Vital Signs As Directional Signals

by Charles Livesey • edited by Julie Aberger

EMT Objectives

After reading this article, the EMT will be able to:

- define signs and symptoms and know the difference;
- define homeostasis and understand its relationship to vital signs;
- identify vital signs and their normal rates for adults, children and infants;
- define normal and abnormal qualities of respirations, pulse, blood pressure, skin condition, and mental status;
- understand the limitations of mechanical devices to monitor vital signs.

Introduction

In EMS we frequently discuss a patient's signs and symptoms. What are they and why are they important?

● A symptom is something the patient experiences and tells the EMT during the patient assessment: *"I feel dizzy."*

● A sign is something the EMT discovers by inspection, palpation and auscultation during the patient assessment. *The patient's skin is cold, sweaty and ashen.*

Like street signs, physical signs provide direction. If the patient says "I feel dizzy" and his skin is cold, wet and ashen, the EMT should promptly provide high-flow oxygen.

The most important signs EMTs routinely assess are vital signs. Vital signs indicate the physiological direction the patient is headed. A thorough patient assessment includes taking baseline vital signs and reassessing them throughout the call. If you have more than one set of vitals, you will be able to chart your patient's progress. Such changes are referred to as "trending" and may indicate either an improvement or deterioration in the patient's condition.

In this article we will discuss vital signs, review how they are determined, and explain what the measurements indicate. We'll focus on pulse, respirations, and blood pressure and also include a review of how to assess the patient's skin, and mental status.

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Keeping The Body In Check

The human body seeks to maintain a relatively stable internal condition called "homeostasis." It is a dynamic state of balance in which internal conditions vary, but always within a relatively narrow range. Nearly every organ participates in maintaining this constant balance. For instance, heart activity and blood pressure are constantly monitored and adjusted so that blood reaches all the body tissues and all the cells are adequately perfused. (Perfusion means that oxygen and nutrients are transported to the cells and waste products such as carbon dioxide – CO_2 – are eliminated.)

Whenever conditions detour from what the brain considers a "normal" range, the body compensates to restore balance. For example, if there is an increase in the level of carbon dioxide (CO_2) in the bloodstream, the body compensates by increasing its respiratory rate so as to "blow-off" the excessive CO_2.

Vital signs reflect the body's juggling act to maintain homeostasis; they fluctuate moment-to-moment. When the body fails to keep its balance, such as when the patient is hemorrhaging and losing blood volume, vital signs reflect the insult. The heart rate first increases then decreases, the respiratory rate increases then decreases, and finally the blood pressure plummets.

Not everyone shares the same "normal" vital signs. What may be required for one person to maintain homeostasis is not necessarily the same for another. For example, a systolic blood pressure of 90 mm Hg may be adequate for one patient, however, another would experience hypotension at this reading and present with signs of shock. Therefore, the EMT must continually monitor ***all*** the vital signs and assess them together to understand the patient's condition.

The Big Picture consists of all the pieces of the assessment puzzle; each vital sign is merely one piece. Other essential pieces include age, medical history, medications, allergies, physical exam, and of course, history of the present illness or injury.

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Adequate Breathing

Adequate breathing – ventilation and respiration – is essential to maintaining homeostasis. Ventilation is the act of moving air into and out of the lungs. Respiration is the exchange of gases – oxygen and carbon dioxide – between the alveoli and bloodstream. The process of gas exchange is called diffusion.

What causes us to breathe? The respiratory rate is regulated primarily by the autonomic nervous system that constantly monitors carbon dioxide levels in the blood. Increased levels of this cellular waste product cause the autonomic nervous system to stimulate an increase in the respiratory rate and volume to offload the excess CO_2.

A second, back-up system exists which does not depend upon carbon dioxide levels in the bloodstream, but oxygen levels instead. This is called the hypoxic drive. For this type of patient, (typically a patient with chronic obstructive pulmonary disease or COPD), a decrease of oxygen in the bloodstream will stimulate breathing. Conversely, an increase in oxygen levels will cause the respiratory rate to slow. High volume oxygen delivery to a COPD patient who depends upon his hypoxic drive to stimulate breathing will eventually cause him to stop breathing. ***However, all patients in respiratory distress need high flow oxygen immediately regardless of their medical history.***

Table 1:

Normal Respiratory Rates

Adults	12-20 breaths per minute
Children	15-30 breaths per minute
Infants	25-50 breaths per minute

How do we know a patient is breathing adequately?

The EMT must evaluate respiratory rate, rhythm, and quality.

- **Rate**: The range of normal respiratory rates for an adult is 12 to 20 breaths per minute (BPM). Children breathe at 15 to 30 times a minute. The newborn can even have a rate of up to 60 BPM. *(See Table 1.)*

To determine respiratory rate the EMT counts the rise and fall of the patient's chest for thirty seconds and then multiplies by two. (Remember that the patient may become self-conscious and alter his breathing rate if he knows you are watching.) For a patient in distress, respirations less than ten per minute or greater than 24 per minute need to be supplemented with high flow oxygen. The EMT can also ventilate the patient with a positive pressure device to provide artificial respiration. (Positive pressure devices include pocket masks and bag-valve-masks or BVM.)

For a patient in distress, respirations less than ten per minute or greater than 24 per minute need to be supplemented with high flow oxygen.

Assessing a patient's respiratory rate is often overlooked by EMTs. But

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it is essential information for the emergency department physicians especially if the patient is in respiratory distress.

EMTs should assess and report a respiratory rate on every patient; make no exceptions!

● **Rhythm**: Rhythm refers to the tempo of breathing. This is assessed noting the time from the peak of one chest rise to the next. If consistent, the rhythm is considered "regular." When you're awake, that rhythm can be affected by mood, exercise, and speech. When you sleep, the rhythm is more regular and even.

An irregular breathing pattern is caused by many conditions. For example, a traumatic brain injury with increased intracranial pressure can alter the regularity of breathing. As the pressure within the skull increases, the patient's breathing becomes more erratic with periods of deep, rapid breathing followed by slow, shallow breathing, followed by periods of apnea (absence of breathing). This pattern is called Cheyne-Stokes breathing and requires aggressive management of the patient's ventilations by the EMT.

A traumatic brain injury with increased intracranial pressure can alter the regularity of breathing.

Irregular breathing patterns may also be caused by chronic illnesses (such as emphysema or asthma), fever, medication overdose, chest injuries, and hyperventilation. At the time of death, breathing patterns change. Breathing may simply stop, or slow down and become extremely shallow and then stop, or there can be a short series of great heaving gasps before the patient stops breathing entirely. The final respiratory effort is called agonal breathing.

When breathing is inadequate, how does the brain compensate in an effort to maintain its equilibrium or homeostasis?

» Initially it raises the body's respiratory rate and volume (amount) of air inhaled or exhaled. If the rate increases to over 30 BPM, however, the volume of air being inhaled decreases to the point where the total overall volume is inadequate. Abnormal rapid breathing is called tachypnea; the patient is breathing too rapidly to adequately refill the alveoli.

» Once the body's compensatory mechanism ceases to function, the respiratory rate and volume both decrease. Suddenly the patient is breathing at ten BPM or less. (Abnormal slow breathing = bradypnea) The volume inhaled decreases and total overall volume becomes inadequate. The EMT should manage both conditions – tachypnea and bradypnea – by ventilating the patient with a bag-valve-mask device.

● **Quality**: Here the EMT assesses how labored the patient's breathing may be as well as any sounds that may be made during inhalation and exhalation. Quality falls into four categories: normal, shallow, labored or noisy.

Let's first look at **normal** quality. A healthy person breathes with little effort. The diaphragm and the external intercostal muscles (those between the ribs) are the muscles primarily responsible for ventilation. No additional muscles of respiration (called accessory muscles) are used. *(See Figure 1.)* There is also a normal depth of respiration which gives rise to a steady rhythmic movement of the chest cage. However, the movement is minimal and can be almost imperceptible on a healthy, immobile patient. Finally, normal respirations make no noise; they are virtually silent.

EMTs must assess each patient's respiratory effort by visual inspection (looking for equal chest rise and fall), auscultation (listening to the lungs with a stethoscope) and palpation (feeling for deformity or any other irregularity).

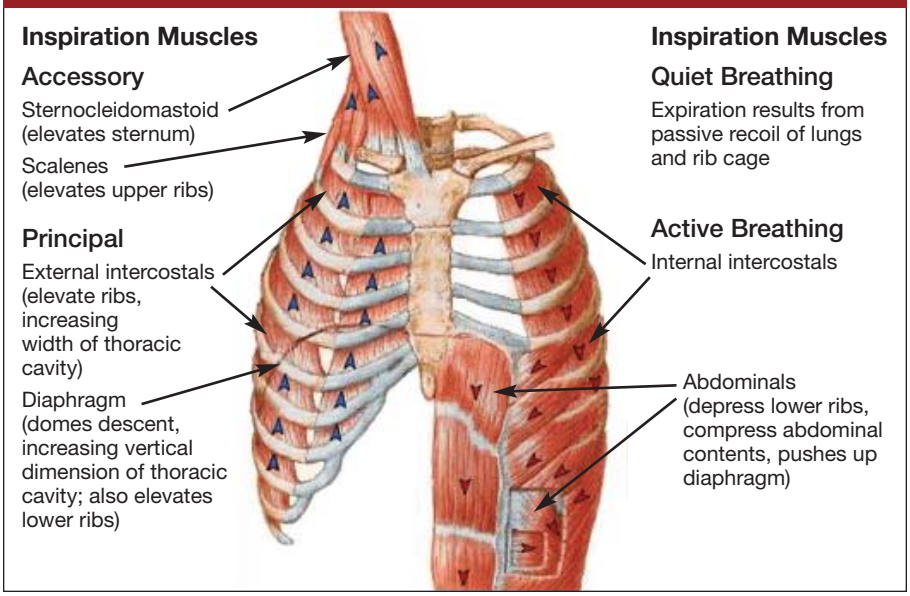
Shallow breathing occurs when there is only a slight movement of the chest or abdomen. We see this often in the nursing home patient who has been bedridden for some time. Ventilation is poor; not enough oxygen and carbon dioxide are being moved in and out of the lungs to allow for proper diffusion.

Labored breathing causes an increase in the amount of work that the body needs to do to exchange lung volume. The patient struggles to get air in and out. The EMT should be aware of signs of labored breathing:

» How is your patient positioned? Is he sitting upright, leaning forward on his hands in a tripod position? Is he unable to lie down? Does he sleep with several pillows under his head and upper body? All of these signs point to respiratory distress.

Figure 1:

Muscles of Respiration



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» Do you see any accessory muscle usage when the patient breathes? Accessory muscles include those in the neck, clavicles, and abdomen. If the patient is breathing adequately, these muscles do not constrict. However, when respiration is inadequate, accessory muscles are used to increase the volume of air being moved. Severe respiratory distress causes these muscles to retract, creating depressions in the neck, above the shoulder blades, and between and below the ribs.

If the patient is breathing adequately, accessory muscles do not constrict.

» Does the pediatric patient present with nasal flaring? Are there sternal retractions, i.e., does the child's sternum pull inward when he inhales? If so, the pediatric patient is in severe respiratory distress.

The EMT also evaluates breathing by listening to the patient speak. Does she have to interrupt the words in each sentence to take a breath? Is she gasping for air after a phrase or a few words? This is labored speech and is not normal.

Finally, is the patient's breathing **noisy**? What do you hear without a stethoscope? Is there stridor, a high pitched sound on inspiration, or grunting on expiration? Is there an obstruction which is causing lack of sound altogether or a partial obstruction causing crowing or gurgling?

What do you hear with a stethoscope? Breath sounds should be evaluated in three places both anteriorly and then posteriorly. Noisy breathing can further be described as:

» Rales, fine crackling sounds, indicate fluid in the lungs.

» Rhonchi, coarse sounds, indicate more significant fluid buildup or mucous accumulation.

» Wheezing, a high-pitched (usually expiratory) sound, indicates lower airway narrowing and is prevalent in asthma.

» No sound at all. If the respiratory sounds are not bilateral, the patient may have a pneumothorax or tension pneumothorax. The patient might also have had a lung removed.

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Heart Rate And Pulse

Adequate circulation is also essential to maintaining homeostasis. As the heart beats, it sends a continuous wave of blood coursing through the body's arteries and veins. The EMT assesses the patient's circulation by taking two fingers and palpating (or feeling) for the heart beat at a point where an artery crosses between a bone and the skin's surface. The EMT assesses pulse rate, rhythm and quality. In the prehospital setting, we

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commonly palpate the radial, brachial, carotid, dorsalis pedis and posterior tibial pulses. *(See Figure 2.)*

During our initial assessment, if the adult patient has no radial pulse we immediately check for a carotid pulse. For an infant, the EMT first palpates the brachial pulse.

● **Rate**: To determine pulse rate the EMT should palpate the pulse for thirty seconds and then multiply by two. The average pulse rate for an adult at rest is 60 to 100 beats per minute. *(See Table 2.)* A palpable radial pulse generally indicates that the patient's organs have minimal perfusion.

● For an adult, a rate over 100 beats per minute is called tachycardia. A rate under 60 beats per minute is called bradycardia. A sustained rate under 50 or over 150 beats per minute for an adult usually indicates a serious condition and the patient should be transported as soon as possible.

● A rise in pulse rate of more than 15 beats per minute when the patient moves from supine to a seated position suggests significant blood loss, or hypovolemia.

Pediatric patients have faster heart rates. A healthy child has a pulse rate of 80 to 120 beats per minute. The EMT should be aware that bradycardia in the pediatric patient is an ominous sign that signifies impending cardiac arrest. A newborn with a heart rate under 100 beats per minute requires immediate ventilation; a heart rate under 60 requires immediate cardiac compressions as well.

● **Rhythm**: The heart beats rhythmically to produce a regular pulse. Irregular pulse patterns, where the intervals between beats are not constant, may be caused when the atria (the top chambers of the heart) do not pump effectively. This condition, called atrial fibrillation, is common in the elderly patient. The atria normally provide a "kick" of blood into the ventricles. The loss of the atrial kick can cause a 20% reduction in the amount of blood the heart pumps. This decreases the patient's ability to compensate to maintain homeostasis.

Figure 2:

Body Sites Where The Pulse Is Most Easily Palpated

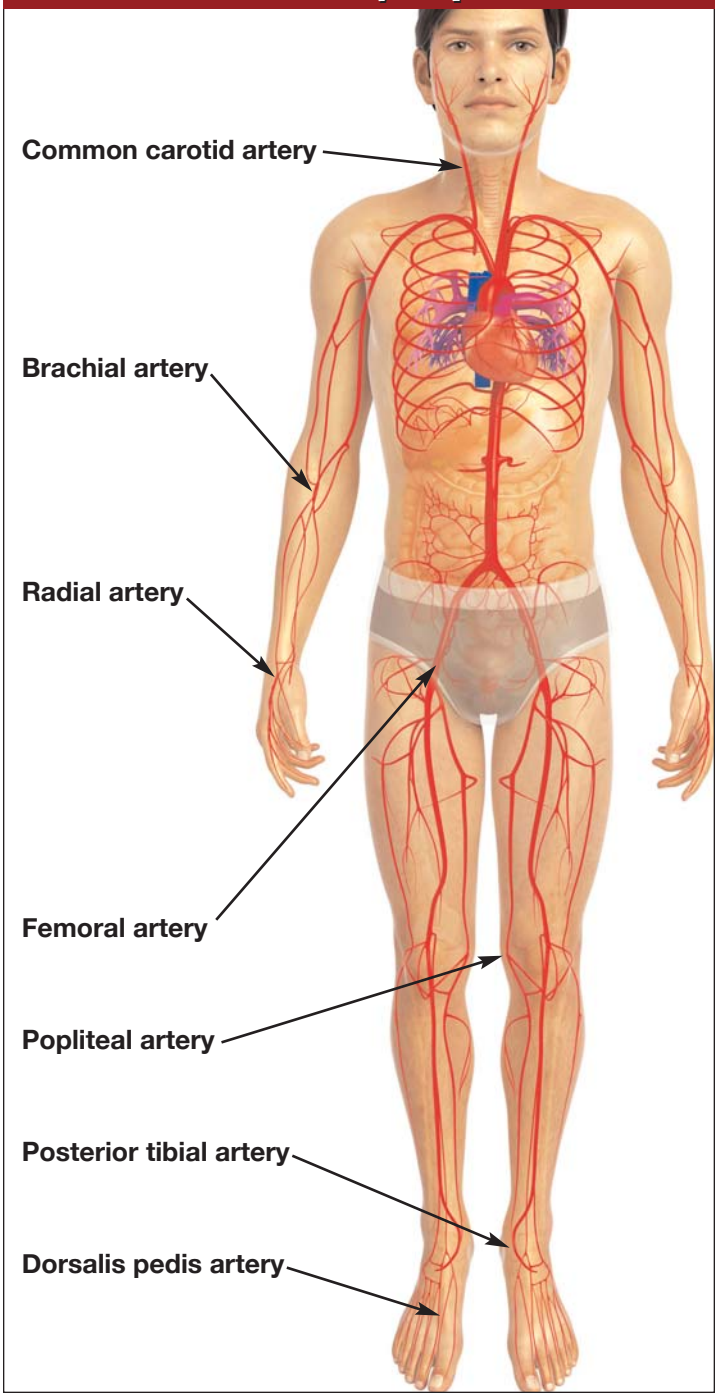

Table 2:

Normal Pulse Rate Ranges

Adults	60-80 beats per minute
Children	80-100 beats per minute
Toddlers	100-120 beats per minute
Newborns	120-140 beats per minute

● **Quality**: Pulse quality is regulated by the heart's rhythm and force. The force of the pulse, or its strength, depends upon normal cardiac output. When you palpate the pulse, the wave should feel strong.

» A weak, thready pulse that is difficult to palpate, means the patient may be in shock; he may be losing blood and/or blood pressure.

» A bounding pulse that feels stronger than a normal pulse, indicates high blood pressure or perhaps head injury or heat stroke.

Blood Pressure

Blood must be kept constantly circulating in order to keep the body's cells perfused.

● The circulatory system does this job with its three components: the heart, the blood vessels and the blood, often referred to as the pump, the container and the volume.

» The heart is a pump that pushes blood through the blood vessels to the cells for perfusion.

» Blood vessels of the body form a closed delivery system, or sort of container, that begins and ends at the heart. The diameter of the blood vessels constricts or dilates (gets bigger or smaller) depending upon the pressure needed in the system. For example, if a patient is hemorrhag-

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ing and losing a lot of blood or volume, the blood vessels will constrict in order to shunt the blood to the vital organs. The heart will also speed up to keep whatever volume is still in the system moving fast enough to keep the cells in the vital organs perfused.

» Adequate blood pressure also depends on adequate blood volume. The average adult blood volume is about six liters; an eight-year old has about two liters, and an infant's blood volume almost fills a soda can (0.35 liters).

Blood pressure is the pressure exerted against the inside walls of the arteries as the heart pumps and then relaxes. We measure two pressures: systolic and diastolic.

- Systolic pressure measures the maximum pressure within the arteries when the heart pumps.
- Diastolic pressure measures the minimum pressure within the arteries when the heart relaxes. The difference between the systolic and diastolic pressure is referred to as the pulse pressure.

How To Take A Blood Pressure

To determine a patient's blood pressure the EMT needs a properly sized blood pressure (BP) cuff. Adult cuffs should have a width of one-third to one-half the circumference of the limb. Pediatric cuffs should have a width of about two-thirds of the upper arm. Using a BP cuff that is too big gives a false low reading. Cuffs that are too small yield a false high reading.

- Auscultation: The blood pressure cuff should be placed on the patient's arm an inch or so above the elbow. Air is pumped into the bladder that inflates and temporarily halts arterial blood flow. The stethoscope is then placed over the patient's brachial artery. When the pressure in the cuff is released and falls below the internal systolic pressure, blood flow resumes and produces sounds. When the pressure in the cuff falls below the internal diastolic pressure, blood flow remains continuous and the sounds disappear completely. Pressure is measured in millimeters of mercury (mmHg).
- Palpation: An alternative method of determining blood pressure is by palpation. No stethoscope is needed. This method can be used if there is too much ambient noise to auscultate the pulse sounds, like in the back of an ambulance en route to the hospital.

To "palp" a BP, the EMT locates a radial pulse with two fingers prior to pumping up the cuff. The cuff is then inflated until the pulse is no longer felt. The EMT should note the point on the gauge where this occurs and continue to inflate the cuff 30 mmHg beyond this point. The cuff should then be slowly deflated, and the EMT should note the reading at which the radial pulse returns, i.e., where it can be felt again. This results in a reading of about 10 mmHg lower than the systolic pressure determined by auscultation. Palpating a blood pressure has a disadvantage in that the diastolic pressure cannot be determined. Palpation should be used only when auscultation is not possible.

The EMT should note the point on the gauge where the pulse is no longer felt and continue to inflate the cuff 30 mmHg beyond this point.

High blood pressure is called hypertension. For an adult, this is usually defined as a systolic pressure that persists above 140 mmHg or a diastolic pressure that persists above 90 mmHg. Hypertension may be a sign of a possible illness (such as renal disease), injury (such as traumatic brain injury), exertion, anxiety, or even fright.

Low blood pressure is called hypotension and causes poor perfusion to the cells. There must be an adequate pressure for oxygen and carbon dioxide exchange to occur between the capillaries and cells. A decreased blood pressure is a late sign of shock that occurs when the body can no longer compensate.

Blood pressure varies among individuals. The accepted rule for "normal" systolic blood pressure for adults up to 40 years of age is the patient's age plus 100 for a male, and the patient's age plus 90 for a female. Thus a "normal" systolic BP for a 25-year old female would be approximately 115 mmHg. Children's "normal" systolic blood pressures are estimated with the formula: 80 + 2 times the child's age. It is now advised that EMTs not take blood pressures on children under the age of three, (although some providers still believe it is important to practice).

Although there has been controversy lately about ideal blood pressure numbers, the American Heart Association declared in October, 2015: *"A report published late in 2013 recommends healthcare providers take a new approach to treating high blood pressure for people older than 60. But based on the current research available, the American Heart Association recommends that healthcare providers continue to follow existing guidelines for treating high blood pressure.*

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"'We believe there's just not enough evidence at this point to justify such a major change in how we treat people with high blood pressure,' American Heart Association Past President Mariell Jessup, M.D., said of the new opinion published in the Journal of the American Medical Association (JAMA).

"One in three American adults has high blood pressure, which is a reading of 140/90 millimeters of mercury or higher. The opinion published in JAMA advises treatment at 140/90 for adults from ages 30 to 59, but starting only at 150/90 for people 60 and older. The American Heart Association maintains its recommendation of initiating treatment – starting with lifestyle changes and then medication if necessary – at 140/90 until age 80, then at 150/90."

Asked At Convention:

What are the best and worst parts of being a volunteer EMT?

"Being able to make a difference in someone's life."

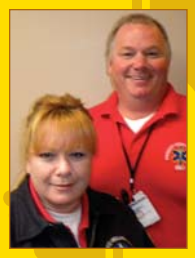
"Doing everything you can for a patient and it not being enough."

Kerry Walsh
Lincoln Park EMS

"Helping the community and saving the taxpayers money."

"Insufficient communications within the squad."

Duchess Lake
Hopewell Fire Dept. EMU



"Helping our community."

"Dealing with 'Type-A' personalities whose egos make it difficult to learn, thrive and succeed."

Tal & Christel Jones
Ringwood AC

"Everyone's really chill and I learn a lot from people of different backgrounds and professions. I love each individual's life stories."

"No respect from paid crew."

Sandy Cheng
Lyndhurst PES

The Importance Of Assessing Skin Condition

One of the most overlooked signs of adequate or inadequate perfusion is the patient's skin. The color, temperature, and condition of the skin lead us to suspect the severity of illness or injury and therefore anticipate treatment.

- **Color**: The second layer of skin, the dermis, is richly embedded with blood vessels. Hemoglobin gives the skin its pinkish hue. Constriction of those vessels results in pale skin. This occurs as the body attempts to compensate for inadequate blood pressure (shock) or to conserve heat. In both cases, the body shunts its blood volume to the vital organs. In order for organs to function normally, the body must maintain an internal temperature within one or two degrees of 98.6 degrees.

In Caucasians, the skin is pink. When the body is poorly oxygenated, that skin appears blue, a condition called cyanosis. In black or dark-skinned individuals, cyanosis is apparent in the mucous membranes and nail beds. Jaundiced (yellow) skin is related to abnormalities of the liver.

- **Temperature & Condition**: Cool and clammy skin is a sign of shock. The skin loses its warmth as blood-flow is diverted from the skin to the vital organs. Patients in shock also experience diaphoresis – or sweating – caused by a surge of epinephrine (adrenaline) in the body. (Epinephrine also causes anxiety and agitation.)

Cold dry skin results from exposure to a cold environment; heat loss has occurred. Conversely, hot, dry skin results from exposure to heat or fever. This can also be a serious sign that the body has exhausted its ability to compensate.

Although skin temperature is important, EMTs do not take core temperatures in the field. Instead we use the back of our hands to assess whether the skin is cold, warm or hot.

Testing capillary refill on adults is not a reliable indicator due to inaccuracies caused by cold environments or a history of poor circulation.

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Responsiveness & Orientation

Mental status is an important parameter for determining the stability of the patient. As you reassess the patient, be aware of any increase or decrease in responsiveness. An epidural bleed caused by intracranial bleeding presents with a patient who "goes in and out of consciousness."

The easiest way to determine mental status is by using the **AVPU** scale. There are several other scales that can be used, including the Glasgow Coma Scale. If you are familiar with these and use them often they work well. However don't delay your care and transport of the patient determining how to use them in the field.

A = The patient is Alert and should be oriented to person (can tell you his name), place (within reason where he is), and time (date or day of week). Elderly and developmentally disabled patients may present a special challenge here. You may need to consult a caregiver to determine what is different about the patient's orientation ***today***. You may also encounter the patient who used alcohol or other substances which makes the accurate assessment of orientation difficult. Do not automatically assume that alcohol is the cause of disorientation.

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V = The patient responds to Verbal stimuli. The most common patient in this category may be oriented, but lethargic and the EMT must repeatedly call her name before she responds. She may be awake, but has no recall of events before the incident. This is called retrograde amnesia. The patient who has no recall of events after the incident has antegrade amnesia. These patients may ask the same question over and over again, a condition called "perseveration." This may be caused by traumatic brain injury or other organic disorder.

P = The patient responds to Painful stimuli with either purposeful or non-purposeful movement. He moves to withdraw from your painful stimuli, e.g., a pinch.

U = The patient is unresponsive to all stimuli. Some patients become combative or even experience seizures. While this is a serious sign, some motion of the limbs is better than none at all. The patient with no movement or muscle tone is said to be flaccid and has a poor chance of survival.

Confusion, lethargy, agitation, stupor – all may be caused by hypoxia, or insufficient oxygen in the brain.

Confusion, lethargy, agitation, stupor – all may be caused by hypoxia, or insufficient oxygen in the brain. Any patient with a mental status lower than "Alert" may have a life threatening injury or illness and should receive high flow oxygen using either a nonrebreather mask or a positive pressure device such as a bag-valve-mask.

Shortcomings Of Mechanical Devices

A word about mechanical devices now being used to take vital signs in the field as well as the hospital:

● A standard piece of equipment in the up-to-date EMS arsenal is the pulse oximeter. *(See Figure 3.)* This small, easy-to-use finger probe and its oximeter automatically measures the percentage of hemoglobin saturation in arterial blood. Healthy persons breathing room air have normal readings of 98% to 100%. Generally, a pulse ox reading of less than 96% in a nonsmoker may indicate hypoxemia.

Figure 3:

Pulse Oximeter

But the pulse ox has its flaws:

» For patients with anemia or very low perfusion states (like shock), the pulse oximeter may not detect peripheral perfusion; you may not get a reading.

» The pulse oximeter produces false oxygen saturation numbers in a patient with carbon monoxide poisoning as carbon monoxide has a greater affinity for hemoglobin than oxygen.

» Dark nail polish or dirty fingers may also throw the results.

» Patients with chronic respiratory illness have "normal" pulse oximetry readings that are low. Therefore, knowing the patient's medical history is essential.

While pulse oximetry readings can provide valuable information about the patient's oxygenation, the EMT must consider its reading as one piece of the clinical picture. An overall clinical assessment must always be performed.

● EMS crews are now using automatic blood pressure gauges to monitor patient blood pressures. These digital cuffs use oscillometric measurements and electronic calculations rather than auscultation. They contain no mercury, are easy to operate and are effective in noisy environments. There is a growing concern, however, that they may not be as accurate as conventional mercury instruments and could lead to inappropriate patient care. An additional concern in the field is the lack of frequent calibration.

While these automatic devices are convenient, you must always observe the patient closely to ensure the Big Picture is consistent with the numbers you're reading. Rely on your clinical skills. Look at the ***entire*** patient, do a thorough patient assessment complete with SAMPLE history and vital signs. Put it all together. Anything that is inconsistent should be investigated.

Summary

Vital signs are needed for every patient. As part of the ongoing exam, vital signs should be repeated every 15 minutes for the stable patient and at least every five minutes for the unstable patient. Repeating and comparing vital signs permit you to chart your patient's progress, establish trends and treat appropriately. Is the patient's condition improving? Worsening?

Vital signs will give you signals and provide compelling evidence, but they don't tell you all you need to know about your patient's condition. Keep a close eye on ***all*** your patient's signs and symptoms, and treat what's occurring at the moment.

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