Objectives:
1. Know the three components of the Pediatric Assessment Triangle
2. Discuss difficulties in the interpretation of vital signs in children compared with adults
3. Describe abnormal appearance and its significance in the evaluation of pediatric injury and illness
4. List three key features of increased work of breathing
5. List three skin signs of abnormal perfusion
6. Discuss two differences in the assessment of the critically ill child and the critically ill adult
**PEDiatric EMERGENCIES**

**Introduction**
Accurate assessment of a child with an acute illness or injury requires special knowledge and skills. The majority of children presenting in the ED have mild-moderate illness and injury and remain alert. In assessing these patients, illness and injury “scoring” methodologies and severity scales for levels of consciousness are rarely useful, since they lack accuracy, especially in the infant and toddler. That is, they will reliably identify and help categorize the moderate to critically ill or injured child, but will not be as useful in the recognition of important early signs of system stress in the ill or injured child who is still compensating well.

This handout provides a model for assessment of all children using a paradigm or template for evaluation called the Pediatric Assessment Triangle (PAT). The PAT is rapid, simple, reproducible and useful for children of all ages with all levels of illness and injury severity. The paradigm is generic and fits medical, traumatic and neonatal patients.

For the critically ill or injured child, determining the primary physiologic problem may be difficult or impossible, because inadequate oxygenation, ventilation or perfusion from any cause will eventually progress to the generic picture of cardiopulmonary failure. The PAT will assist with early recognition and prioritization of problems, as a basis for an organized resuscitation, general support and specific treatment.

**The Pediatric Assessment Triangle (PAT)**

Speedy assessment is essential to determine urgency for treatment. For injury, the assessment is sometimes straightforward, because there is usually a known mechanism, and the child’s pain and/or tissue deformity may identify the anatomic problem. The child still requires careful evaluation for less obvious but potentially serious injuries. For illness, the assessment may be much trickier, because of the variability in onset, duration and nature of symptoms, and the more subtle characteristics of underlying organ system dysfunction.

The PAT (Figure 1) is a rapid, accurate and easily-learned model for the initial assessment of any child. It allows the clinician, using only visual clues, to rapidly assess the severity of the child’s illness or injury and urgency for treatment, regardless of the underlying diagnosis. The three components of the PAT are overlapping and interdependent, and reflect the child’s overall physiologic status.

By using the PAT at the point of initial patient contact, the clinician will instantaneously establish a level of severity and urgency for life support, and identify key physiologic problems to address. The PAT provides a baseline to monitor response to therapy and is the foundation for communication among medical professionals.
Functionally, the PAT brings together three key features of the overall pediatric cardiopulmonary assessment that are more accurate for initial evaluation than traditional vital signs: 1) appearance 2) work of breathing and, 3) circulation to the skin. It is based mainly upon astute, directed observation, and does not require a stethoscope, blood pressure cuff, cardiac monitor, pulse oximeter, or any other equipment or test. Because it entails simply observing a properly exposed child, the PAT can be completed in seconds. In reality, the PAT is designed to systematize what is an intuitive process for many experienced pediatric providers -- the “across the room assessment”.

**Characteristics of appearance**

The child's general appearance is the single most important parameter when assessing severity of illness or injury. Appearance reflects the adequacy of ventilation, oxygenation, brain perfusion, body homeostasis and CNS function. It is more accurate than any other clinical characteristic of the patient in predicting overall distress, need for treatment and response to treatment.

Components of appearance are many, but one easy mnemonic that summarizes some of the most important ones is “tickles” (TICLS): **T**one, **I**nteractability, **C**onsolability, **L**ook/Gaze, and **S**peech/Cry. (Table 1)

Appearance is a much more sensitive indicator of degree of distress than the formal neurologic exam, or the AVPU (Alert, responsive to **V**erbal, **P**ainful stimuli, or **U**nresponsive) neurologic assessment in the pediatric primary survey. Most children with mild to moderate illness or injury, even when they are progressing to more severe degrees of distress, are “alert” and have a “normal” neurologic exam, although they have an abnormal appearance.

**Table 1**
Components of Appearance
The “tickles” (TICLS) mnemonic

<table>
<thead>
<tr>
<th>Element</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tone</td>
<td>Is she moving around or resisting examination vigorously and spontaneously? Is there good muscle tone?</td>
</tr>
<tr>
<td>Interactability</td>
<td>How alert is she? How readily does a person, object, or sound distract her or draw her attention? Will she reach out, grasp and play with a toy or new object, like a penlight or tongue blade?</td>
</tr>
<tr>
<td>Consolability</td>
<td>Can she be consoled or comforted by the caregiver or by the clinician?</td>
</tr>
<tr>
<td>Look/Gaze</td>
<td>Can she fix her gaze on the clinician’s or caregiver’s face or is there a “nobody home,” glassy-eyed stare?</td>
</tr>
<tr>
<td>Speech/Cry</td>
<td>Is her speech/cry strong and spontaneous? Or weak, muffled, or hoarse?</td>
</tr>
</tbody>
</table>

Techniques to assess appearance

Ordinarily, assess the child’s appearance from the doorway. This is Step 1 in the “ABC’s of Pediatric Assessment”. Techniques for assessment of a conscious child's appearance include: observing from a distance, allowing the child to remain in the caregiver's lap or arms, using distractions such as bright lights or toys to gauge responsiveness, and kneeling down to be on eye level with the child.

An immediate "hands-on" approach may cause agitation and crying, and may prevent the assessment of work of breathing, and circulation to skin. Rapid laying on of hands is only indicated in the unresponsive child or in the child with abnormal appearance. Get all the information possible by observing the child before touching the child or taking vital signs.

An example of a child with a benign appearance would be one with good eye contact, good color; spontaneously reaching for a tongue blade. An example of an infant with a worrisome appearance would be one with poor eye contact with caregiver or clinician, pale or mottled, listless.

Abnormal appearance may be due to inadequate oxygenation, ventilation or brain perfusion; it may be the result of systemic insults or failure from poisoning, infection, hemorrhage or metabolic abnormalities such as hypoglycemia; or from direct brain injury due to injury, infection, or toxic substances. Regardless of the cause of the abnormal appearance, once it is established with the PAT that the child is seriously ill or injured, immediately begin life support efforts to optimize oxygenation, ventilation and perfusion. Then perform the primary survey, as described later.

While an alert, interactive child is usually not critically ill, there are some exceptions to the reliability of general appearance, and it is important to recognize those infants who are at risk of becoming critically ill. For example:

1) Children with severe acute intoxications, such as acetaminophen, iron, or cyclic antidepressants may be asymptomatic early in their presentation. Despite
their benign appearance, they have potential to develop lethal complications in the ensuing minutes or hours.

2) A child with blunt trauma may be able to maintain adequate core perfusion despite internal bleeding by increasing cardiac output and systemic vascular resistance. When these compensatory mechanisms fail, she may acutely "crash", with rapid progression to clinical shock.

Age differences are associated with important developmental differences in psychomotor and social skills. Therefore, "normal" or expected appearance and behavior varies between age groups. Knowledge of normal development will guide the approach to children and enhance clinical ability to judge the appropriateness of behavior and appearance.

The appearance of an infant with early shock or decreased brain perfusion may include irritability and failure to console. As the condition deteriorates, one may see alternating lethargy and irritability, where the slightest stimulation causes crying and shaking. When the noxious stimulus is removed, lethargy returns quickly. As symptoms progress, lethargy becomes the dominant observation. The "glassy-eyed" or "nobody home" stare is a sign of altered consciousness in infants. A high-pitched screeching or cephalic cry may indicate poor brain perfusion, brain injury or a central nervous system infection in infants.

While appearance reflects the presence of real illness or injury, it does not necessarily indicate the source of the distress. Appearance is the screening tool for the PAT. The other elements of the PAT, work of breathing and circulation to skin, provide specific information about the physiologic derangement; they help identify the likely source of system dysfunction while assisting with the assessment of degree of severity.

**Key characteristics of work of breathing**

Work of breathing is a more accurate immediate indicator of oxygenation and ventilation than conventional adult measures, such as counting RR or chest auscultation. Work of breathing reflects the child’s physiologic compensatory response to cardiopulmonary stress. Assessing work of breathing entails careful listening for abnormal airway sounds and observing for specific visual information about breathing effort. Table 2 summarizes characteristics of work of breathing.

Abnormal sounds provide excellent clues to breathing effort, type of breathing problem and degree of hypoxia. Examples of abnormal sounds that can be heard from a distance are altered speech, stridor, grunting and wheezing. Altered tone of voice or stridor suggests upper airway obstruction. Grunting is a technique the body evokes to keep lower respiratory air sacs or alveoli open, during certain illness states, for maximum gas exchange. Grunting means hypoxia and lower airway disease. Wheezing indicates lower airway obstruction.
There are several useful visual signs of increased work of breathing. These observational clues indicate the amount of respiratory effort the child is mounting to handle the physiologic stress; therefore presence or absence of certain physical features reflects the overall severity of the illness or injury. Examples of such visual signs are abnormal positioning, retractions, and nasal flaring.

Abnormal positioning, such as head bobbing and tripoding, represents the child’s instinctive efforts to optimize airway patency. Head bobbing and tripoding are immediately evident from the doorway.

Retractions and flaring are good physical signs of increased work of breathing, but they are easily missed. The clinician must look specifically for them after the child is properly exposed. Retractions are a more sensitive measure of work of breathing in children than adults because their chest walls are thin, making retractions more apparent. The presence of retractions means the child is taking extra effort to move air into the lungs.

Nasal flaring indicates advanced compensatory effort to improve oxygenation and ventilation. Flaring indicates hypoxia.

**Technique to assess work of breathing**

After noting the child’s overall appearance, Step 2 in the PAT is assessing work of breathing by listening for abnormal airway sounds and looking for physical indicators of increased breathing effort. Without using a stethoscope, first listen for audible abnormal breathing sounds. Then, look for abnormal positioning, especially head bobbing and tripoding.

Next, have the caregiver expose the chest of the child for direct inspection or have the child disrobed on the caregiver’s lap. Children may have increased work of breathing because of abnormalities anywhere in their airways, pulmonary parenchyma, pleura or chest wall. Look for intercostal, supraclavicular, and substernal retractions. After looking for retractions, inspect for nasal flaring. Table 2 summarizes the characteristics of work of breathing.

<table>
<thead>
<tr>
<th>Element</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abnormal airway sounds</td>
<td>Altered speech, stridor, wheezing or grunting</td>
</tr>
<tr>
<td>Abnormal positioning</td>
<td>Head bobbing, tripoding</td>
</tr>
<tr>
<td>Retractions</td>
<td>Supraclavicular, intercostal or substernal retractions of the chest wall</td>
</tr>
<tr>
<td>Flaring</td>
<td>Nasal flaring</td>
</tr>
</tbody>
</table>
Combining assessment of appearance and work of breathing can establish severity. A child with normal appearance and increased work of breathing is in respiratory distress. Abnormal appearance and increased work of breathing means early respiratory failure. Abnormal appearance and abnormally decreased work of breathing is late respiratory failure.

**Characteristics of circulation to skin**

The goal of rapid circulatory assessment is to determine the adequacy of cardiac output and perfusion of vital organs. The child's appearance is one indicator of adequacy of brain perfusion, but abnormal appearance may be caused by a variety of other conditions and therefore is not specific to the condition of decreased core perfusion.

An important indicator of core perfusion is circulation to skin. When cardiac output is inadequate, the body shuts down circulation to non-essential anatomic areas such as the skin in order to preserve blood supply to vital end organs (e.g. brain, heart and kidney). Therefore, circulation to skin reflects the overall status of circulation to the body’s important end organs. Pallor, mottling and cyanosis are key visual indicators of reduced circulation to skin. Table 3 summarizes these characteristics.

<table>
<thead>
<tr>
<th>Element</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pallor</td>
<td>White skin coloration from lack of peripheral blood flow.</td>
</tr>
<tr>
<td>Mottling</td>
<td>Patchy skin discoloration, with patches of cyanosis, due to vascular instability or cold</td>
</tr>
<tr>
<td>Cyanosis</td>
<td>Bluish discoloration of skin and mucus membranes.</td>
</tr>
</tbody>
</table>

Pallor may be the first sign of poor skin perfusion. Its presence may suggest attempts to compensate for shock. Mottling, or patches of pallor and cyanosis, are late signs of shock and usually demonstrates loss of compensatory mechanisms. Do not confuse mottling with the fine marbled appearance often seen in infants who are cold. Cyanosis is blue discoloration of the skin and mucus membranes. Cyanosis can be a sign of shock or respiratory failure.

Other important indicators of circulation to skin, such as skin temperature, capillary refill time, and quality of pulses, are best delayed until the hands-on assessment occurs in conjunction with the primary survey, as described later.

**Technique to assess circulation to skin**

After assessing the child’s appearance and work of breathing, Step 3 in the PAT is evaluating circulation to skin. Be sure the child is disrobed but not cold. Cold will give false positive skin signs (i.e. the child will have normal perfusion, but will have abnormal skin and signs.) Cold ambient air temperature is the most important reason for misinterpretation of skin signs.
With the child disrobed, inspect the skin for pallor, mottling and cyanosis. Look at the face, chest, abdomen and extremities. Then, inspect the lips for cyanosis.

Using the PAT to evaluate severity and illness or injury categories

The three elements of the PAT are interdependent and together allow rapid assessment of the child’s overall physiologic stability. For example, if a child is alert and interactive, pink, but has mild retractions, one can take time to approach the child in a developmentally appropriate manner to complete the physical assessment. On the other hand, if the child is poorly responsive, with unlabored rapid respirations, and has pale or mottled skin, the diagnosis of shock can be made immediately, and one should move rapidly through the pediatric primary survey, and initiate resuscitation. Abnormal appearance and decreased circulation to skin means shock.

By combining the different characteristics of the PAT, one can both establish a degree of severity and identify the likely type or category of physiologic abnormality. This will help the clinician gauge how fast to intervene and what type of general and specific treatment to give.

The PAT has two crucial advantages. First, it allows the health care professional an opportunity to rapidly obtain critical information about the child’s physiologic status before touching or irritating the child. It is difficult to identify abnormal appearance or increased work of breathing when a child is agitated and crying. Second, it helps set priorities for the primary survey. The PAT only takes seconds, identifies need for life-saving interventions, and blends rapidly into the primary survey.

Another important aspect of the PAT is that it is an equilateral triangle. It can be rotated in any direction on its axis and still provide the key observational information, i.e., the three components can be assessed in any order. Any sequence of the ABCs (appearance, breathing, circulation) works, regardless of which is first or second or third, and the ABC order is purely for easy recall in an emergency.

The PAT and the pediatric primary survey

The PAT (Triangle) differs from the pediatric primary survey in content and intent. The PAT uses selected elements of the primary survey, in combination with pediatric-specific observations to establish an overall level of cardiopulmonary function and a level of severity or urgency for care. Its intent is to provide an objective, instantaneous picture of the child’s degree of distress to help gauge the timing of treatment. The PAT will also give the clinician a good idea of which organ system is the source of the problem.

In contrast, the pediatric primary survey is an ordered and comprehensive first physical evaluation of cardiopulmonary status, which has as its intent a prioritized sequence of life support interventions and reversal of pathophysiology. The visual PAT should be
completed in every patient before performing the more complete and more time-consuming pediatric primary survey, and prior to initiating life support interventions.

The pediatric primary survey

The pediatric primary survey is an approach for a comprehensive, hands-on assessment of an ill or injured child regardless of complaint. As in adults, the primary survey provides a specific sequence for treating life-threatening problems as they are identified, before moving to the next step. The steps in the survey are the same as with adults, but there are differences in the specific signs of distress or physiologic instability.

Components of the pediatric primary survey: airway and breathing

First determine airway patency by observing work of breathing and listening for abnormal audible breath sounds such as stridor, wheezing and grunting as part of performing the PAT.

The loudness of the stridor or wheezing is not strongly correlated with the degree of airway obstruction. For example, asthmatic children in severe distress may have little or no wheezing. Similarly, children with an upper airway foreign body below the vocal cords may have minimal stridor. Abnormal breath sounds merely indicate whether there is any degree of upper or lower airway obstruction.

Several adjunctive findings from the pediatric primary survey will help further define the degree of respiratory distress and the anatomic location of the abnormality. Listen with a stethoscope for inspiratory crackles, which indicate disease in the air sacs themselves. Also, evaluate tidal volume and effectiveness of work of breathing, by listening for air movement bilaterally over the midaxillary line. A child with increased work of breathing and poor tidal volume may be in impending respiratory failure.

Table 4 lists the various breath sounds that may be detected while performing the PAT and pediatric primary survey, their meaning, and common examples.

<table>
<thead>
<tr>
<th>Sound</th>
<th>Cause</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stridor</td>
<td>Upper airway obstruction</td>
<td>Croup, foreign body</td>
</tr>
<tr>
<td>Wheezing</td>
<td>Lower airway obstruction</td>
<td>Asthma, foreign body</td>
</tr>
<tr>
<td>Expiratory grunting</td>
<td>Inadequate oxygenation</td>
<td>Pulmonary contusion, pneumonia, drowning</td>
</tr>
<tr>
<td>Inspiratory crackles</td>
<td>Fluid/mucus/blood in the airway</td>
<td>Pneumonia, pulmonary contusion</td>
</tr>
<tr>
<td>Absent breath sounds despite increased work of breathing</td>
<td>Complete airway obstruction (upper or lower airway) Pleural fluid, consolidation, or pneumothorax</td>
<td>Foreign body, severe asthma, hemothorax, pneumothorax</td>
</tr>
</tbody>
</table>
Determine the respiratory rate, but interpret the respiratory rate cautiously. Rapid rates may simply reflect high fever, anxiety, pain or excitement. Normal rates, on the other hand, may occur in a child who has been breathing rapidly for some time to overcome an airway obstruction and is now becoming fatigued. Finally, interpret respiratory rate in light of what is normal for age. A very rapid respiratory rate (>60/min for any age), especially in association with abnormal appearance or marked retractions, indicates respiratory distress and possibly failure. An abnormally slow respiratory rate is always worrisome and suggests respiratory failure. Red flag respiratory rates are <20/min for child <2 years, and <10 for children >2 years.

Frank cyanosis is a late finding. A hypoxic child is likely to show other abnormalities, such as increased work of breathing, agitation or lethargy long before they look “blue”. Do not wait for cyanosis to initiate treatment with supplemental oxygen. However, if cyanosis is present, immediately intervene.

Pulse oximetry is an excellent tool to confirm the clinical assessment of a child’s breathing. A pulse oximetry reading above 94% indicates that oxygenation is probably adequate; a reading below 90% with mask oxygen in place is an indication for assisted ventilation. Don’t underestimate respiratory distress in a child with a reading above 94%. Avoid this error by using work of breathing to help interpret pulse oximetry. A child in respiratory distress or early respiratory failure, through intense compensatory mechanisms, may maintain their oxygen saturation and appear minimally ill based on pulse oximetry alone. Table 5 summarizes the usefulness of different signs of work of breathing.

<table>
<thead>
<tr>
<th>Sign</th>
<th>Key Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Indicates real distress if abnormal, but may reflect a variety of other organ system problems other than breathing. Very sensitive but nonspecific.</td>
</tr>
<tr>
<td>Flaring, head-bobbing</td>
<td>Needs close inspection to see, and may not be present if there is only mild-moderate distress. If present, be aggressive with oxygen. Specific for hypoxia but not sensitive to mild distress.</td>
</tr>
<tr>
<td>Retractions</td>
<td>Best and most visible indicator of increased breathing effort.</td>
</tr>
<tr>
<td>Grunting</td>
<td>Suggests severe air space disease and hypoxia. If present, be aggressive with oxygen and possible ventilatory support.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sign</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory rate</td>
<td>Only useful in extremes, &gt; 60/min or &lt; 10-20/min.</td>
</tr>
<tr>
<td>Cyanosis</td>
<td>Late finding. Abnormal appearance will precede this finding.</td>
</tr>
<tr>
<td>Pulse Oximetry</td>
<td>Helpful, but not available in all EDs.</td>
</tr>
</tbody>
</table>

Components of the pediatric primary survey: circulation

Next, assess circulation. The PAT will have provided important visual clues about adequacy of circulation. Appearance and work of breathing may also be altered if the child is in shock. Appearance will be abnormal because of inadequate perfusion of the
brain. The combination of abnormal appearance and decreased circulation to skin suggests shock, either compensated or decompensated.

However, abnormal appearance may also result from many severe stress states, such as hypoxia, hypercarbia, head trauma, infection, or drugs. In addition, sometimes children in shock seem remarkably alert, although careful observation of appearance will always indicate some abnormality such as listlessness or restlessness.

Children in shock will often be tachypneic, without retractions, as they attempt to compensate for metabolic acidosis (due to poor perfusion) by blowing off CO₂. This pattern of rapid respiration may be termed "effortless tachypnea", and is distinct from the rapid labored respirations with retractions seen with underlying airway/breathing problems.

Heart rate (HR) and blood pressure (BP) have a limited but still useful role in evaluating core circulation. Parameters commonly used to assess adult circulatory status, i.e. HR and BP, have important limitations in children. First, normal HR varies inversely with age. Second, tachycardia may be an early isolated sign of hypoxia or low perfusion, but, it may also be present because of benign conditions such as fever, anxiety, pain and excitement. HR must therefore be interpreted in the context of the overall history, PAT and comprehensive physical exam. A trend of increasing or decreasing HR may be quite useful, and may suggest worsening hypoxia or shock, or improvement after treatment.

When hypoxia or shock becomes critical, HR falls to frank bradycardia. Bradycardia means critical hypoxia and/or ischemia. When the HR is above 180/min, HR cannot be accurately determined without the assistance of an electronic monitor.

BP determination is difficult in children because of lack of cooperation, difficulty remembering the proper cuff size and errors in interpretation. For patients less than three years of age these technical difficulties reduce the value of a BP. When shock is suspected in this age group based on other parameters (e.g., history, mechanism, PAT), attempt BP once, but do not delay management further.

BP may be misleading. Although a low BP definitely indicates decompensated shock, a "normal" BP frequently exists in compensated shock. An easy formula for determining the lower limit of acceptable blood pressure by age is: minimal systolic blood pressure = 70 + 2 x age (in years).

Circulatory assessment also entails further detection of signs of decreased circulation to skin. This includes hands-on evaluation of skin temperature, capillary refill time (CRT) and pulse quality. To quickly assess circulation, lay your hand on the kneecap or forearm and feel for skin temperature. Be sure the child is not cold from exposure, because skin signs will be deceptive if the child is not warm.

Next, feel the pulse and check the capillary refill time (CRT). Signs of circulation to the skin, i.e. skin temperature and color, CRT, and pulse strength, are tools to assess a child's circulatory status, especially when performed serially on a child who is not cold.
In a normal infant, you can easily palpate the brachial pulse, the extremities are warm and have a uniform color (not "mottled"), and the CRT is less than two seconds. Table 6 summarizes the relative value of signs of shock or abnormal circulation.
Table 6: Relative Value of Signs of Shock

<table>
<thead>
<tr>
<th>Sign</th>
<th>Key Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAT Assessment Skin Color</td>
<td>Pallor is an early sign of poor skin perfusion; cyanosis and/or mottling can be late signs of shock.</td>
</tr>
<tr>
<td>Appearance</td>
<td>Irritability, lethargy, confusion or an altered response to stimuli are signs of poor brain perfusion.</td>
</tr>
<tr>
<td>Work of Breathing</td>
<td>Rapid and deep respirations without an increase in work of breathing may indicate the body's effort to compensate for the acidosis of shock.</td>
</tr>
</tbody>
</table>

Primary Survey

<table>
<thead>
<tr>
<th>Heart Rate</th>
<th>Fast heart may be the first sign of shock, but very nonspecific; may also be seen with hypoxia, fever or fright.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin Temperature</td>
<td>Cool extremities indicate poor perfusion to skin from hypovolemic shock; warm skin with mottling suggests septic shock.</td>
</tr>
<tr>
<td>Capillary Refill</td>
<td>Child needs to be in a properly warmed environment for accuracy.</td>
</tr>
<tr>
<td>Pulse Quality</td>
<td>Compare central pulse with peripheral pulse quality.</td>
</tr>
<tr>
<td>Blood Pressure</td>
<td>Can be difficult to obtain, and a drop in BP is a late sign of shock.</td>
</tr>
</tbody>
</table>

Components of the pediatric primary survey: disability or neurological status

Assessment of neurologic status involves rapid evaluation of both cortical and brainstem function. Assess neurological status by observation of appearance (Table 1), pupillary responses to light, level of consciousness, and motor activity. In the evaluation of motor activity, assess purposeful movement, symmetrical movement of extremities, seizures, posturing, or flaccidity.

The AVPU pneumonic (Table 7) is a rapid method of assessing level of consciousness that is quite consistent with different observers. It categorizes motor response based upon simple responses to stimuli. The child is either Alert, responsive to Verbal stimuli, responsive only to Painful stimuli, or Unresponsive.

Table 7
AVPU Neurological Assessment

<table>
<thead>
<tr>
<th>Category</th>
<th>Stimulus</th>
<th>Response Type</th>
<th>Reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Alert</td>
<td>Ambient environment</td>
<td>Appropriate</td>
<td>Normal interaction with environment</td>
</tr>
<tr>
<td>V Verbal</td>
<td>Simple command/ sound stimulus</td>
<td>Appropriate</td>
<td>Obeys command</td>
</tr>
<tr>
<td>P Painful</td>
<td>Pain</td>
<td>Appropriate</td>
<td>Withdraws from pain, sound or motion without purpose or localization</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inappropriate</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inappropriate</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pathological</td>
<td>Posturing</td>
</tr>
<tr>
<td>U Unresponsive</td>
<td>No perceptible response to any stimulus</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Abnormal appearance and altered level of consciousness

A child with altered level of consciousness on the AVPU will always have abnormal appearance, because any patient so sick that she is no longer “alert” and will only respond to verbal stimuli is already moderately to critically ill. Therefore, the signs of abnormal appearance are most useful in identifying distress in the alert child who has mild to moderately severe distress. The AVPU is simply not a very sensitive method to identify children in early stages of system stress from illness or injury.

Assessing appearance using the characteristics as described for the PAT allows a more subtle appreciation of compensated illness and injury, facilitates early intervention and averts progression to more advanced states of neurologic deterioration on the AVPU scale. A child who has an abnormal appearance or who is not alert on the AVPU, yet has no increased or decreased work of breathing or abnormal circulation to skin, probably has a focused insult to the brain. Such brain insults include a post-ictal state, intoxication, metabolic abnormality (e.g., hypoglycemia), infection, hemorrhage or trauma.

The resuscitation tape and determining weight, appropriate drug doses and equipment sizes

In an emergency, when a child cannot readily be weighed, use a length-based resuscitation tape for determining appropriate drug dosing and equipment size. In children, this method is preferable to guessing a child’s weight as visual weight estimates are unreliable and memorization of weight based medication dosing is error prone.

If a resuscitation tape is not available and the caregiver does not know an approximate weight, use age to estimate weight.Only a "ballpark" estimate is needed. Use the following rules:

1) An average birth weight is 3.5 kg
2) Infants double birth weight by 5 months (7.0 kg)
3) Infants triple birth weight at one year (~10kg).
4) In older children, weight in kg = 8 + (2 x age in years)

If an infant's/child's weight in pounds is known, divide by 2 to get an approximate kg weight.

Comparison between pediatric and adult cardiopulmonary assessment

Adult cardiopulmonary assessment begins with a “hands-on” approach. In contrast, for the awake, alert child over six months of age, begin the assessment from a distance, with maneuvers to gain the child's confidence. After establishing the child's level of distress from the doorway, using key elements of the PAT, immediately proceed to the formal primary survey to prioritize life support interventions.
As in adults, vital signs can impart important information. Obtaining and interpreting vital signs in children however may present more difficulty because it is difficult to obtain accurate values. Children may be uncooperative and properly sized equipment may not be available. Normal values vary with age, making recognition of abnormalities more challenging.

Remember, vital signs are just a piece of the overall clinical picture, which includes history of illness, mechanism of injury, the elements of the PAT, and your comprehensive clinical evaluation. Vital signs alone should rarely drive clinical decision making, because true alterations in vital signs will have been manifest earlier in the form of abnormalities in the elements of the PAT.
PEDIATRIC EMERGENCIES

Case 1
A young mother presents to the ED with a 6-month-old boy who has had constant vomiting for 24 hours. The infant is lying still and has poor muscle tone. He is irritable if touched, and his cry is weak. There are no abnormal airway sounds, retractions, or flaring. He is pale and mottled. The respiratory rate is 30 breaths/min, heart rate is 180 beats/min, and blood pressure is 50 mm Hg/palp. Air movement is normal and breath sounds are clear to auscultation. The skin feels cool and capillary refill time is 4 seconds. The brachial pulse is weak. His abdomen is distended.

What are the key signs of illness in this infant?
How helpful are respiratory rate, heart rate, and blood pressure in evaluating cardiopulmonary function?

Case 2
A father brings his 11-month-old daughter to the ED because she awoke fussy, and he thinks the child has “infection on her brain.” A cousin had been hospitalized in the last few days with that condition, he tells you.

The child is standing, screaming in the room. The father is anxious and demanding immediate hospitalization for the child. The infant turns pink and becomes agitated whenever you approach. There are no abnormal airway sounds, retractions, or flaring. The respiratory rate is 50 breaths/min, and she vigorously fights when you touch her to perform the physical assessment. You are unable to obtain a heart rate or blood pressure.

How useful is the Pediatric Assessment Triangle (PAT) in evaluating severity of illness and urgency for care? How is the PAT different than the ABCDEs in the initial assessment?

Case 3
A 5-year-old girl is hit by a car in the crosswalk on the first day of kindergarten. She is thrown 10 feet and has a brief loss of consciousness. In the ED, she is lying motionless on the gurney, but opens her eyes with a loud verbal stimulus. She will not speak or interact. There are no abnormal airway sounds, retractions, or flaring. Her skin is pink. Respiratory rate is 20 breaths/min, heart rate is 95 beats/min, and blood pressure is 100 mm Hg/palp. The chest is clear with good tidal volume. The skin feels warm, capillary refill time is less than 2 seconds, and her brachial pulse is strong. She has a large frontal hematoma.
Does this child’s appearance suggest serious injury?
How does the AVPU scale complement appearance in assessing brain function in this child?

Case 4
A school principal calls 911 because a 13-year-old asthmatic “can’t breathe.” The boy is on daily treatments with a metered dose inhaler (MDI). His physician prescribed oral steroids yesterday for worsening asthma symptoms. In the ED, he tells you that he was up all night, using his albuterol MDI every 1 to 2 hours.

The boy is sleepy and pale and has audible wheezing. He is in the tripod position. There are suprasternal, intercostal, and subcostal retractions and nasal flaring. The respiratory rate is 45 breaths/min, the heart rate 160 beats/min, and the blood pressure is 120/70 mm Hg. Blood oxygen saturation is 83% on room air. On auscultation you hear minimal air movement and a prolonged expiratory phase.

What is this child’s physiologic status?
What is the most important treatment?

Case 1 Answer
This infant is severely ill. The PAT indicates poor appearance with diminished tone, poor interactiveness, and weak cry. These are important signals of weakened cardiopulmonary and/or neurologic function in an infant. Work of breathing is normal, but circulation to skin is poor. The PAT establishes this child as a critical patient that requires rapid resuscitation. However, the respiratory rate, heart rate, and blood pressure are possibly within the normal ranges for age. Therefore, vital signs in this child could be deceptive, unless correlated with the PAT and the entire initial assessment. In this case, the PAT tells you that the child has an abnormal appearance and decreased skin circulation, which suggest shock.

The hands-on ABCDE phase of the assessment shows poor skin signs and diminished brachial pulse. These important physical findings confirm the PAT impression of shock. Furthermore, when you review the vital signs in the context of the initial assessment, you may identify that this child has “effortless tachypnea,” a physiologic attempt to clear acidosis generated by shock.

Case 2 Answer
The PAT is a good way to get a general impression of this child and to judge degree of illness and urgency for care. Many other conventional assessment methods such as history taking, auscultation, and blood pressure determinations would be frustrating to attempt and possibly inaccurate in the first few minutes. The child’s appearance is reassuring. She has good tone, a vigorous cry and she is easily consoled by her father. There are no abnormal airway sounds, retractions, or flaring, so work of breathing is normal in spite of a respiratory rate in the highest range for her age. Circulation to the skin is normal. With these PAT findings, it is highly unlikely that the child has a serious illness. The PAT provides the impression of a relatively well child
and allows you to stand back and gain the confidence of the child and father before rushing to a hands-on evaluation. Place this child in the father’s arms and allow the father to keep the girl on his lap while you proceed with the evaluation. When the child is less agitated, approach gently to complete the initial assessment. Use a “toe-to-head” sequence.

The PAT is the important first phase of the initial assessment. It does not replace the hands-on assessment of the ABCDEs and vital signs. The PAT for this child should reassure you. Urgent treatment is not needed, and a focused history and detailed physical exam can be performed first.

**Case 3 Answer**
This child’s appearance is grossly abnormal. The girl’s lethargic appearance with no increased work of breathing or abnormal skin signs on the PAT suggests a possible intracranial injury. This could be a concussion, hemorrhage, or brain edema. The appearance indicates an unstable patient who needs rapid treatment. Complete the ABCDEs and immobilize the child. Provide 100% oxygen by mask.

Use the resuscitation tape to determine her length, endotracheal tube size, weight, volume requirements, and other information relevant to drug doses. Get vascular access and give 20 ml/kg of crystalloid. Reassess. Repeat crystalloid if necessary.

There are many methods of determining neurologic function in this child in order to guide treatment decisions, minimize differences among different observers, and provide for consistent exams. Different systems use different methods such as the Glasgow Coma Scale or the Pediatric Glasgow Coma Scale. Some of the problems with these numerical neurologic scoring systems in children include the following: they require memorization or written prompting; they may not be easily adapted to children because of difficulties evaluating speech in nontalking or frightened youngsters; they may only apply to injury cases; and there is no validated national standard.

The AVPU scale is a basic approach for children adapted from adult disability assessment. It has not been validated in children. The AVPU scale is easily linked to abnormal appearance in the PAT, which may identify more subtle signs of early neurologic dysfunction. The AVPU scale divides brain response into general categories that are simply remembered, seem to remain consistent among different observers, and provide good information for treatment decisions.

**Case 4 Answer**
This child is in respiratory failure. He has poor appearance (sleepy), poor color (pallor), and increased work of breathing (retractions, audible wheezing, flaring, tripod position). His tachypnea, tachycardia, documented hypoxia, and poor air movement support this assessment.

Further, he was treated aggressively at home, with worsening symptoms despite steroids and utilization of his albuterol MDI far more frequently than is recommended.
for patient self-administration. The fact that he was up all night indicates that he was in too much respiratory distress to recline or sleep.

Asthma is a chronic disease, involving inflammation of the small airways. Although bronchoconstriction, airway edema, and increased secretions all contribute to lower airway obstruction, the only part of this pathophysiology that can be reversed quickly is bronchoconstriction.

General noninvasive treatment includes administration of high-flow oxygen through a nonrebreathing mask, and position of comfort. Support ventilation with BVM if his condition deteriorates. Positive pressure ventilation will require high peak inspiratory pressures and may be associated with worse air trapping and barotrauma.

Specific treatment includes continuous high-dose nebulized albuterol, using 10 mg per dose, and “back-to-back” nebulizer treatments. Consider giving SQ epinephrine if he does not respond to the first nebulizer treatment or if his condition worsens. Endotracheal intubation may become necessary if his work of breathing results in fatigue and hypoventilation or worsening hypoxia.
Bibliography:
1. Dieckmann RA, Gausche M, Brownstein D: Textbook of Pediatric Education for Prehospital Professionals, Jones and Bartlett, 2005


