

## Scenario Overview

The heat stroke scenario simulates the body's temperature regulation system. This scenario highlights the ability of the Pulse physiology engine to simulate the energy exchange between the human body and the environment.

Base Physiology	Insults and injuries	Assessments	Interventions
A 25 year old physically fit male.	Strenuous activity combined with over dressing leads to heat stroke.	Core Temperature Sweat Rate Heart Rate Complete Blood Count Metabolic Panel?	Active Cooling IV Fluids

### Scenario Narrative

Segment 0	Engine initialization period.
Segment 1	A 25 year old male is hiking to a rock formation near Fort Carson to begin a recreational free climb. It is a chilly morning, and the man has decided to wear a thick jacket, heavy pants, and thick socks. The terrain is steep and the man is excited to begin his climb. The man's rate of perceived exertion is 13 on the Borg scale (0.5 on a 0-1 scale) during the hike to the rock formation. It takes him about 20 minutes to hike to the rock formation.
Segment 2	The hiker takes a moment to rest.
Segment 2	When the man arrives at the rock formation, he is so excited that he begins climbing without removing any clothing. He climbs at an intensity of 18 on the Borg scale (0.857 on a 0-1 scale). It takes him about 5 minutes to climb to the top of the rock formation. At the top of the rock formation the man becomes dizzy and sits down. A hiker at the top of the formation notices the man and offers assistance. The man explains that he had not had very much to eat or drink that morning and he thinks he may have overexerted himself during the climb. Then the climber passes out.
Segment 3	The bystander, an off-duty medic stationed at Fort Carson, recognizes that something is wrong and takes action. First, the bystander removes some of the man's clothing. Being a well-prepared medic, the hiker has a small first responder kit with her. She measures the man's core temperature, and the resultant abnormally high temperture coupled with the loss of consciousness suggests that the climber is suffering from heat stroke. She begins active cooling using some instant cold packs from the kit, starts an IV of isotonic saline, and calls for help.
Segment 4	The off-duty medic calls for help. An ambulance arrives to transport the man to Evans Army Community Hospital. During transport, the man's core temperature begins to decrease toward normal. Upon arrival at the hospital, the ER physician orders a comprehensive metabolic panel.

## References

Publications:

1	BANCHERO, NATALIO et al. "Pulmonary Pressure, Cardiac Output, and Arterial Oxygen Saturation during Exercise at High Altitude and at Sea Level." <i>Circulation</i> 33.2 (1966): 249–262. Print.
2	Benzinger, T. H. "Heat Regulation: Homeostasis of Central Temperature in Man." <i>Physiological Reviews</i> 49.4 (1969): 671–759. Print.
3	Bouchama, Abderrezak, and James P. Knochel. "Heat Stroke." <i>New England Journal of Medicine</i> (Mass Medical Soc) 346, no. 25 (2002): 1978 - 1988.
4	Brutsaert, Tom D. et al. "Higher Arterial Oxygen Saturation during Submaximal Exercise in Bolivian Aymara Compared to European Sojourners and Europeans Born and Raised at High Altitude." <i>American journal of physical anthropology</i> 113.2 (2000): 169–181. Print.
5	Christie, Jeffery, LM Sheldahl, FE Tristani, KB Sagar, MJ Ptacin, and S Wann. "Determination of stroke volume and cardiac output during exercise: comparison of two-dimensional and Doppler echocardiography, Fick oximetry, and thermodilution." <i>Circulation</i> (Am Heart Assoc) 76, no. 3 (1987): 539 - 547.
6	O'Donnell, Thomas F. "The Hemodynamic and Metabolic Alterations Associated with Acute Heat Stress Injury in Marathon Runners." <i>Annals of the New York Academy of Sciences</i> 301.1 (1977): 262–269. Print.
7	Pickering, Thomas G., Gregory A. Harshfield, Hollis D. Kleinert, Seymour Blank, and John H. Laragh. "Blood Pressure During Normal Daily Activities, Sleep, and Exercise: Comparison of values in Normal and Hypertensive Subjects." ( <i>Journal of the American Medical Association</i> ) 247, no. 7 (1982).
8	Universtiy of California San Fransico Medical Center, <a href="http://www.ucsfhealth.org/tests/003468.html">www.ucsfhealth.org/tests/003468.html</a>

SMEs:

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### Key

	Good Agreement with data/trends
	Agreement with most trends, some deviations from validation data/trends
	Some major disagreements with validation data/trends



Engine CoreTemperature (C)	SkinTemperature (C)	Engine SkinTemperature (C)	SweatRate (ml/s)	Engine SweatRate (ml/s)	Blood Panel AlbuminConcentration (g/dL)	Blood Panel AlbuminConcentration (g/dL)	Blood Panel BUN (mg/dL)	Blood Panel BUN (mg/dL)	Blood Panel CalciumConcentration (mg/dL)	Blood Panel CalciumConcentration (mg/dL)	Blood Panel BicarbonateConcentration (mmol/L)	Blood Panel BicarbonateConcentration (mmol/L)	Blood Panel CreatinineConcentration (mg/dL)	Blood Panel CreatinineConcentration (mg/dL)	Blood Panel GlucoseConcentration (mg/dL)	Blood Panel GlucoseConcentration (mg/dL)	Blood Panel SodiumConcentration (mEq/L)	Blood Panel SodiumConcentration (mEq/L)
37	< Core [2]	33	0 [2]	0	3.9 to 5.0 [8]		7 to 20 [8]		8.5 to 10.9 [8]		20 to 29 [8] Acutely decreased due to hyperventilation [52]		1.4 [8]		128 [8]		136 to 144 [8] Acutely decreased [52]	
37.5	< Core [2]	32.8	Depends on core temperature. Use direct calculation or [2] For direct calc = 2.3045e- 5*(core-37.3) NOTE this may be low [2]	0.05	Acutely, moderate increase [52]		No change [52]		No change [52]		Decreased due to hyperventilation [52]		No Change [52]		Acutely increased [52]		No Change [52]	
37.6	< Core [2]	32.8	No change [51]	0.05														
38.3	< Core [2]	32.8	Depends on core temperature. Use direct calculation or [2] For direct calc = 2.3045e- 5*(core-37.3) NOTE this may be low [2]	0.11	Acutely, moderate increase [52]		No change [52]		No change [52]		Decreased due to hyperventilation [52]		No Change [52]		Acutely increased [52]		No Change [52]	
38.3	< Core [2]	30	Depends on core temperature. Use direct calculation or [2] For direct calc = 2.3045e- 5*(core-37.3) NOTE this may be low [2]	0.11	Decreased [52]		Elevated [52]		Hypocalcemia secondary to increased calcium binding in damaged muscle [52]		Decreased [52]		Elevated [52]		Decreased [52]		Decreased [52]	
38.1	< Core [2]	24.4	Depends on core temperature. Use direct calculation or [2] For direct calc = 2.3045e- 5*(core-37.3) NOTE this may be low [2]	0.1	Decreased [52]	3.51	Elevated [52]	13.82	Hypocalcemia secondary to increased calcium binding in damaged muscle [52]	4.87	Decreased [52]	26.14	Elevated [52]	0.95	Decreased [52]	47.94	Decreased [52]	145