HYPERTHERMIA IN COCAINE OD

As an EMT, you may know about, or cared for, patients that have had a cocaine overdose. Do you know what tends to be seen in patients that have fatal versus nonfatal outcomes?

Information provided here is based on two things: (1) my experience dealing with patients in the field with unsuspected temperature derangements, and (2) taken from two articles on the subject of fatal cocaine OD and the role of temperature in such outcomes.

THE OFTEN "MISSING" VITAL SIGN IN EMS

Let's consider the scenario we just encountered. What were the vital signs telling us?

- Mental status is altered in the form of no sensible verbal responses and combative behavior. She is gnashing at people & thrashing about, even while physically restrained.
- Her pink, warm & dry skin indicates she is perfusing her tissues overall, thus shock is not evident.
- The strong radial pulse @ 136 indicates a heart rate well above the normal range of 60-100 in an adult. Of course, we can expect a tachycardia for people that are frightened, in pain, affected by illicit drugs and other possibilities.
- The BP of 174/p is definitely hypertensive, especially for a young woman. For it to be that high, we can suspect something pathological is happening. It is concerning and factors in a lot on our differential diagnosis. The tricky thing is whether the high blood pressure is the cause of her problem, or the result of it. It is easy to recognize an abnormal vital sign. However, the "thinking" EMSP goes further and asks the question "is this hypertension the reason for her condition, or is something else happening that caused the BP to rise so high?" Further evaluation will help narrow this down.
- R ~ 24-26, O₂ saturation 100% on room air. She is tachypneic (rapid respirations), although not dangerously so, and there is no evidence of respiratory compromise. Again, we need to think about why she is tachypneic.
- Pupils PERL at 6mm. The pupils are equal and reactive, which is a good sign. The other observation is the size of her pupils. EMS Providers of all levels should be familiar with normal and abnormal pupil sizes and what abnormal sizes can indicate. The normal size range is 3-5mm. Less than 3mm is considered to be "constricted" pupils. They are "dilated" when greater than 5mm.
- CBG = 128. This is a normal blood sugar, no issue here.

As we look at all these observations, we see evidence that her body systems are "ramped up." Her behavior and baseline vitals are all increased, which tells us her nervous and cardiovascular systems are hyperactive. So we need to think about problems that can cause that.
The good thing is her airway, breathing and perfusion are not compromised. They are elevated, and left untreated are apt to worsen. But at this moment, there is not an immediate threat with the three vitals signs of pulse, respirations and BP.

HOWEVER, there is the “fourth” vital sign and we have not checked it!

WHAT IS NEXT?

BLS

- Protect personnel from injury & spitting
- O₂?

ALS

- IV?

Oxygen is a consideration. However, it does not appear that oxygen levels are a problem. And there is no evidence of shock. An IV is also a consideration for Intermediates & Paramedics, although there is no apparent treatment indicated by IV. Would be a judgment call if it is worth the risks with the patient’s thrashing behavior. For Paramedics, chemical sedation would be a consideration. That is, administer a drug that will sedate the patient.

And what about that other vital sign... temperature? Is this something that can clue us in to her problem? Can it guide us in how we treat the patient?

There are four “vital” signs in the body. In EMS we commonly measure three of them – pulse, respirations and blood pressure. They are “vital” because without them in their normal parameters, a person can die, especially if the body cannot compensate or its compensatory mechanisms have failed. The fourth vital sign – temperature – must also be present within its proper range, or we will not survive. Yet, in many EMS organizations, temperature is not measured and in fact, EMSPs may not even have thermometers available to them. Some argue it doesn’t matter, it won’t change how we treat the patient. I challenge that way of thinking.

Let's look at the case at hand. Since this patient is so combative, we cannot get an oral temperature. A rectal temperature would be risky for concern of injuring rectal tissue with her combativeness. An axillary temp is a great option in this case. We use the oral thermometer probe, place the tip in her axilla, and firmly hold her arm against her side so the probe has continuous contact with the skin. It doesn’t take long with a professional type of thermometer to get a reading. As you watch the display, it gets up to 101°F and continues to rise. It passes 102, then 103..... gets to 104 and still keeps going..... 105..... 106..... 107.... and stops at 107.5°F. Does this get our attention? Is this just a fever, or something more serious? Is this a life threat?
CONSIDER OUR PRIORITIES

This is a time where you halt further assessment and immediately begin treatment, because this is a life threat. Uncontrolled high temperature is lethal. A member of the team may do some more assessment while others are treating, as long as we do not delay treatment to assess further.

The key intervention here is immediate active cooling measures. Ice packs in the patient's armpits and groin areas, uncover the patient and run the air conditioning in the ambulance.

As for further assessment, we need to consider altered mental status is a neurologic issue, thus a neurologic exam is in order.

- LOC abnormal = AMS
- AMS = neurological
- Neurological = neuro exam

Our neuro exam findings:

- Doesn’t follow commands
- No facial droop
- PERL 6mm
- Sensorimotor intact all exts
- MAE w/ strength and flailing movements

There does not appear to be any sensorimotor deficits.

WHAT ABOUT TRANSPORT?

We can certainly begin to transport any time, the sooner the better, and this is an emergency justifying lights and sirens.

HYPERTHERMIA

As we went through this case, did you have any idea this would be a temperature derangement? Any sense of what may have caused it?

With her body systems accelerated the way they were, she appeared to be in a hyper-adrenalized state. One high suspicion for this, along with her behaviors, is some form of drug overdose, especially an illicit drug. The type of drug is something that puts the body into overdrive. Any ideas?
WHAT IS HYPERTHERMIA

Hyperthermia is elevated body temperature due to failed thermoregulation that occurs when a body produces or absorbs more heat than it dissipates. Extreme temperature elevation then becomes a medical emergency requiring immediate treatment to prevent disability or death.

CAUSES

Common causes include heat stroke and adverse reactions to drugs. The former is an acute hyperthermia caused by exposure to excessive heat, or combination of heat and humidity, that overwhelms the heat-regulating mechanisms of the body causing uncontrollable elevation of body temperature. The latter is a relatively rare side effect of many drugs, particularly those that affect the central nervous system.

HYPERTHERMIA VS FEVER

Hyperthermia differs from fever in that the body's temperature set point remains unchanged. The opposite is hypothermia, which occurs when an organism's temperature drops below that required to maintain normal metabolism.

Hyperthermia is defined as a temperature greater than 37.5–38.3 °C (100–101 °F), depending on the reference used, that occurs without a change in the body's temperature set point.

The normal human body temperature in health can be as high as 37.7 °C (99.9 °F) in the late afternoon. Hyperthermia requires an elevation from the temperature that would otherwise be expected. Such elevations range from mild to extreme; body temperatures above 40 °C (104 °F) can be life-threatening.

<table>
<thead>
<tr>
<th>Temperature Classification</th>
<th>Core (rectal, etc.)</th>
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</thead>
<tbody>
<tr>
<td>Hypothermia</td>
<td>&lt;35.0 °C (95.0 °F)</td>
</tr>
<tr>
<td>Normal</td>
<td>36.5–37.5 °C (97.7–99.5 °F)</td>
</tr>
<tr>
<td>Fever</td>
<td>&gt;37.5–38.3 °C (99.5–100.9 °F)</td>
</tr>
<tr>
<td><strong>Hyperthermia</strong></td>
<td>&gt;37.5–38.3 °C (99.5–100.9 °F)</td>
</tr>
<tr>
<td>Hyperpyrexia</td>
<td>&gt;40.0–41.5 °C (104–106.7 °F)</td>
</tr>
</tbody>
</table>

Note: The difference between fever and hyperthermia is the mechanism.
HEAT STROKE

Heat stroke occurs when thermoregulatory mechanisms are overwhelmed by a combination of excessive metabolic production of heat (exertion), excessive environmental heat, and impaired heat loss, resulting in an abnormally high body temperature. In severe cases, temperatures can exceed 40 °C (104 °F). Heat stroke may be non-exertional (classic) or exertional.

Significant physical exertion in hot conditions can generate heat beyond a body's ability to cool itself, because the heat and humidity of the environment reduce the efficiency of the body's normal cooling mechanisms. The mechanisms available for heat loss are limited to vasodilation of skin vessels and increased rate of sweating. The vasodilation dissipates heat by convection while sweating dissipates it by evaporation. However, thermoregulation can be assisted with shade or fans. Other factors, such as insufficient water intake, consuming alcohol, or lack of air conditioning, can worsen the problem.

The principles of physics involved include Newton's law of cooling which states that dry heat loss is proportional to temperature difference between the human body (shell) and surroundings and Stefan-Boltzmann law which states that the higher the temperature of an object, the more it radiates, and the energy radiating from an object and received by human body is proportional to temperature difference between object and skin.

Non-exertional heat stroke is predominant in the young and the elderly. In the elderly in particular, it can be precipitated by medications that reduce vasodilation, sweating, and other heat-loss mechanisms, such as anticholinergic drugs, antihistamines, and diuretics. In this situation, the body's tolerance for high environmental temperature may be insufficient, even at rest.

DRUGS

Some drugs cause excessive internal heat production. The rate of drug-induced hyperthermia is higher where use of these drugs is higher.

- Many psychotropic medications, such as selective serotonin reuptake inhibitors (SSRIs), monoamine oxidase inhibitors (MAOIs), and tricyclic antidepressants, can cause hyperthermia. Serotonin syndrome is a rare adverse reaction to overdose of these medications or the use of several simultaneously.
- Many illicit drugs, including amphetamines, cocaine, PCP, LSD, and MDMA can produce hyperthermia as an adverse effect.
- Malignant hyperthermia is a rare reaction to common anesthetic agents (such as halothane) or a reaction to the paralytic agent succinylcholine. It is a genetic condition and potentially fatal. (Paramedics often use succinylcholine to chemically paralyze people they need to intubate patients that still have a gag reflex.)
A fever occurs when the core temperature is set higher, through the action of the anterior hypothalamus in the brain. For example, in response to a bacterial or viral infection, certain white blood cells within the blood will release pyrogens which have a direct effect on the anterior hypothalamus, causing body temperature to rise, much like raising the temperature setting on a thermostat.

In contrast, hyperthermia occurs when the body temperature rises without a change in the heat control centers.

**PUTTING IT ALL TOGETHER**

In the patient we dealt with, hyperthermia due to external factors is not likely, considering the cool weather and temperature described.

In her case, we were dealing with a cocaine overdose. We often hear of "cocaine MI" where people have a heart attack from such an OD. However, many such ODs result in hyperthermia that becomes lethal!

An EMS provider that identifies this can contribute to the survival of such patients by taking active cooling measures. But we must first find this cause of AMS by taking an accurate temperature.

Hyperthermia due to cocaine intoxication is probably multifactorial and includes increased muscle activity, seizures, an increased metabolic rate from increased sympathetic nervous system activity, and impaired heat loss from peripheral vasoconstriction. Therapy is directed at rapidly lowering the body temperature to prevent irreversible cellular injury.

**THE ROLE OF AMBIENT TEMPERATURE**

An article in the Journal of the American Medical Association identified the correlation of deaths from unintentional cocaine OD and hot weather.

The study took a retrospective review of all medical examiner cases over a five year period in New York, NY. Findings cited in the article include:

- The average number of deaths from cocaine ODs on days with a temperature of ≥ 88°F was 33% higher than those on days with lower temperatures. On days with temperatures increasing beyond 88°F, the number of deaths steadily increased.
- The association ambient temperature with drug OD deaths appears to be with cocaine, and not other drugs commonly abused, such as opiates.
- A quarter of all persons under age 55 that died from hyperthermia in New York City had taken cocaine immediately prior to their deaths.

There are several things that cannot be identified here, as explained in the article. However, it does seem that there is an increased risk of deaths from cocaine increase with hotter weather.
TWO CASE REPORTS

Another article in the Western Journal of Medicine identifies two cases of fatal cocaine-associated hyperthermia.

From these cases, the authors noted that the patients' clinical findings were consistent with described cases of heat stroke. They deduce that cocaine-associated hyperthermia may be a primary cause of various clinical toxic reactions associated with cocaine use.

The authors reference a study of cocaine intoxication in dogs. Evaluation of the dogs after IV cocaine was administered. The effects of hyperthermia on the clinical outcome were evaluated and it was found to be the most important factor associated with a fatal outcome.

CONCLUSION

As you can see, in this case, we had an altered mental status call. However, without identifying the patient's temperature, a serious condition would have been overlooked and left untreated. To gain the most benefit from this learning opportunity, you should read the two articles referenced below.

BIBLIOGRAPHY
