

Seizures

What You'll Cover

- Emergency management of brief seizures and status epilepticus
- Assessment findings and appropriate interventions for a child in the postictal state
- Basic and advanced interventions for active seizures
- Common types and causes of pediatric seizures

Glossary

The following specialized terms are used in this chapter:

absence seizure—a type of generalized seizure in which the patient experiences a brief loss of awareness and appears to be staring

anorexia—diminished appetite

antipyretic agent—fever-reducing medication

circumoral—around the mouth

clonic—relating to rapid alternate contraction and relaxation of affected muscles, resulting in a jerking motion

complex partial seizure—a type of partial seizure that usually causes altered mental status and may cause a variety of abnormal behaviors

febrile seizure—a seizure caused by an elevated body temperature

focal seizure—another name for a simple partial seizure

generalized seizure—a class of seizures that usually involve a period of altered mental status

grand mal seizure—another name for a generalized tonic-clonic seizure

hypocalcemia—a condition involving abnormally low levels of calcium in the blood

hypopnea—respiration that is shallow or slow or both

hypotonia—decreased muscle tone

impact seizure—a brief seizure that occurs immediately after head trauma

meninges—thin tissues that cover the brain and spinal cord

meningitis—an infection of the meninges

nuchal—pertaining to the nape of the neck

partial seizure—a class of seizures that includes simple partial seizures and complex partial seizures

petechiae—small hemorrhagic spots on the skin, usually less than 1 to 2 millimeters in diameter

petit mal seizure—another name for an absence seizure

postictal—relating to the state that follows a seizure

purpura—a condition characterized by dermal lesions due to hemorrhage into the skin

seizure—an abnormal electrical discharge of central nervous system neurons, often resulting in

muscle contractions

simple partial seizure—a type of partial seizure that may involve tonic or clonic muscle movement in a single part of the body with no change in mental status

status epilepticus—a seizure that continues for longer than 30 minutes, or a series of seizures in which the patient remains unresponsive between seizures

substrate—a substance acted upon and changed by an enzyme

tonic—relating to continuous, unremitting muscle contractions, causing the appearance of rigidity in the affected muscle

tonic-clonic seizure—a type of generalized seizure in which the patient may experience tonic or clonic muscle activity followed by a period of somnolence or confusion

vesicle—a blister

Interventions described in this chapter are recommendations based on the medical literature, national pediatric prehospital protocols, and expert opinion. They are not intended to serve as a standard of care. Interventions for individual patients must adhere to regional protocols and medical direction.

Learning Objectives and Key Points

The following learning objectives are covered in this chapter. Key points are discussed in more detail within the chapter text.

describe the difference between a brief seizure and status epilepticus

Most seizures are brief, lasting only a minute or two. These seizures usually do not harm the child. *Status epilepticus* denotes a seizure that continues for 30 minutes, or a series of seizures occurring over a 30-minute period in which the child does not recover normal mental status and function between active seizures. If a seizure continues from the time the emergency call is received through the time you arrive on the scene, treat it as status epilepticus.

describe 4 assessment findings often seen in a child experiencing a seizure

During a seizure, a child may exhibit altered mental status, behavioral changes, hypotonia, emesis, eye deviation, and uncontrolled tonic and clonic muscle movements. Bowel or bladder incontinence may be observed in toilet-trained children. Airway obstruction and respiratory problems are commonly seen as well.

describe 3 interventions for children following a brief seizure

Following a brief seizure, open the child's airway and provide suctioning as necessary. Initiate pulse oximetry if available; provide high-concentration oxygen in all cases. Reassess airway, breathing, circulation, and mental status frequently. Assess for hypoglycemia and head trauma; if present, provide appropriate management.

describe 2 immediate interventions for active seizures

During an active seizure, open and maintain the airway as needed. Protect the child from striking

hard or sharp objects. Provide suctioning and assisted ventilation if necessary. Give high-concentration oxygen in all cases. Transport promptly after initial stabilization. If time allows, initiate the focused history and detailed physical examination during transport.

state 2 hazards presented by bite blocks during an active seizure

Do *not* insert a bite block during a seizure. Bite blocks may break during an active seizure, presenting the risk of aspiration with airway obstruction. Unbreakable bite blocks can damage the teeth if the child bites down hard. In either case, soft tissue injuries may result if the child bites down and catches the lips, tongue, or cheek between the hard object and the teeth.

state 1 hazard presented by oropharyngeal airways during an active seizure and how to prevent it

Oropharyngeal airways pose risks similar to bite blocks. If the airway becomes obstructed or assisted ventilation is necessary during an active seizure, consider inserting a nasopharyngeal airway as a safer alternative.

describe secondary assessment and transport priorities for brief seizures and status epilepticus

If you arrive on the scene after a brief seizure has ended and the child's initial assessment findings are normal, proceed with the focused history and detailed physical examination on the scene, then transport according to regional protocols. Status epilepticus is a medical emergency requiring prompt initial interventions followed by immediate transport. Begin the focused history and physical examination en route to the hospital if time allows.

list 3 focused history points that can help you describe seizure activity

If you did not witness the seizure, it is important to gather information that can help hospital personnel determine its cause. Ask the parents to describe (1) the duration of the seizure; (2) specific seizure activity, such as eye deviation, bladder or bowel incontinence, mental status, and tonic-clonic muscle movements; (3) events leading up to the seizure, including history of fever; and (4) whether multiple seizures occurred, either at this time or on a previous occasion.

describe 1 pharmacologic intervention for ongoing seizures

If the child has continuing seizures, consider administering an anticonvulsant medication after transport is underway. Benzodiazepines are most commonly given. Use the intravenous or intraosseous route if readily available. Rectal diazepam or intramuscular midazolam are acceptable alternatives if vascular access cannot be readily obtained.

describe 1 complication associated with anticonvulsant drug treatment

Most anticonvulsant drugs can cause respiratory depression. This problem will be more pronounced if the seizure is prolonged or if the child's seizures have already been treated with barbiturates or benzodiazepines. Monitor the airway, ventilation, and oxygenation carefully after drug administration.

describe the emotional impact of a seizure on the patient and family and list 2 appropriate responses

The child and family often feel tremendous fear and anxiety during and after a seizure, particularly if it has never happened before. To alleviate this reaction, remain calm and reassuring throughout your assessment and interventions. Use the opportunity to educate the patient and family about seizures and explain that everything is being done to safeguard the child. Mention that the seizure itself usually does no harm. Explain that drowsiness or confusion following a seizure is normal and will soon pass.

list 3 common causes of seizures in infants and children

Causes of seizures in infants and children vary according to age. Some of the more common causes include fever, hypoglycemia, hypoxia, poisoning, drug abuse, head trauma, meningitis, and epilepsy (particularly when patients do not take their medication as directed).

NSC Objectives

Information in this chapter supports the following objectives from the paramedic *National Standard Curriculum*:

- 5-3.12 Discuss the pathophysiology of seizures. (C-1)
- 5-3.13 Discuss the assessment findings associated with seizures. (C-1)
- 5-3.14 Define seizure. (C-1)
- 5-3.15 Describe and differentiate the major types of seizures. (C-3)
- 5-3.16 List the most common causes of seizures. (C-1)
- 5-3.17 Describe the phases of a generalized seizure. (C-1)
- 6-2.65 Describe the epidemiology, including the incidence, morbidity/ mortality, risk factors and prevention strategies for neurological emergencies in infants and children. (C-1)
- 6-2.66 Discuss the pathophysiology of neurological emergencies in infants and children. (C-1)
- 6-2.67 Discuss the assessment findings associated with neurological emergencies in infants and children. (C-1)
- 6-2.68 Discuss the management/ treatment plan for neurological emergencies in infants and children. (C-1)

Introduction

A seizure is caused by abnormal electrical discharge of neurons in the central nervous system. It is a common medical event in children. During the first 16 years of life, about 4% to 6% of all children experience at least 1 seizure. Most of these are febrile seizures affecting children younger than 6 years.

During a seizure, a child may exhibit altered mental status, behavioral changes, hypotonia, emesis, eye deviation, and uncontrolled tonic and clonic muscle movements. Bowel or bladder

incontinence may be observed in toilet-trained children. Airway obstruction and respiratory problems are commonly seen as well.

During the postictal period, the child may exhibit somnolence or confusion lasting from a few minutes to several hours, with shorter seizures usually having shorter recovery periods.

Seizures increase the body's demand for oxygen, glucose, and other substrates. Prolonged seizures can cause brain damage.

Brief seizures

Most seizures last less than 2 minutes, ending before you arrive on the scene. Brief seizures usually are not life threatening and will not cause brain injury. However, any seizure is an indication of an underlying problem, and the child should be transported and evaluated in the ED to determine the cause.

Status epilepticus

When a single seizure continues for more than 30 minutes, or a series of seizures continues for a 30-minute period without the child recovering normal mental status and function in between, it is called *status epilepticus*.

If a seizure continues from the time the emergency call is received through the time you arrive on the scene, *or* if the child is unresponsive when you arrive and then experiences a new seizure, treat it as status epilepticus. This is a true medical emergency that can cause brain damage or death. Management includes airway maintenance, oxygenation, ventilation, and immediate transport followed by anticonvulsant administration. Lengthy seizures are particularly likely to result in hypotonia and hypoxia, leading to airway obstruction and ineffective respiration. In all cases, there is a risk of aspiration due to emesis.

Status epilepticus can occur as the first seizure event in a child who has no prior history of seizures.

Management of Patients in the Postictal State

Because most seizures are brief, you will usually find the child in the postictal state when you arrive on the scene. In the aftermath of a brief seizure, children generally appear somnolent or confused, exhibiting poor interaction with their parents or others on the scene.

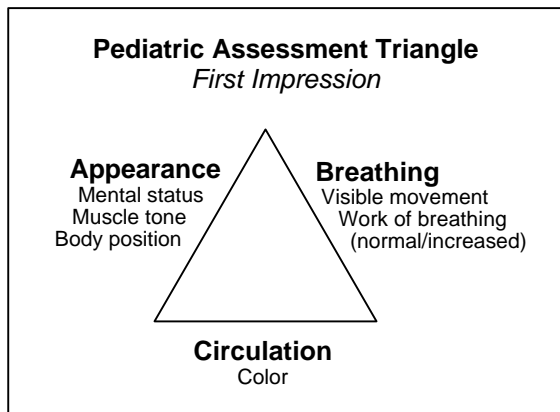
Focus your initial management actions on airway and ventilation: Position the airway and suction secretions as necessary. Initiate pulse oximetry if available; provide high-concentration oxygen in all cases. Assist ventilation as indicated.

If time allows, try to establish potential causes of the seizure through the focused history and

detailed physical examination. Treat the child for any significant findings, such as hypoglycemia or head trauma. Reassess airway, breathing, circulation, and mental status frequently throughout transport.

Scene Safety

On arrival, secure the area and ensure scene safety before proceeding with the first impression.



First Impression

Form a rapid first impression of the patient’s appearance, breathing, and circulation as illustrated in the Pediatric Assessment Triangle (*Figure 1*). Visually evaluate mental status, muscle tone and body position, chest movement, work of breathing, and skin color. Look for obvious injuries at the same time.

If you arrive during the postictal state following a brief seizure, the child will usually appear confused and may be difficult to rouse. You may also note hypotonia, which sometimes causes airway obstruction and hypoventilation.

Figure 1

If you arrive during an active seizure, you may note any combination of the following findings:

- uncontrolled tonic or clonic movements of the arms and legs (*see Figure A34*)
- tonic or clonic movements affecting a single part of the body, such as a finger or an eyelid
- eye deviation
- reduced level of consciousness
- periods of unresponsiveness
- hypotonia
- changes in behavior
- audible breath sounds or poor chest rise due to airway obstruction

Note, however, that seizure activity varies with the type of seizure involved. In partial seizures, for example, signs are less specific. See the *Explanatory Text* later in this chapter for more information.

Initial Assessment

Proceed with initial assessment of the patient’s airway, breathing, circulation, and mental status, applying appropriate interventions as you go. In postictal patients who were not alert or

responsive to voice during the first impression, establish level of consciousness by gently shaking the child's shoulder before proceeding with airway assessment. In patients experiencing an active seizure, immediately begin management actions described below.

Observe body substance isolation procedures (universal precautions) before performing any action that may involve contact with blood, emesis, or secretions.

Airway

Emesis and hypotonia increase the risk of airway obstruction during both the active seizure and the postictal state. Hypotonia can also affect respiratory muscles, leading to hypoventilation and respiratory failure. This makes airway maintenance, suctioning, and attention to adequate ventilation particularly important.

Airway management during the postictal period

If the airway is patent without positioning or suctioning and there is no history or evidence of trauma, place the patient in the left lateral decubitus position (recovery position, *see figure A35*). This will reduce the risk of aspiration if emesis occurs.

If airway opening and suctioning are needed or if there is a risk of trauma, place the child supine, observing spinal precautions. Open the airway as necessary, using a modified jaw thrust if trauma is possible.

Give high-concentration oxygen in all cases. Provide suctioning as needed. Resume high-concentration oxygen after suctioning.

If respirations are inadequate after positioning and suctioning, begin assisted ventilation using a bag-mask device with high-concentration oxygen. Children with persistent altered mental status and no gag reflex may require airway adjuncts. Be prepared to perform endotracheal intubation if assisted ventilation is ineffective or if the airway cannot otherwise be maintained.

Airway management during an active seizure

If the child is experiencing an active seizure and there is history or evidence of trauma to the head or neck, place the child supine and manually stabilize the head and cervical spine. If there is no possibility of trauma, place the child in the sniffing position. Open and maintain the airway as needed during the seizure, using a modified jaw thrust if trauma is possible.

If the child has uncontrolled tonic-clonic muscle movements, gently support the head to prevent injury. Loosen any tight or restrictive clothing. Move hard or sharp objects away to protect the patient from striking them. If emesis occurs, place the patient in the left lateral decubitus (recovery) position to reduce the risk of aspiration. Provide suctioning and assisted ventilation as necessary.

Do *not* insert a bite block during a seizure. Bite blocks may break during an active seizure, presenting the risk of aspiration with airway obstruction. Unbreakable bite blocks can damage the teeth if the child bites down hard. In either case, soft tissue injuries may result if the child bites down and catches the lips, tongue, or cheek between the hard object and the teeth.

Oropharyngeal airways pose risks similar to bite blocks. If an airway adjunct is necessary to support assisted ventilation during an active seizure, consider inserting a nasopharyngeal airway as a safer alternative. Never put your fingers in the patient's mouth during a seizure, as jaw muscle spasms can cause serious bite injuries.

In most cases, even in children with persistent seizures, you will be able to maintain the child's airway and ventilation with positioning, suctioning, high-concentration oxygen, and assisted ventilation. In rare cases, you may find that jaw clenching and emesis during seizures interferes with these measures.

Endotracheal intubation should be considered *only* if BLS actions, including placement of a nasopharyngeal airway adjunct, are ineffective. Consult medical control or regional protocols. Rapid sequence intubation, utilizing paralytic agents, will help to decrease jaw muscle spasm, making airway management actions, such as oral suctioning and endotracheal intubation, easier to accomplish. (see Advanced Airway).

Breathing

Assess breathing, including work of breathing, rate, pattern, and depth, after the airway has been stabilized. Altered mental status can cause hypotonia and hypopnea during both the active seizure and the postictal state. Initiate pulse oximetry if available, as this will help you assess the degree of hypoxia as well as the child's response to treatment. Look for signs of persistent airway obstruction, inefficient respiration, or ineffective assisted ventilation. Assess for signs of respiratory distress as well.

Continue high-concentration oxygen. Assist ventilation if the child is cyanotic, has shallow chest rise with bradypnea, or has an oxygen saturation reading below 90% despite high-concentration oxygen.

Circulation

If active hemorrhage is present due to injuries suffered during the seizure, apply direct pressure over wounds. Seizures rarely cause poor perfusion; if signs of shock are present, provide treatment as outlined in *Circulatory Emergencies*. Evidence of poor perfusion may be caused by severe hypoxemia.

Mental Status

Try to rouse any postictal child who appears somnolent or unresponsive, then evaluate AVPU findings. Perform a brief neurologic assessment by checking pupil size and reactivity to light as well as movement and sensation in all extremities. Calculate the child's Glasgow Coma Scale score if head trauma is suspected (see *Altered Mental Status*).

Children experiencing active seizures are often unresponsive. Children in the postictal state may be alert with confusion or somnolence, or they may be responsive to voice or painful stimulus. Continue high-concentration oxygen and reassess mental status frequently.

Completing the Initial Assessment

Unless the child has completely recovered from the seizure with *no* abnormal assessment findings, provide spinal immobilization if indicated and initiate transport immediately upon completion of the initial assessment.

Consider initiating continuous cardiac monitoring in conjunction with pulse oximetry once you are en route. ECG monitoring is generally indicated for all infants and children who display abnormal findings involving respiratory rate or effort, heart rate, perfusion, blood pressure, or mental status. Do not delay lifesaving interventions to set up a monitor.

If your findings suggest that the patient may be experiencing hypoglycemia, test blood glucose levels using a glucose test strip or an electronic glucose meter. Treat hypoglycemia as described in *Altered Mental Status*.

CUPS Assessment

Table 1 summarizes CUPS assessment categories for pediatric seizures.

Table 1. CUPS Assessment of Pediatric Seizures

Category	Assessment	Actions
Critical	Absent airway, breathing, or circulation; AVPU=U; ongoing seizure	Perform initial interventions; transport immediately to a pediatric critical care center; initiate drug interventions en route
Unstable	Compromised airway, breathing, or circulation; AVPU=V or P; history of brief seizure that has ended	Perform initial interventions; transport as soon as possible; begin focused history and physical exam during transport if time allows
Potentially unstable	Normal airway, breathing, and circulation; AVPU=A or V; history of brief seizure that has ended	Perform initial assessment with interventions; monitor airway and ventilation; perform focused history and physical exam; transport according to regional protocols
Stable	Children who have experienced a seizure should not be considered stable	

Based on CUPS Assessment Table © 1997 N. D. Sanddal, et al. *Critical Trauma Care by the Basic EMT, 4th ed.*

Focused History

If you did not witness the seizure, it is important to gather focused history information that can help hospital personnel determine its cause. Begin the focused history on the scene if the seizure has ended and all of the child's initial assessment findings are normal; otherwise, initiate it en route to the hospital as time allows. Cover the following points:

- parents' or bystanders' description of the seizure, including (1) its duration (this estimation is frequently inaccurate, as seizures evoke emotional anxiety in onlookers that make them seem lengthier than they are, but it should be recorded anyway); (2) specific seizure activity, such as eye deviation, bladder or bowel incontinence, mental status, and tonic-clonic muscle movements; (3) events leading up to the seizure, including history of fever; (4) whether more than 1 seizure occurred, either at this time or on a previous occasion
- past history of seizures; history of a known seizure disorder, such as epilepsy; medications being taking for a seizure disorder; time and amount of last dose
- exposure to a toxic substance or medication
- recent illness, including upper respiratory infection
- history of head injury, including the time and cause of injury, how long after the injury the seizure occurred, and whether a period of unresponsiveness or signs of respiratory problems followed the injury
- potential causes of hypoglycemia, including diabetes in children of all ages, and alcohol

poisoning or anorexia due to illness in infants and toddlers

If head injury or hypoglycemia appears likely, initiate appropriate management actions as indicated. See *Traumatic Emergencies* and *Altered Mental Status* for more information.

Note that neonates and those experiencing head trauma, toxic ingestion, hypoxia, multiple seizures, or a prolonged seizure (continuing for more than 5 to 10 minutes) may be at higher risk for recurrent seizures or brain injury.

Detailed Physical Examination

Examine the child for

- signs of head injury or other trauma
- petechiae or purpura (a purplish skin rash that accompanies septic shock)
- skin rash with circumoral vesicles, suggesting herpes infections (a risk factor in meningitis)
- injuries to extremities caused by tonic-clonic muscle movements during the seizure
- a distended fontanel in infants
- pupil size and reactivity
- nuchal rigidity

Initiate appropriate management actions for any significant findings.

Further Treatment

Drug Treatment for Status Epilepticus

A child who is experiencing a seizure should be transported immediately after initial interventions and stabilization. Consider administering an anticonvulsant agent once transport is underway. The benzodiazepines (diazepam, lorazepam, and midazolam) are highly effective anticonvulsants. However, most anticonvulsant drugs can cause respiratory depression. This problem will be more pronounced if the seizure is prolonged or if the child's seizures have already been treated with barbiturates or benzodiazepines. Monitor the airway, ventilation, and oxygenation carefully during and after drug administration.

Routes of administration

Use the intravenous or intraosseous route if readily available. Rectal diazepam or intramuscular midazolam are acceptable alternatives if vascular access cannot be obtained.

Diazepam

If vascular access is readily available, give intravenous or intraosseous diazepam at 0.1 to 0.2 mg/kg (maximum 4 mg/dose). Infuse *slowly* at 1 mg/minute, as rapid administration can cause

respiratory arrest. The onset of action for IV or IO diazepam is 2 to 5 minutes. The duration of effect is only 5 to 10 minutes, so repeat dosing may be needed. Administer the same dose up to 3 times at 10- to 15-minute intervals.

Dosing example: In a 1-year-old child with an estimated weight of 10 kg, the dose would be calculated at $0.1 \text{ mg/kg} \times 10 \text{ kg}$, or 1 mg. Administer slowly over 1 minute.

Intravenous diazepam is associated with a high probability of respiratory depression, especially with rapid IV push.

If vascular access cannot be established, diazepam solution for intravenous administration can be given rectally using a lubricated 1-mL tuberculin syringe *with the needle removed*. If a small syringe is not available, attach a soft catheter or feeding tube to a larger syringe to deliver the medication. The rectal dose is 0.5 mg/kg (maximum 10 mg/dose). Decrease the dose if the child is taking phenobarbital or has received a benzodiazepine within a few hours of the seizure.

A diazepam gel that is prepackaged in a disposable rectal syringe is also available (see *Task Analysis* appendix). When given PR, the onset of action is 5 to 10 minutes. The duration of effect is only 5 to 10 minutes, so repeat dosing may be needed. Administer the same dose up to 3 times at 10- to 15-minute intervals.

Lorazepam

Administer 0.05 to 0.1 mg/kg (maximum 4 mg/dose) IV or IO. Lorazepam has a long duration of effect; if the initial dose controls the seizure, repeat doses should not be necessary. This drug requires refrigeration. The onset of action is 3 to 5 minutes.

Midazolam

Midazolam can be given intramuscularly, circumventing the need for vascular access. The dose is 0.1 to 0.2 mg/kg (maximum 5 mg/dose). When given IM, the onset of action is 5 to 10 minutes.

Table 2 summarizes pharmacologic agents for control of pediatric seizures.

Table 2. Drug Treatment of Pediatric Seizures

Agent	Route	Dosage Range	Max Dose	Comments
Diazepam	IV/IO	0.1B0.2 mg/kg	4 mg	Inexpensive, effective first-line agent; short duration of effect
	PR	0.5 mg/kg	10 mg	
Lorazepam	IV/IO	0.05B0.1 mg/kg	4 mg	Long duration of effect; requires refrigeration
Midazolam	IM	0.1B0.2 mg/kg	5 mg	Rapid onset, IM administration; limited studies

Management of respiratory depression caused by benzodiazepines

If respiratory depression or apnea arises after benzodiazepine administration, provide assisted ventilation.

Flumazenil, a benzodiazepine antagonist, may be considered after assisted ventilations have reversed the respiratory depression, however there are problems with using flumazenil in this situation. These problems include 1) flumazenil does not routinely reverse respiratory depression caused by benzodiazepines; 2) flumazenil blocks the anticonvulsant action of benzodiazepines, which may precipitate additional seizures.

Additional Considerations

Emotional impact of seizures

The child and family often feel tremendous fear and anxiety during and after a seizure, particularly if it has never happened before. To alleviate these emotional reactions, remain calm and reassuring throughout assessment, interventions, and transport. Use the opportunity to educate the patient and family about seizures.

If the child's seizure has ended, take the time to calm the patient and parents by noting the following points:

- every possible action is being taken to safeguard the child
- in most cases, the seizure itself does no harm
- drowsiness or confusion following a seizure is normal and will soon pass

Without alarming the parents, stress the need to have the child evaluated in a hospital, explaining that it is important to make sure no serious problem caused the seizure.

Reassessment and Transport

Children who experience a seizure should routinely be transported and receive further evaluation in a hospital to determine if there is a serious etiology, such as occult brain injury, meningitis, or

child abuse.

Transport decisions should be based on regional protocols and directives from medical control. In some cases you may be directed to release a child without transport, *providing* the seizure has ended and there are no abnormal findings throughout the initial assessment, focused history, and detailed physical examination. This may be the case in children with a history of epilepsy or febrile seizures who have completely recovered and present no additional risk factors or complications.

Reassess the patient's ABCs and mental status frequently throughout transport, particularly if you have administered an anticonvulsant agent. Repeat anticonvulsant administration if necessary during longer transport times. Revise interventions if the patient's condition deteriorates.

Documentation

It is important to describe seizure activity as fully as possible in the patient care record, including how the child behaved and how long the seizure lasted. This information may help hospital personnel find the underlying problem that caused the seizure. Also list any significant findings gathered during the focused history and detailed physical examination, if performed. Describe interventions and the child's response to treatment. Continue to record vital signs and cardiac rhythm during transport, as this documentation may be helpful should the child's condition deteriorate en route to the hospital or soon after arrival.

Explanatory Text

Etiology

Common causes of pediatric seizures vary according to age.

- In newborns younger than 1 month, birth injuries, hypoglycemia, hypocalcemia, meningitis, congenital defects, and metabolic problems are the most prevalent causes of seizures.
- In children aged 6 months to 6 years, fever is the most common cause of seizures. It is virtually certain that you will eventually encounter febrile seizures in this age group.
- Additional causes of seizures in infants, toddlers, and preschoolers include meningitis, hypoglycemia, hypoxia, poisoning, brain injury, and epilepsy (particularly when parents do not give their children anticonvulsant medication as directed). Less common causes include metabolic disorders and malformations of the brain.
- Common causes of seizures in older children include epilepsy, trauma, drug abuse,

poisonings, and failure to take prescribed anticonvulsants. Infrequently, cerebral hemorrhage, tumors, or strokes may cause seizures.

Types of Seizures

There are 4 types of seizures within 2 broad classes. The classes are *generalized seizures* and *partial seizures*.

Generalized seizures usually involve a period of unresponsiveness. There are 2 types of generalized seizures: *tonic-clonic* seizures (also called *grand mal* seizures), in which the patient may have uncontrolled muscle contractions involving both arms, both legs, or the entire body, followed by a period of somnolence or confusion; and *absence* seizures (also called *petit mal* seizures), in which the patient experiences a brief loss of awareness and may appear to be staring. Absence seizures do not cause muscle contractions.

The most common type of seizures you will encounter are generalized tonic-clonic seizures.

Partial seizures are divided into *simple partial* seizures (also called *focal* seizures), which may involve tonic or clonic muscle movements in a single part of the body, and *complex partial* seizures, which cause altered mental status.

Twitching or jerking in a finger, hand, or arm is typical of a simple partial seizure. Clonic muscle movements can start in the hand and then move to the forearm and upper arm in a progression called a *Jacksonian march*. Seizure activity that causes a Jacksonian march originates in the cerebral cortex along the motor control region of the brain, which is located at the top of the cerebral hemispheres near the fissure that divides them.

Simple partial seizures can also cause visual or auditory hallucinations and abnormal behavior, including anger, fear, and unusual vocalizations, such as barks or grunts. This type of seizure activity originates in the temporal lobe of the brain at the side of the head.

A partial seizure may progress into a generalized seizure.

Pathophysiology

Febrile seizures

Children between the ages of 6 months and 6 years sometimes experience *febrile* seizures, which are caused by high fever. About 5% of all children will suffer a febrile seizure before the age of 6 years. About one-third of these children will experience a recurrence. While brief febrile seizures are alarming to witness, they do not cause brain damage and are not predictive of an increased risk of epilepsy as the child grows older. Many febrile seizures are of short duration, lasting less than 1 to 2 minutes. The majority last from 10 to 15 minutes. In a few cases, febrile seizures may last longer than 30 minutes, and are categorized as *febrile status epilepticus*.

There is no conclusive evidence that antipyretic agents reduce the risk of future febrile seizures. Despite this, many physicians prescribe antipyretics for children with fever and a history of febrile seizures. Most children with a history of occasional febrile seizures are not treated with long-term anticonvulsants.

While most febrile seizures are brief and do not harm the child, a seizure occurring with fever can also be caused by meningitis, a life-threatening infection of the meninges requiring immediate medical care. The difference between early meningitis and a febrile seizure is subtle and may be difficult to distinguish in the prehospital setting.

Seizures and head injury

Seizures following a head injury are more common in children than in adults. A brief seizure that occurs immediately after head trauma and does not recur (referred to as an *impact seizure*) does not necessarily indicate significant brain injury. If a seizure occurs minutes to hours after head injury, it is more likely to indicate intracranial hemorrhage or injury to brain tissue. However, any seizure associated with head injury, even a brief impact seizure, should be considered a sign of potential brain injury. The patient should be carefully monitored and transported for further evaluation. Hospital personnel will usually perform a careful neurologic examination and observe the child for several hours. Computed tomography of the brain may be performed as well.

Anticonvulsant drug therapy for status epilepticus

Each of the benzodiazepines commonly given for control of status epilepticus has advantages and drawbacks.

Diazepam has a rapid onset, but its duration of action is short. It is generally safe and effective, stopping seizures in 80% of children within 2 to 5 minutes. Significant respiratory depression may occur with diazepam, so respiratory status must be monitored closely.

Lorazepam has a longer period of efficacy than diazepam, so repeat dosing may not be necessary. Respiratory depression may be less pronounced with lorazepam. However, lorazepam requires refrigeration; otherwise it must be replaced every few weeks.

Midazolam is currently the only rapid-onset benzodiazepine that can be safely administered as either an intravenous or intramuscular injection. Nasal administration of midazolam has also been reported as an effective means of stopping seizures.

If respiratory depression or apnea arises after administration of a benzodiazepine, *the initial response is to administer oxygen and assisted ventilation*. After that, flumazenil, a benzodiazepine antagonist, may be administered to reverse the sedative and anticonvulsant

actions of these drugs if indicated. However, flumazenil has 2 serious disadvantages:

- it may not completely reverse respiratory depression from benzodiazepines
- due to its antagonistic action, it can actually precipitate seizures in some patients who have been treated with benzodiazepines; such seizures may not respond to benzodiazepines until the flumazenil has worn off

Flumazenil is contraindicated in older children who have drug toxicity caused by a mixed overdose, as it may precipitate seizures in these patients.

Because of these factors, flumazenil must be used with extreme caution.

Disorders that mimic seizures

Other disorders can that cause abnormal movements or a loss of consciousness may mimic seizures.

Syncope or fainting may be confused with seizures. A small percent of children experiencing syncope may have associated myoclonic movements. (see Syncope).

Breath holding spells are common in children. They typically present between 6 and 18 months and resolve by 5 years of age. The history includes a precipitating event such as pain, anger frustration or fear followed by a period of apnea and loss of consciousness. A return to consciousness occurs rapidly. A color change (which may be pale or cyanotic) is also a common feature. Breath holding spells may have associated myoclonic movements as well.

Tics present with head shaking, blinking, twitching or other movement disorders and may include vocalizations. They occur during periods of anxiety or stress. The child may be able to suppress the movement, which is usually non rhythmic (different from seizures). They are not associated with a loss of consciousness, but may mimic simple partial seizures.

Sleep disorders, such as somnambulism (sleep walking), and night terrors may be confused with seizures. Sleep walking occurs in school age children, who “wake up and walk around” during the non dreaming phase of sleep. Night terrors typically occur in preschool age children. The child sits up in bed, wide eyed, screaming or crying, and may also have rapid breathing, and rapid heart rate. The child is not aware of parents or caregivers attempts to calm them, and after 10-15 minutes fall back to sleep. Nightmares or unpleasant dreams occur dreaming or REM (rapid eye movement) phase of sleep, which usually occurs during the later part of the night cycle. These children can be awakened and reassured that all is well.

Infants with reflux of stomach contents into the esophagus can present with back arching or head turning (Sandifer syndrome).

Barriers to Learning

The sight of a child having a seizure can be disturbing. Parents are frequently distressed by the experience, making this an emotionally charged situation. It is helpful to begin with the understanding that most brief seizures, particularly febrile seizures, do no harm; that they are more common in children than in adults; and that management is often fairly simple. By conveying these principles to parents, you can help to calm them, which will be beneficial to the child as well.

Practice Sessions

You may wish to view videotapes that show children experiencing seizures and other abnormal neurologic events. Call the Epilepsy Foundation at 800/332-1000 for general information, or call 800/213-5821 for catalog sales of videotapes.

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EMSC Resources

Item 0718. *When Seizures Are Medical Emergencies*. (MN and the Epilepsy Foundation)

Item 0793. *Illinois Prehospital Pediatric Course*. (IL) Disk Set “Common Medical Emergencies:

Seizures,” 73-77.

Item 0828. *Helping Kids Survive: Interactive Training for Prehospital Providers*. (Critical Illness and Trauma Foundation) CD-ROM Set.

Item 0835. *Red Flags in Pediatric Medical Emergencies*. (AZ) CD-ROM.

Item 0866. *Alaska Medevac Manual*, 3rd ed. (AK) “Seizures,” 70–71.

Item 0871. *Emergency Medical Services for Children Pediatric Emergency Care Course*. (TN and NC) “Medical Emergencies.”

Additional Reading

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■ HANDOUT Key Points

Most seizures are brief, lasting only a minute or two. These seizures usually do not harm the child. *Status epilepticus* denotes a seizure that continues for 30 minutes, or a series of seizures occurring over a 30-minute period in which the child does not recover normal mental status and function between active seizures. If a seizure continues from the time the emergency call is received through the time you arrive on the scene, treat it as status epilepticus.

During a seizure, a child may exhibit altered mental status, behavioral changes, hypotonia, emesis, eye deviation, and uncontrolled tonic and clonic muscle movements. Bowel or bladder incontinence may be observed in toilet-trained children. Airway obstruction and respiratory problems are commonly seen as well.

Following a brief seizure, open the child's airway and provide suctioning as necessary. Initiate pulse oximetry if available; provide high-concentration oxygen in all cases. Reassess airway, breathing, circulation, and mental status frequently. Assess for hypoglycemia and head trauma; if present, provide appropriate management.

During an active seizure, open and maintain the airway as needed. Protect the child from striking hard or sharp objects. Provide suctioning and assisted ventilation if necessary. Give high-concentration oxygen in all cases. Transport promptly after initial stabilization. If time allows, initiate the focused history and detailed physical examination during transport.

Do *not* insert a bite block during a seizure. Bite blocks may break during an active seizure, presenting the risk of aspiration with airway obstruction. Unbreakable bite blocks can damage the teeth if the child bites down hard. In either case, soft tissue injuries may result if the child bites down and catches the lips, tongue, or cheek between the hard object and the teeth.

Oropharyngeal airways pose risks similar to bite blocks. If the airway becomes obstructed or assisted ventilation is necessary during an active seizure, consider inserting a nasopharyngeal airway as a safer alternative.

If you arrive on the scene after a brief seizure has ended and the child's initial assessment findings are normal, proceed with the focused history and detailed physical examination on the scene, then transport according to regional protocols. Status epilepticus is a medical emergency requiring prompt initial interventions followed by immediate transport. Begin the focused history and physical examination en route to the hospital if time allows.

If you did not witness the seizure, it is important to gather information that can help hospital personnel determine its cause. Ask the parents to describe (1) the duration of the seizure; (2) specific seizure activity, such as eye deviation, bladder or bowel incontinence, mental status, and tonic-clonic muscle movements; (3) events leading up to the seizure, including history of fever; and (4) whether multiple seizures occurred, either at this time or on a previous occasion.

If the child has continuing seizures, consider administering an anticonvulsant medication after transport is underway. Benzodiazepines are most commonly given. Use the intravenous or intraosseous route if readily available. Rectal diazepam or intramuscular midazolam are acceptable alternatives if vascular access cannot be readily obtained.

Most anticonvulsant drugs can cause respiratory depression. This problem will be more pronounced if the seizure is prolonged or if the child's seizures have already been treated with barbiturates or benzodiazepines. Monitor the airway, ventilation, and oxygenation carefully after drug administration.

The child and family often feel tremendous fear and anxiety during and after a seizure, particularly if it has never happened before. To alleviate this reaction, remain calm and reassuring throughout your assessment and interventions. Use the opportunity to educate the patient and family about seizures and explain that everything is being done to safeguard the child. Mention that the seizure itself usually does no harm. Explain that drowsiness or confusion following a seizure is normal and will soon pass.

Causes of seizures in infants and children vary according to age. Some of the more common causes include fever, hypoglycemia, hypoxia, poisoning, drug abuse, head trauma, meningitis, and epilepsy (particularly when patients do not take their medication as directed).

■ HANDOUT

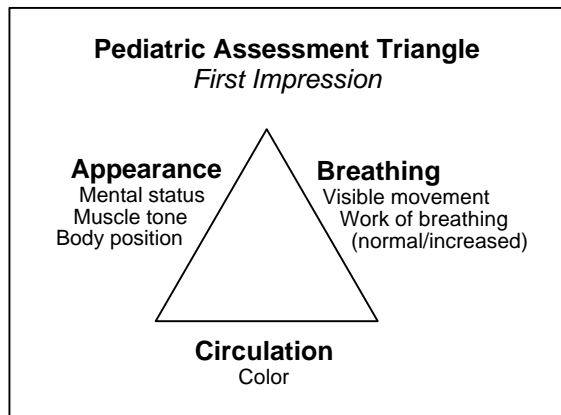


Figure 1

■ HANDOUT

Table 1. CUPS Assessment of Pediatric Seizures

Category	Assessment	Actions
Critical	Absent airway, breathing, or circulation; AVPU=U; ongoing seizure	Perform initial interventions; transport immediately to a pediatric critical care center; initiate drug interventions en route
Unstable	Compromised airway, breathing, or circulation; AVPU=V or P; history of brief seizure that has ended	Perform initial interventions; transport as soon as possible; begin focused history and physical exam during transport if time allows
Potentially unstable	Normal airway, breathing, and circulation; AVPU=A or V; history of brief seizure that has ended	Perform initial assessment with interventions; monitor airway and ventilation; perform focused history and physical exam; transport according to regional protocols
Stable	Children who have experienced a seizure should not be considered stable	

Based on CUPS Assessment Table © 1997 N. D. Sanddal, et al. *Critical Trauma Care by the Basic EMT, 4th ed.*

Table 2. Drug Treatment of Pediatric Seizures

Agent	Route	Dosage Range	Max Dose	Comments
Diazepam	IV/IO	0.1B0.2 mg/kg	4 mg	Inexpensive, effective first-line agent; short duration of effect
	PR	0.5 mg/kg	10 mg	
Lorazepam	IV/IO	0.05B0.1 mg/kg	4 mg	Long duration of effect; requires refrigeration
Midazolam	IM	0.1B0.2 mg/kg	5 mg	Rapid onset, IM administration; limited studies