to emergency care professionals

**Emergency Care Professionals**

Emergency care professionals:

- Must be trained and competent in the care of pediatric patients. Support personnel from respiratory therapy, radiology, laboratory, and other departments should be oriented to the care of the pediatric patient.
- Must be able to recognize the signs that indicate a child’s condition is becoming potentially life-threatening. This requires understanding that there are differences in anatomic and physiologic characteristics, as well as cognitive, emotional, and psychosocial responses, in pediatric age groups.

Essential knowledge for emergency care professionals includes growth and development, pediatric triage and acuity level identification, pediatric assessment and intervention techniques, common pediatric disease and injury processes, and prevention strategies as they relate to the infant, child, and adolescent. 

Children account for a small percentage of the total patients treated by emergency care professionals. Therefore, there are frequently insufficient opportunities to use pediatric assessment and life-saving skills. Because skill decay is rapid, frequent practice sessions and refresher training are extremely important to maintaining preparedness.
Primary prevention measures applicable in this situation include the use of a pool fence and a self-latching and locking gate surrounding the entire pool area, and ensuring that the caregivers know how to swim. Parents, other relatives, and neighbors should be taught CPR. These individuals should also be taught that **constant** supervision of children is necessary, particularly around water.

As a healthcare professional, you play a vital role in the Chain of Survival. By working together, we can increase the pediatric patient’s chance of survival.

### Web Resources

- [www.aap.org](http://www.aap.org) (American Academy of Pediatrics)
- [www.naemsp.org](http://www.naemsp.org) (National Association of EMS Physicians)

### References

Chapter Quiz

1. The efforts of the _______________ program have improved the availability of child-size equipment in ambulances and emergency departments, initiated hundreds of programs to prevent injuries, and provided thousands of hours of training to emergency medical care providers.

2. True or False: The upper age limit of a child, as defined by the federal EMSC program, is 14 years of age.

3. List the seven phases of child and family services encompassed by the EMSC program:
   1. _______________________________
   2. _______________________________
   3. _______________________________
   4. _______________________________
   5. _______________________________
   6. _______________________________
   7. _______________________________

4. Which of the following correctly reflects the sequential steps in the pediatric Chain of Survival?
   A) Early EMS activation, early ALS, prevention of illness or injury, early CPR, post-cardiac arrest care
   B) Early CPR, prevention of illness or injury, early ALS, early EMS activation
   C) Early ALS, early EMS activation, early CPR, prevention of illness or injury
   D) Prevention of illness or injury, early CPR, early EMS activation, early ALS, post-cardiac arrest care

5. ____________ prevention involves measures that can be applied in advance to reduce the likelihood that an injury will occur. ____________ prevention includes interventions that will help prevent or minimize an injury while it happens. ____________ prevention includes measures to lessen the severity of an injury and improve the patient’s outcome after the injury has occurred.

6. List the “Four E’s” required for successful injury prevention:
   1. _______________________________
   2. _______________________________
   3. _______________________________
   4. _______________________________
Chapter Quiz Answers

1. The efforts of the Emergency Medical Services for Children (EMSC) program have improved the availability of child-size equipment in ambulances and emergency departments, initiated hundreds of programs to prevent injuries, and provided thousands of hours of training to emergency medical care providers.

2. False. The federal EMSC program defines the population of children to include those from birth to 21 years of age.

3. The seven phases of child and family services encompassed by the EMSC program are:
   - Prevention
   - System access
   - Field treatment (prehospital response)
   - Transport
   - Emergency department (stabilization) care
   - Inpatient services (definitive care)
   - Rehabilitation (physical therapy, occupational therapy, social services)

4. D. The pediatric Chain of Survival represents a sequential series of events to assess, support, or restore effective ventilation and circulation to the child experiencing a respiratory or cardiorespiratory arrest. The sequence consists of five important steps: 1) Prevention of illness or injury, 2) Early CPR, 3) Early EMS activation, 4) Early ALS, and 5) Integration of post-cardiac arrest care.

5. Primary prevention involves measures that can be applied in advance to reduce the likelihood that an injury will occur. Secondary prevention includes interventions that will help prevent or minimize an injury while it happens. Tertiary prevention includes measures to lessen the severity of an injury and improve the patient’s outcome after the injury has occurred.

6. Successful injury prevention requires an approach that incorporates the “Four Es”: Education, Enforcement, Environmental modification, and Engineering.