

## PedsCases Podcast Scripts

This is a text version of a podcast from PedsCases.com on the “Approach to Pediatric Vital Signs.” These podcasts are designed to give medical students an overview of key topics in pediatrics. The audio versions are accessible on iTunes or at [www.pedcases.com/podcasts](http://www.pedcases.com/podcasts).

### **Approach to Pediatric Vital Signs**

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#### Intro

Hi everyone, my name is Chris Novak and I’m a medical student at the University of Alberta. This podcast was developed with Dr. Melanie Lewis, a general pediatrician and Associate Professor at the University of Alberta and Stollery Children’s Hospital in Edmonton, Alberta, Canada and Dr. Peter Gill, a pediatric resident at the Hospital for Sick Children and University of Toronto. This podcast is designed to give an approach to the interpretation of vital signs in children.

To start, let’s look at a clinical case – You are a medical student on an inpatient pediatric unit. You have been assigned to look after a 12 month-old male admitted with bronchiolitis. Before entering the patient’s room you look at the record of the patient’s vitals. His HR is 120, RR 36, BP is 85/37, he has a tympanic temperature of 36.6°C and oxygen saturation of 92% on room air. How do you interpret these vital signs and what do they tell you about your patient’s clinical status?

The interpretation of vital signs in pediatrics can be a confusing topic for learners. Normal values for vital signs may vary with age, gender, height, level of anxiety and the technique that you use measure them. Therefore, vital signs have to be interpreted as a continuum that depends on the clinical context. The objectives of this podcast are the following:

- 1) Develop an approach to interpretation of pediatric heart rate, respiratory rate, blood pressure, temperature and oxygen saturation.
- 2) Understand how to accurately measure pediatric vitals and identify common sources of error.
- 3) Understand broad trends of how vital signs change as a child ages.

A table of normal reference ranges is included in the supplementary materials at PedsCases.com. Numerous bodies have worked to create normal reference ranges for vital signs in different age groups, however there is some disagreement between groups as to what is truly normal. Recent research suggests that many normal ranges for

pediatric vital signs may need to be updated, but for now current reference ranges are used in practice and in resuscitation protocols. All values referenced in this podcast come from the Pediatric Advanced Life Support guidelines. A good approach to pediatric vital signs is to keep an approximate normal value in mind, and to always interpret vitals based on the clinical context. For example, in a toxic-appearing child, an elevated HR or RR would be suggestive of sepsis, but those same vital signs may be normal in a child who is scared or agitated.

## Heart Rate

Measuring a pulse is one of the oldest physical exam techniques with reports dating back to Ancient Egypt in 3500 BC where physicians would use the pulse as a sign of advancing disease. The heart rate is of equal importance today and can tell us much about a patient's clinical status.

Measurement: The HR can be determined by feeling a peripheral pulse, or by direct auscultation of the heart to determine an apical rate. For accurate measurement, you can count the pulse for 30 seconds and then multiply this number by two. You may also get the heart rate from an external monitor, pulse oximeter or blood pressure machine, but you can gain additional information by feeling the strength, contour and regularity of a pulse. A heart rate should be measured when a patient is either at rest or asleep. Separate reference ranges exist for children who are awake and sleeping.

Trends with Age: Resting heart rate is fastest in infants and decreases with age. A normal HR for an awake, healthy term newborn is between 85 and 205 bpm. As a child gets older, their HR will slowly decrease until age 10 where it approximately reaches normal adult values. A normal HR for a child older than 10 years is between 60 and 100 bpm.

Tachycardia, or an elevated heartrate could suggest a cardiac arrhythmia, hypovolemia, a metabolic disturbance, infection or more. Sinus bradycardia during sleep is very common in infants and children; as long as they are pink and well perfused there is rarely cause for worry. Children with bradycardia during awake periods should be evaluated for an underlying abnormality to the heart's conduction system such as a third degree heart block.

## Respiratory Rate

The respiratory rate is unique in that is the one vital sign that we can consciously control. A person can hold their breath, or purposefully breathe faster. After a certain amount of time however, the autonomic nervous system will take over to maintain homeostasis, as is seen when you try to hold your breath for too long.

Measurement: RR can be measured by observation of the chest wall or by direct auscultation of the lung fields. It is best to measure it when the patient is not aware that you are doing so, such as when you are counting the pulse or by observation at the

bedside, especially in young children. This prevents children from breathing abnormally when they are being watched.

Trends with Age: Respiratory rate is fastest in newborns and decreases with age. A normal resting respiratory rate in an infant less than one year ranges from 30 to 60 bpm. Over time respiratory rate gradually decreases, and reaches approximately normal adult ranges by about age 13. A normal resting respiratory rate in an adolescent is 12 to 16 bpm.

Tachypnea, or an elevated RR, is a sign of respiratory distress and is the body's physiologic response to hypoxemia, hypercarbia or pyrexia. The differential for tachypnea is large, but includes pulmonary conditions such as infection/inflammation/obstruction of the airways, trauma or pneumothorax. Non-pulmonary causes of tachypnea include cyanotic heart disease, heart failure with pulmonary edema, metabolic acidosis or severe anemia. Bradypnea in children is rare, but usually suggests a central lesion, such as a central nervous system insult or intoxication like an opioid overdose.

### Blood Pressure

Blood pressure is defined as the pressure exerted by circulating blood on the walls of blood vessels. Pressure in a vessel rises and falls with each heartbeat. The maximum pressure is called the systolic pressure, and the minimum pressure is called the diastolic pressure.

Measurement: The first step of a good blood pressure measurement is preparation. Ideally, depending on patient age, the child should be sitting in a chair with their back supported and their arm at the level of the heart. The patient should rest for at least 5 minutes before measuring and should not have had stimulants (e.g. caffeine) at least 30 minutes prior. Next you need to select the appropriate cuff size by looking at the cuff bladder, the part that fills up with air. The cuff bladder length should encircle at least 80% of the arm circumference while the bladder width should be at least 40% of the arms circumference. A cuff that is too small overestimates blood pressure, and a cuff that is too large may slightly underestimate the blood pressure.

Clinics and hospitals should have a variety of cuff sizes available, so test a few out to get the best fit for the individual child. Once you are prepared, palpate the radial pulse and inflate the cuff until you feel the radial pulse is occluded. This point should represent approximately the systolic blood pressure. Release the pressure and then inflate the cuff to 20-30 mm Hg above the point at which the pulse was occluded. Then slowly release the pressure at a rate of 2 mm Hg/sec. Korotkoff sounds become apparent starting at the systolic blood pressure, and continue until you reach the bottom end of the diastolic blood pressure. Ideally you should obtain 2 or more measures and compare both arms.

With all this being said, measuring a blood pressure on a young child can be difficult and ideal technique may be impossible in a scared child who does not like having their arm squeezed by a stranger. If accurate measurement is not essential, you can get an approximation of the systolic pressure by quickly inflating to the point where you occlude the radial pulse, and then quickly releasing the pressure.

**Trends with Age:** Unlike other vital signs, blood pressure starts low and increases with age. The normal ranges for blood pressure depend on a child's age, gender, and height, but here are some good numbers to remember. In a term neonate, systolic blood pressure should be higher than 60 mm Hg. In a child aged 1 to 10 years, the minimum systolic blood pressure can be determined using the formula  $70 + (\text{age in years} \times 2)$ . For example, the minimum systolic pressure for an 8 year old would be  $70 + (8 \text{ years} \times 2) = 86$  mm Hg. For children older than 10, systolic blood pressure should be higher than 90. For precise determination of a child's blood pressure percentile, as is needed to diagnose hypertension, specific reference ranges are available from the National High Blood Pressure Education Program Working Group. You can also calculate the child's percentile using medical calculator apps.

Hypotension, or abnormally low blood pressure is a very late sign of shock in children, including hypovolemic, septic, distributive and cardiogenic shock. Unlike adults, children compensate during shock and maintain an adequate blood pressure; hypotension is an ominous sign of impending deterioration. Hypertension can be suggestive of a number of problems including renal disease, coarctation of the aorta, endocrine disorders, medication side effects, intoxications and increased intracranial pressure.

## Temperature

Temperature is the last of the four traditional vital signs and is a key measurement when working with infection.

**Measurement:** Temperature varies considerably depending on where it is measured. Ideally the goal is to measure a person's core temperature, however the measurements that we use are surrogate measurements from peripheral sites. Rectal temperatures are the preferred method for infants and young children, however this is uncomfortable for older children. Oral temperatures are good for children older than 5 who can cooperate to keep a thermometer under their tongue. Tympanic thermometry uses an electric thermometer to measure the temperature inside the ear. This is becoming a popular technique, however measurements may be somewhat variable depending on how deep in the ear the thermometer goes and interfering factors like ear wax impaction. Axillary temperature measures the temperature in the armpit. Axillary measurements are the farthest from the core, and are prone to imprecise and inaccurate measurements due to factors such as sweat or vasodilation. Rectal, Oral and Tympanic temperatures give the closest estimate to core temperature, although oral temperatures tend to be slightly lower than the other two methods. Axillary temperatures are consistently colder, and have a greater variability.

Patients, or their parents frequently will report that their child feels warm or has a fever. Studies have found that subjective reporting does increase the likelihood of a child having a fever, but fevers should be documented and measured for confirmation, especially in young children.

Trends with Age: Temperature does not vary significantly with age.

As mentioned earlier, the precise definition of fever varies depending on how you measure it, however a good cut-off to remember is  $>38^{\circ}\text{C}$ . Fever represents an infectious process in the majority of cases. However the differential of fever also includes immune reactions to medications or vaccinations, CNS dysfunction, or chronic inflammatory conditions like inflammatory bowel disease and juvenile idiopathic arthritis. Hypothermia or low temperature is due to increased heat loss. Neonates and especially preterm babies are prone to hypothermia due to an increased body surface area to body mass ratio and reduced ability to produce heat. In neonates, hypothermia can be an early indicator of sepsis.

### Pulse Oximetry

Pulse oximetry is a measurement of arterial oxygen saturation or the SPO<sub>2</sub>. The device is attached to the child's finger or ear and uses the differential absorbance of light by oxygenated hemoglobin compared to deoxygenated hemoglobin. The SPO<sub>2</sub> has widely been accepted as the 5<sup>th</sup> vital sign. SPO<sub>2</sub> is expressed as a percentage, and has been shown to be superior to the physical sign of cyanosis at detecting low oxygen levels in the blood.

Sources of error in pulse oximetry include poor perfusion such as in hypothermia, excessive ambient light, motion, and nail polish/artificial nails. The SPO<sub>2</sub> also fails to detect problems of poor oxygen delivery such as anemia, decreased cardiac output or hemoglobinopathies. Interestingly, patients with carbon monoxide poisoning will have normal SPO<sub>2</sub> because their hemoglobin is saturated with carbon monoxide and the device cannot detect a difference.

Trends with Age: SPO<sub>2</sub> is lower in the immediate newborn period. Beyond this period, normal levels are stable with age.

Normal pediatric pulse oximetry (SPO<sub>2</sub>) values have not yet been firmly established. Generally, a SPO<sub>2</sub> of  $<92\%$  should be a cause of concern and may suggest a respiratory disease or cyanotic heart disease.

### Conclusion

Now let's review our clinical case – Your patient is a 12-month old boy admitted with bronchiolitis. His vitals include HR of 120, RR of 36, BP of 85/37, tympanic temperature of  $36.6^{\circ}\text{C}$  and SPO<sub>2</sub> of 92% on room air. You first walk into the room and assess the clinical picture. The baby is resting peacefully on room air, with only some mild

expiratory wheeze noted. You review a reference table and find the following. A normal heart rate for a child 1 year of age is between 100 and 190 bpm, therefore his heart rate of 120 is comfortably within normal limits for a child his age. A normal respiratory rate for his age would be between 24 and 40 bpm. His respiratory rate of 36 is at the high end of normal, which is in keeping with his diagnosis of bronchiolitis. Using a blood pressure calculator, you find that his blood pressure is at the 50<sup>th</sup> percentile for his age, height and gender. He is afebrile. His oxygen saturation is low, but on the border of what might be concerning. In summary, the child has stable vital signs, but may need a few more days of supportive care before he is back to full health.

This concludes our podcast. Before we leave, here are a few take-home points:

- 1) Pediatric vital signs vary with age, and it is important to use age-adjusted reference values
- 2) Measure respiratory rate from the bedside when the patient is not aware you are measuring it, as they may consciously alter their rate of breathing.
- 3) Use an appropriately sized blood pressure cuff for the individual child. The length of the cuff's bladder should encircle at least 80% of the arm circumference. The bladder width should be at least 40% of the arm's circumference.
- 4) Rectal, oral or tympanic temperatures give a more accurate reading of core temperature than axillary temperature.
- 5) Pulse oximetry is a useful tool for detecting low oxygen saturation, but remember its limitations and sources of error.

Thanks for listening.

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