Continuing Education

February 2016

Participant Edition

NORTHWEST COMMUNITY EMERGENCY MEDICAL SERVICES SYSTEM

EST 1972

"Baby, you are hot!"

Communicable Diseases and other febrile illnesses in the pediatric population

Questions regarding this material are welcome and should be directed to
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Objectives:

Upon completion of the class and any supplemental materials, each participant will independently do the following with a degree of accuracy that meets or exceeds the standards established for their scope of practice to:

1. classify common medical emergencies found in the pediatric population related to febrile illnesses.
2. correlate a medical diagnosis for the pediatric pt. with a febrile illness associated with a rash, vomiting or seizure activity.
3. describe the pathophysiology and physical assessment for children with suspected communicable diseases identified from a febrile illness.
4. determine the appropriate medical treatment for children with suspected communicable diseases identified from a febrile illness.
5. by using the pt. history and physical exam findings, implement a treatment plan for a pediatric patient who has a cough with fever and respiratory distress.
6. analyze assessment findings for the pediatric pt. that is found to have complaints of seizure activity without any history of recent illness.
7. construct proper precautionary measures for the pediatric pt. who presents with a fever and a rash.
8. appreciate an understanding for proper PPE for the pediatric pt. identified as having a fever with seizure activity or vomiting.
9. participate in case study scenarios that include pediatric pt.'s presenting with a febrile illness and either additional symptoms of a rash, seizure activity or vomiting.
10. appreciate the importance of transporting all infants less than 3 months of age presenting with a febrile illness.

Fever in the Neonate & the Young Infant

by Scott R. Snyder, BS, NREMT-P
Sep 5, 2014

Fever is one of the most common chief complaints in pediatric patients presenting to the emergency department, accounting for up to 20% of pediatric ED visits.1 Fever tends to be of a higher clinical importance in neonates and infants younger than 3 months, as they are immunologically immature and incompletely vaccinated. Children younger than 3 months have unique risks for serious bacterial infection, bacteremia and occult bacteremia, making the recognition of fever and transport to an ED for evaluation extremely important. Assessing these patients can be difficult and misleading due to the absence of traditional signs and symptoms of severe disease. To help you best appreciate and understand fever in this unique patient population, this article will review maintenance of normal body temperature, purpose of fever, development of the immune system in the neonate and young infant, and assessment and management of the neonate and young infant with fever.

Normal Body Temperature

Body temperature is regulated by thermosensitive neurons located in the hypothalamus that respond to signals from two sources: peripheral nerves that transmit information from specific warmth/cold receptors in the skin, and from the temperature of the various blood-bathing tissue regions in the body. These signals are integrated by the thermoregulatory center in the hypothalamus, and thermoregulatory responses are initiated to raise or lower temperature as needed. These responses include behavioral actions, such as seeking a warmer or cooler environment, as well as physiologic responses, such as redirecting of blood to and from capillary beds, increased or decreased sweating and fluid volume regulation.

A normal body temperature is usually easily maintained by balancing the heat lost through the skin and lungs with the heat produced by metabolic activity, such as from muscle and liver function. In a neutral temperature environment, the metabolic activity of the human body produces more than enough heat to maintain a core body temperature of about 37ºC (98.6°F) in an adult.

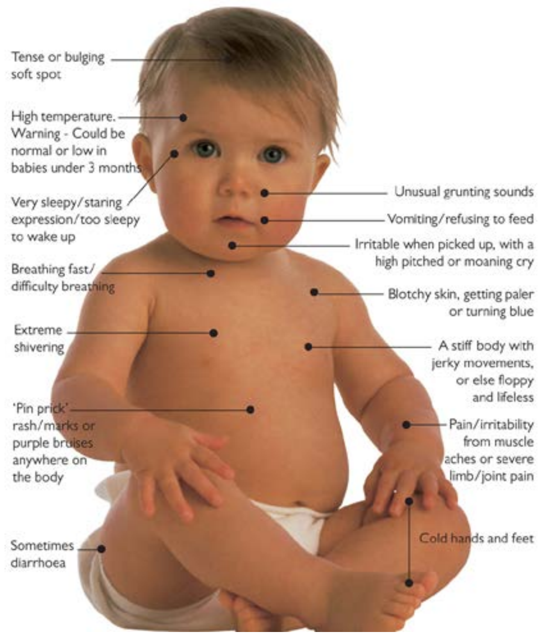
An infant’s normal body temperature will vary based on age, activity and time of day. Infants tend to have higher average temperatures than older children and adults (37.5°C or 99.5°F). An infant’s normal core body temperature will vary by as much as 1°–2°F throughout the day. Typically, core body temperature will rise during the day and be slightly lower during the night while the infant is sleeping. This circadian temperature rhythm, or diurnal variation, will occur without pathology being present. Fever is defined as a body temperature elevated above the norm. It is generally accepted that for the appropriately dressed child at rest, fever is present with a rectal temperature of 38°C (100.4°F) or an oral temperature of 37.2°C (99.0°F) or higher.2

In the prehospital environment, temperature in the infant is most often measured via rectal, oral or tympanic membrane (TM) thermometer. Rectal temperatures are usually the most accurate and are about 0.6°C (1.0°F) higher than oral readings, most likely because breathing through the mouth results in a decreased average oral temperature. Axillary measurement is less accurate—typically 0.6°C (1.0°F) lower than oral measurement. TM thermometers, while convenient, carry a risk of error.3 They measure the radiant heat from the tympanic membrane and nearby ear canal and display either the absolute value or an adjusted value. The adjusted value is calculated by taking the absolute value and adjusting the result based on nomograms relating the radiant temperature measured to actual core temperatures obtained in clinical studies.

Fever

Fever is an elevation in body temperature that exceeds the normal daily variation and occurs secondary to an increase in the hypothalamic set point. As such, fever is regulated in the same manner that normal temperature is maintained in a normal environment, the difference being that the body's thermostat (the hypothalamus) has been reset at a higher temperature (a higher hypothalamic set-point). This shift from a normothermic to a febrile set point is analogous to resetting a thermostat to raise room temperature.

The hypothalamic set-point is reset in response to the release of endogenous (internal) and exogenous (external) pyrogens. A pyrogen is a substance that results in fever. Essentially, all endogenous pyrogens are cytokines—molecules that are released by various cells of the immune system, such as neutrophils, monocytes, macrophages and lymphoid cells. Examples of major endogenous cytokines include interleukin 1 (IL-1) and IL-6 tumor necrosis factor-α (TNF-α). Specific causes of immune system activation and subsequent endogenous cytokine release include infection, malignancy and rheumatic disease. We will focus on fever secondary to infection in this article. Microbes, such as viruses and bacteria, and the toxins they release are the most common exogenous pyrogens. They stimulate macrophages to produce their endogenous pyrogens, which results in fever.



Fever is not necessarily a bad thing. On the good side, it enhances the body's immune response, making it more effective at fighting infection; it may have direct antimicrobial activity; and it can be a valuable diagnostic aid to the healthcare provider. On the bad side, fever can make an infant uncomfortable, and it increases metabolic activity, resulting in increased oxygen consumption, carbon dioxide production and water loss.

There is a distinct difference between an elevated body temperature caused by fever and an elevated body temperature caused by hyperthermia. Hyperthermia is characterized by an uncontrolled increase in body temperature that exceeds the body's capacity to lose heat, in contrast to a fever caused by the release of endogenous pyrogens secondary to infection. Causes of hyperthermia in infants include exposure to a hot environment and excessive swaddling.

Causes of Fever in Neonates and Infants

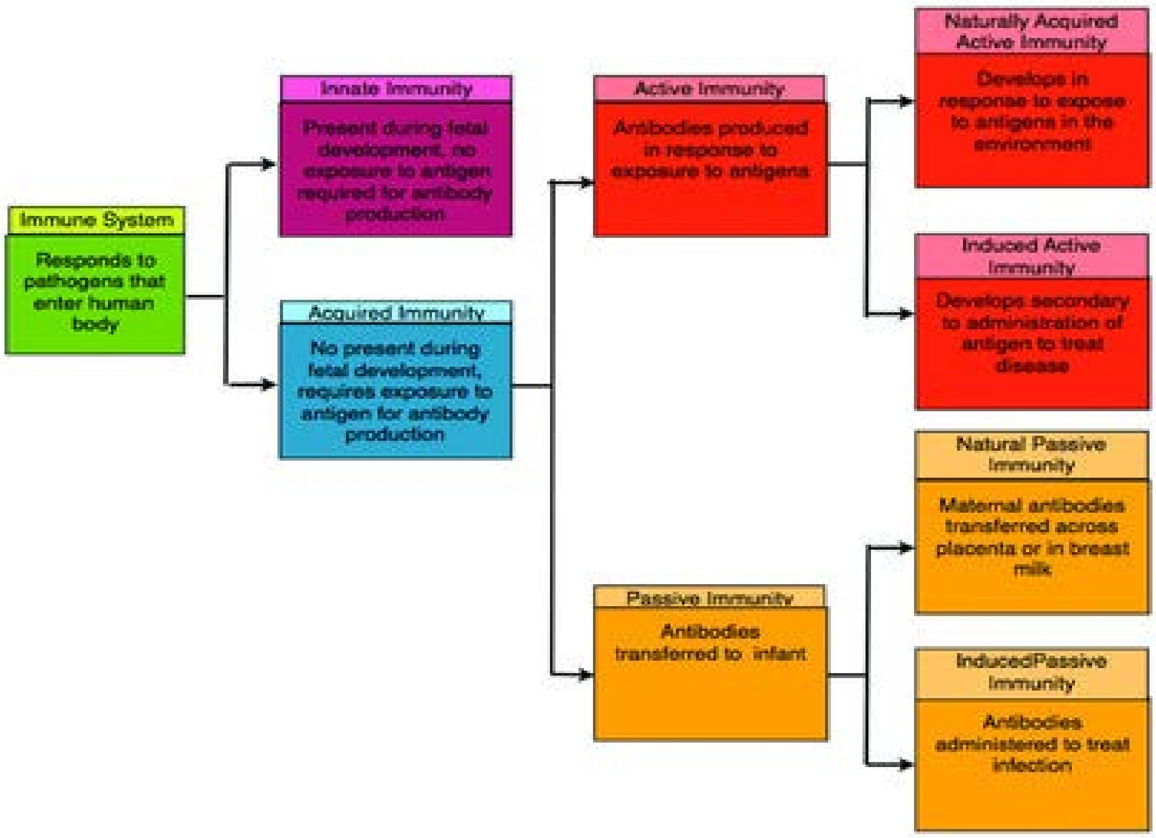
The causes of fever in young children vary with age. The vast majority of pediatric fever is due to infections, and the vast majority of infections are due to viral sources.4Table 1 lists common etiologies of fever in neonates and infants. Common viral and bacterial infections are often benign in healthy neonates and infants and respond well to simple supportive or antimicrobial treatment. Examples of common bacterial illnesses include otitis media, urinary tract infections, appendicitis, pharyngitis and sinusitis. Examples of common viral illnesses include gastroenteritis, upper respiratory infections, bronchiolitis and flu-like illnesses common in the fall and winter months. Infections like sepsis or meningitis, however, can have significant morbidity and mortality if left untreated.5 Compared with viral infections, bacterial infections are a more serious cause of infection in children, as they can be difficult to identify and are associated with high mortality. Neonates (less than 28 days old) and young infants (28–90 days old) have traditionally been discussed as subsets of febrile pediatric patients because of differences in the type and severity of infections they encounter. Children under 3 months may present with an apparent viral syndrome and still harbor serious bacterial illness (SBI). In children less than 3 months of age, the urinary tract is the most common site of SBI, followed by bacteremia and meningitis.5Bacteremia is the presence of pathogenic (harmful) bacteria in the bloodstream. Occult bacteremia describes the presence of pathogenic bacteria in the bloodstream of a well-appearing febrile child in the absence of an obvious source (focus) of infection. Prior to the widespread use of vaccines against Haemophilus influenzae type B (HIB) and S. pneumoniae, the incidence of bacteremia in this population was approximately 5%.6,7 While the current rate of occult bacteremia is about 1%, the risk is real. It can be argued that all febrile children under the age of 3 months should be transported to the ED for evaluation, as the risk of occult bacteremia, though low, is real and the associated mortality is high.8

To better understand why the neonate and young infant are at high risk of developing a SBI that can lead to bacteremia and occult bacteremia, it is necessary to understand the two different types of immunity (Figure 1) and how these systems mature in this population.

The Maturing Immune System

Immunity is either innate or acquired. Innate immunity is genetically determined; its components are produced by the individual. It is present at birth and does not require previous exposure to an antigen (a substance that produces an immune response). Acquired immunity is not genetically determined, is not present at birth, and involves the use of antibodies (specialized proteins produced after exposure to an antigen).

There are two types of acquired immunity: active and passive. Active immunity results from the production of antibodies against a specific antigen and can be naturally acquired or induced. Naturally acquired active immunity begins immediately after birth, as the neonate is exposed to "new" pathogens in its environment. Induced active immunity develops after immunization, or vaccination. Immunization is the intentional administration of a specific antigen prior to a natural exposure, with the intent of inducing the recipient to produce antibodies to that specific antigen.



Passive immunity occurs via the transfer of antibodies from an outside source and can be divided into naturally acquired passive immunity and induced passive immunity. Naturally acquired passive immunity occurs when maternal antibodies cross the placenta during gestation, or are passed on to a newborn via the mother's breast milk. Immunoglobulin G (IgG) is the only antibody able to cross the placenta to the fetus. IgG is the most abundant antibody in the human body, representing about 75%–80% of all antibodies. It protects the fetus against infection during gestation and the neonate immediately after birth. In addition to IgE, the mother's breast milk contains four other types of antibodies: immunoglobulin A (IgA), immunoglobulin D (IgD), immunoglobulin E (IgE) and immunoglobulin M (IgM). The realization of this immunity benefit has led to the recommendation that breast-feeding be provided to newborns whenever possible.9 In induced passive immunity, specific antibodies are administered to a patient to fight infection or prevent disease after exposure to an antigen. As an example, the tetanus immune globulin (TIG) is administered to individuals who have sustained a wound with a high risk of tetanus infection. TIG provides passive immunity until the patient's body can produce antibodies specific to tetanus. The patient is also administered a tetanus vaccination to encourage induced active immunity for subsequent exposures.

In an adult, a healthy and functioning immune system is very often adequate to prevent life-threatening infection in the majority of cases. The neonate and young infant, however, have immature immune systems that lead to a physiological immunodeficiency that renders them more susceptible to viral and bacterial infections compared with older infants, children and adults. As discussed above, the neonate at birth only has the IgG antibodies that crossed the placenta during fetal development. Over the next two to three months, breast-feeding will supplement the neonate's IgE antibodies with IgA, IgD, IgG and IgM, though the supply will decrease over this period. At about two to three months, the fetus will start producing its own antibodies. During this time, when the maternal antibody supply is decreasing and the infant's production is steadily increasing, the infant will experience a period of relatively low antibody concentration in the bloodstream, increasing the risk of infection. At six months, the infant is producing antibodies at a normal rate, and blood antibody concentrations increase to normal levels.

Over the same period, the neonate and infant is being exposed to pathogens in its environment, resulting in an increasingly robust naturally acquired active immune system, which is producing antibodies to these pathogens. Immunizations, begun at birth with the HBV vaccine and continuing throughout childhood, boost induced active immunity, further enabling the infant to combat pathogens and fight off life-threatening infection.

Assessing the Neonate / Young Infant with Fever

When you are presented with a febrile neonate or young infant, a number of historical factors are

especially important. As infection in this population is more likely to result from maternal-acquired pathogens than community-acquired pathogens, a detailed history of any maternal infections is important. Of particular concern is a history of group B streptococcus and/or sexually transmitted diseases such as herpes. Infections arising within the first week of life are most likely secondary to vertical transmission (from the mother during childbirth), while during the second week it is typically hospital-acquired. A birth history should be ascertained that includes the mode of delivery (vaginal versus cesarean section), amount of time between the rupture of the membranes and the onset of labor, and if maternal fever was present at the time of delivery. Risk factors for serious bacterial infection in the neonate include maternal infection, septic or traumatic delivery, fetal hypoxia, a birth weight less than 2,500 grams, and rupture of the membranes prior to the onset of labor.10

Additionally, immunization status, contacts with sick persons, prior use of antibiotics and use of antipyretics like Tylenol are important components of the history. A reduction in fever after the use of antipyretics does not exclude the possibility of a serious bacterial infection and should not decrease your level of suspicion for such.11 Any history of previous hospitalization, prolonged ICU stay, or immunocompromise should also be recorded.

Dehydration is a risk in any patient with fever, so ask about any history of nausea, vomiting, diarrhea, or decreased oral intake or urine output. A caregiver-described history of lethargy, irritability or altered mental status may be present with severe dehydration, but should also increase the suspicion of SBI. Asking the caregiver about alterations in the neonate and young infant's normal behavior is important, as at this age there are few to no developmental or social characteristics for the examiner to evaluate.

Assessment of the febrile neonate or young infant should begin with an assessment of airway, breathing and circulation. Signs of respiratory distress, such as grunting, stridor, nasal flaring or retractions, can accompany infectious processes such as pulmonary infections or sepsis, and stridor may be present with upper airway infections like epiglottitis or bacterial tracheitis. Note if the child is crying, and if it is strong or weak, or otherwise abnormal. Oxygen saturation should be determined via a pulse oximeter.

Skin signs of poor peripheral perfusion such as cyanosis should be noted. Neonates and young infants will typically develop tachycardia in response to fever, and the heart rate can be expected to increase linearly by about 9.6 beats/min with each 1°C increase in body temperature.12 Tachycardia out of proportion to fever can occur secondary to other conditions, such as dehydration and developing hypovolemia. At times, it can be difficult to discern true tachycardia from the already rapid physiological base heart rates of neonates and infants, and the provider must be familiar with the normal vital sign ranges for these age groups or have the information resource, such as a pocket guide, readily available.

The patient's temperature should be taken, preferably with a rectal thermometer. In the neonate, fever is often the only sign of potentially life-threatening disease, and other signs and symptoms may be exceedingly subtle or nonexistent. If you do not have a thermometer as part of your regular equipment, you can ask the caregivers to use one of their own; however, things like user error and uncalibrated digital thermometers can lead to unreliable results. Patients with sepsis may be normothermic or even hypothermic, so the absence of fever does not rule out infection in patients who present with a history consistent with infection and appear extremely ill. The presence of rash is a serious finding in the febrile neonate or young infant, as it suggests serious illness. A petechial rash in the setting of a febrile illness is classically associated with meningococcal infection. It is important to note that other traditional signs of meningitis, such as nuchal rigidity, will typically be absent in this age group.

If possible, attempt to identify the source of infection

during the physical assessment, although one may not always be apparent. The presence of a SBI cannot be determined by physical exam alone and should not falsely reassure the EMT or paramedic. As a general approach, infants with a fever can be divided into low risk and high risk for SBI, based on whether the patient is ill-appearing, has a significant birth or medical history, and has irregular lab values. These factors are components of the Rochester Criteria, a decision-making algorithm developed to guide the assessment of febrile patients between the age of 28 and 90 days (see Table 2). Although some of the criteria, such as laboratory values, cannot be evaluated in the field, the majority can be easily assessed by the EMT or paramedic. Low-risk, non-ill-appearing patients have a 1.4% SBI rate, while higher-risk, ill-appearing patients have been shown to have SBI up to 21% of the time.13 These criteria do not apply to neonates, as any febrile patient younger than 28 days is considered high-risk.

Suffice it to say, every infant younger than 3 months old who presents with a fever greater than 38°C (100.4°F) should be transported to the ED for an evaluation. How important is it? Current algorithms for the management of previously healthy neonates aged less than 28 days who present with a fever equal to or greater than 38°C (100.4°F) recommend, at a minimum, treatment with intravenous antibiotics and a full sepsis workup consisting of a complete blood cell count (CBC) with differential, blood culture, enhanced urinalysis (UA), urine culture and a lumbar puncture to collect a cerebrospinal fluid (CSF) specimen for analysis and culture. Young infants aged 28–90 days will receive, at minimum, a white blood cell (WBC) count, urinalysis and urine culture.14 When you consider the lab studies that will be directed at these patients, even when they seem healthy, the importance of transporting them to the ED for evaluation becomes obvious.

Management

For the neonate or infant who presents with a fever but otherwise appears healthy and is hemodynamically stable, no management other than monitoring and transport is required. If a fever results in patient irritability or discomfort, an antipyretic like acetaminophen (Tylenol) or

ibuprofen (Advil, Motrin) can be administered per protocol.

Patients with fever and evidence of cardiopulmonary compromise or shock should receive more aggressive care. The neonate or young infant with altered mental status, hypoxemia (evidenced by a SpO2 less than 94%) or respiratory insufficiency unresponsive to supplemental oxygen should receive bag-mask ventilation with 100% supplemental oxygen with the goal of obtaining a SpO2 of greater than 94%. If signs and symptoms of shock, such as poor perfusion, hypotension or altered mental status, are present, the patient should receive fluid volume replacement with an isotonic crystalloid solution via an intravenous or intraosseous line. An initial bolus of 20 mL/kg can be repeated to a total of 60 mL/kg if signs of hypovolemia persist. For cases of hypovolemic shock unresponsive to fluid volume replacement, the use of a vasopressor such as dopamine can be considered, but only after fluid volume has been restored.14

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For those who like to take notes, this section is designed to do so while following along with the power point presentation.

	Mode of transmission	Fever?	Rash?	Other S & S	Complications	Diagnosis	Treatment	EMS protection
Meningitis								
Pertussis								
Chicken Pox								
Measles								
Hand, foot and Mouth								
Gastro-enteritis (AGE)								

Scenario #1:

EMS is called for an 8 month old infant that parent complains that they have had a runny nose and a bad cough. The infant attends a day care facility that has recently had a "bad rash of kids ill." The symptoms started 2 weeks ago, but sent them to day care anyway as the parent had to work. Parents called today since they noted that the infant was not breathing "normal" and seemed to stop every so often.

General Impression: PAT	
Primary assessment A B C D	
Causative factors of distress	
VS/LOC	
Hydration status	
Treatment priorities	
EMS (self) protection/priorities	

Scenario #2:

EMS responds to a single family dwelling in which one adult worker is surrounded by multiple (~9) children varying in age, skin color and apparent ethnic backgrounds. Upon further questioning, the adult explains that this is a day care facility that is not licensed and hosts approx. 15 children a day, depending on if families are here or traveling back to their homeland.

General Impression: PAT	
Primary assessment A B C D	
Causative factors of distress	
VS/LOC	
Hydration status	
Treatment priorities	
EMS (self) protection/priorities	

Scenario #3:

Arrive at a single family home for the child who parent states, "just had a seizure." EMS finds a 13 month old child in the care of parents. Two older school aged children are also in the home and crying in concern for their sibling. Child is limp, appears post-ictal lying on floor.

General Impression: PAT	
Primary assessment A B C D	
Causative factors of distress	
VS/LOC	
Hydration status	
Treatment priorities	
EMS (self) protection/priorities	

Note of caution: when discussing febrile seizures previously in CE, it's noted that more likely than not, there will not be any underlying cause for the seizure and the child may not have another one ever again. With that being said, it is not ok to encourage denial of transport as with any acute change in condition, these symptoms do warrant a work up in the emergency dept to rule out many things including meningitis. Even if rash was NOT present, this would ***not rule out*** meningitis.

Scenario #4:

Dispatched for the “sick child” in whom you receive information of a 5 year old is unresponsive. On a warm and sunny summer day, EMS arrives at an apt complex and are escorted to an apt in which is told to you that 3 families living together. A total of 5 adults and 6 children reside in a two bedroom apt. There are 2 teenaged children present, 2 school aged children and 2 babies in only diapers in a playpen crying. The teen explains that the 5 year old brother was sleeping on the bed and then they heard a “thud.” “He must have fallen off the top bunk bed,” he explained then started shaking all over.

General Impression: PAT	
Primary assessment A B C D	
Causative factors of distress	
VS/LOC	
Hydration status	
Treatment priorities	
EMS protection/priorities	

Scenario #5:

EMS is called for the "sick child." Upon arrival to a single family home, the father opens the door and leads EMS to the bedroom where a 3 year old with a fever, runny nose, cough, red eyes, and sore throat is found in the arms of his mother. "His fever is so high," she says. "And today this rash suddenly appeared all over his body. He is coughing and sneezing and won't eat."

General Impression: PAT	
Primary assessment A B C D	
Causative factors of distress	
VS/LOC	
Hydration status	
Treatment priorities	
EMS protection/priorities	

Scenario #6:

EMS is called for abdominal pain. Upon arrival, a caregiver opens the door, explaining that the 4 year old child has had nausea and vomiting for 2 days. Every time an attempt is made to eat, it is met with resistance as it just keeps coming back up.

General Impression: PAT	
Primary assessment A B C D	
Causative factors of distress	
VS/LOC	
Hydration status	
Treatment priorities	
EMS protection/priorities	

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