## Section 1: Case Summary

| Scenario Title: | **Heat Stroke** |
|---|---|
| Keywords: | Heat Illness, Heat Stroke, Sympathomimetic Toxicity |
| Brief Description of Case: | Man in his late 30s presenting with agitation and hyperthermia in the context of recent stimulant use. Subsequently he developed heat stroke and required resuscitation including management of his deteriorating airway, hypotension, hyperkalemia and AKI.<br>(note: scenario best presented in the summer months) |

| Goals and Objectives | |
|---|---|
| Educational Goal: | Approach to Heat Stroke Diagnosis and Management |
| Objectives:<br>(Medical and CRM) | CRM: Effectively lead team members through complex critical scenario.<br>Medical:<br>1) Early recognition of heat stroke and prompt initiation of core cooling<br>2) Maintain an awareness of the complications of heat illness and administering adjuvant therapies beyond cooling<br>3) Use closed-loop communication and frequent summaries in order to maintain effective communication and a shared mental model. |
| EPAs Assessed: | F1 Initiating and assisting in resuscitation of critically ill patients |

| Learners, Setting and Personnel | | | | |
|---|---|---|---|---|
| Target Learners: | ☐ Junior Learners | ☒ Senior Learners | | ☒ Staff |
| | ☐ Physicians | ☐ Nurses | ☐ RTs | ☒ Inter-professional |
| | ☐ Other Learners: | | | |
| Location: | ☒ Sim Lab | ☒ In Situ | | ☐ Other: |
| Recommended Number of Facilitators: | Instructors: 1 | | | |
| | Confederates: | | | |
| | Sim Techs: 1 | | | |

| Scenario Development | |
|---|---|
| Date of Development: | Nov 25th 2021 |
| Scenario Developer(s): | Dr. Matei Stoian |

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| | |
|---|---|
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| Last Revision Date: | Nov 25th 2021 |
| Revised By: | Matei Stoian |
| Version Number: | #1 |

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## Section 2A: Initial Patient Information

| A. | | | Patient Chart | | |
|---|---|---|---|---|---|
| Patient Name: Not IDed | | | Age: Late 30s | Gender: male | Weight: 75kg |
| Presenting complaint: EHS called by bystanders as patient was agitated and confused on sidewalk | | | | | |
| Temp: 39.5 | HR: 115-120 | BP:90/61 | RR:28 | $O_2$Sat:98% r/a | $FiO_2$: R/A |
| Cap glucose: 3.5 | | | GCS: (E V M ) 4-3-6 | | |
| Triage note:<br>Friend called EHS due to increasing agitation and confusion. They had been using cocaine and methamphetamines throughout the morning. They noted the patient is housing insecure.<br><br>EHS notes the above vitals. They have not provided any treatment. There is one 18gg IV in the right AC. | | | | | |
| Allergies: None known | | | | | |
| Past Medical History:<br>None known (presumed healthy) | | | Current Medications:<br>None (on pharmanet) | | |

## Section 2B: Extra Patient Information

| A. Further History | |
|---|---|
| *No further collateral* | |
| **B. Physical Exam** | |
| *List any pertinent positive and negative 6indings* | |
| Cardio: S1 + S2, no EHS, no murmurs | Neuro: PEARL, ~7mm. Inappropriate words but no motor agitation |
| Resp: Mild crackles to bases | Head & Neck: Normal |
| Abdo: Soft, non-tender, non-distended | MSK/skin: Not diaphoretic, flushed skin |

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Other: No further positive findings.
Notable pertinent negatives.

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## Section 3: Technical Requirements/Room Vision

| A. Patient |
| --- |
| ☒ Mannequin *(adult)* |
| ☐ Standardized Patient |
| ☐ Task Trainer |
| ☐ Hybrid |

| B. Special Equipment Required |
| --- |
| Not required but if possible the following to be available upon request:<br>-Fan<br>-Bodybag |

| C. Required Medications |
| --- |
| -IVF, Calcium Gluconate, Dextrose<br>-Benzodiazepines<br>-Airway medications (induction agents, paralytics, etc.) |

| D. Moulage |
| --- |
| None |

| E. Monitors at Case Onset |
| --- |
| ☐ Patient on monitor with vitals displayed<br>☒ Patient not yet on monitor |

| F. Patient Reactions and Exam |
| --- |
| When asked questions patient just moans/vocalizes non-sensical words |

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## Section 4: Confederates and Standardized Patients

| Confederate and Standardized Patient Roles and Scripts | |
|---|---|
| *Role* | *Description of role, expected behavior, and key moments to intervene/prompt learners. Include any script required (including conveying patient information if patient is unable)* |
| | Patient unable to provide any helpful information at any point |
| | No Confederates |

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## Section 5: Scenario Progression

| Scenario States, Modifiers and Triggers | | | | |
|---|---|---|---|---|
| Patient State/ Vitals | Patient Status | Learner Actions, Modifiers & Triggers to Move to Next State | | Facilitator Notes |
| **1. Baseline State**<br>Rhythm: sinus<br>HR: 115-125<br>BP: 87/49<br>RR: 28<br>$O_2$SAT: % 97 r/a<br>T: 41.5 °C<br>GCS: 13 | Confused | Expected Learner Actions<br>-Rapid identification of heat stroke<br>-Rapid initiation of cooling via evaporative cooling or ice water immersion<br>-Fluid resuscitation +/- covering for sepsis<br>-Treating sympathomimetic too with benzo | Modifiers<br>-If not using ice water immersion or evaporative cooling within a few minutes should proceed to **4. CODE**<br><br>Triggers<br>-Initiation of cooling + fluids, and ordering initial investigations (bloodwork, ECG, XR), proceed to **2. Low GCS** | -If asked for a temperature should ask them how they checked. If not core temp (rectal/esophageal) should instead give a reading of 39.5<br>-If learners ask to cool the patient facilitator should ask them how they go about it |
| **2. Low GCS**<br>Rhythm: Sinus<br>HR: 110-120<br>BP: 100/61<br>RR: 30<br>$O_2$SAT: % 90 r/a<br>T: 40.5 °C<br>GCS: 7 | Decreasing GCS in the context of ongoing heatstroke | Expected Learner Actions<br>-Re-assessment and recognition of decreased GCS and worsening clinical status as indication for intubation | Modifiers<br>-If using succinylcholine for intubation proceed to **4. CODE**<br>-If using a vasopressor infusion should proceed to **4. CODE**<br>**-**If not intubated promptly patient should have a seizure. If given benzodiazepine then seizure should abort. If not intubated after seizure should then proceed to **4. CODE**<br><br>Triggers<br>-If patient is intubated successfully proceed to **3. Continued Resus** | -Once proceeding to this stage should prompt learners by saying the patient has stopped making comprehensible sounds. They should re-assess the GCS<br>-If not moving to intubation quickly prompt them with further decrease in GCS and decreasing O2 sat. |

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| | | | | |
|---|---|---|---|---|
| **3. Continued Resus**<br>Rhythm: runs of non-sustained Vtach lasting up to 30 seconds<br>HR: 115-125<br>BP: 87/49<br>RR: intubated<br>$O_2$SAT: % 97 r/a<br>T: 40 —> 38°C<br>GCS: intubated | Hemo-dynamically unstable. Having runs of Vtach. Intubated. | Expected Learner Actions<br>-continued fluid resuscitation<br>-Calcium for hyperkalemia and hypocalcemia +/- potassium shifting<br>-Continuous temperature monitoring<br>-Switching to passive cooling after patient reaches a temperature of 38°C<br>-Disposition of patient to ICU | Modifiers<br>-If given 3L of ]luids BP and HR should normalize<br>-If temperature reaches 38°C and patient has been given calcium runs of Vtach should stop<br>-If not stopping rapid cooling at 38°C facilitator should continue to reduce the temperature rapidly. If reaching 36°C then proceed to **5. Hypothermia**<br><br>Triggers<br>-If at a temperature of 38°C the learners stop the rapid cooling and the other metabolic abnormalities have been addressed then the scenario is over and the learner should be prompted as to how they dispo the patient (ICU) | -Prompt the learners at the start of this stage with the bloodwork/ECG/XR<br>-During this stage as long as continued cooling is taking place slowly lower temperature from 40° to 38°C |
| **4. CODE**<br>Rhythm: sinus<br>HR: 220<br>BP: n/a<br>RR: n/a<br>$O_2$SAT: % 97 r/a<br>T: unchanged<br>GCS: 3 | In ACLS (VT without pulse) | Expected Learner Actions<br><br>-ACLS | Modifiers<br>-N/A<br><br>Triggers<br>-After 2 shocks return to previous state where they left off | Prompt learners to note HR to start this stage. This should prompt them to check a pulse, if they do not check a pulse prompt them. |
| **5. Hypothermia**<br>Rhythm: 3rd degree heart block<br>HR: 35<br>BP: 90/60<br>RR: intubated<br>$O_2$SAT: % 97 r/a<br>T: 34 °C<br>GCS: intubated | -3rd degree heart block from overshoot hypothermia | Expected Learner Actions<br>-Rewarming to address hypothermia | Modifiers<br>-No change to status if paced<br><br>Triggers<br>-If warming back up to 37°C can return to stage **3. Continued Resus**<br>-If slow to recognize hypothermia can proceed to **4. CODE** | -When entering this stage prompt the learner with a decreasing GCS and low HR |

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## Appendix A: Laboratory Results

| | |
|---|---|
| CBC<br>WBC - 9.6<br>Hgb - 144<br>**Plt - 105**<br><br>Lytes<br>**Na - 130**<br>**K - 6.2**<br>Cl - 104<br>**$HCO_3$ - 8**<br>**AG - 14**<br>**Urea - 20**<br>**Cr - 330 (eGFR 18)**<br>**Glucose - 3.3**<br><br>Extended Lytes<br>**Ca - 1.98**<br>Mg - 1.8<br>$PO_4$ - 3.1<br>Albumin - 40<br>TSH - 2.2<br><br>VBG<br>**pH - 7.1**<br>$pCO_2$ - 38<br>$pO_2$ - 88<br>**$HCO_3$ - 8**<br>**Lactate - 2.9** | Cardiac/Coags<br>Trop - 7<br>D-dimer - 450<br>**INR - 2.1**<br>**aPTT - 45**<br><br>Biliary<br>**AST - 307**<br>**ALT - 352**<br>GGT - 102<br>ALP - 89<br>**Bili - 23**<br>Lipase - 50<br><br>Tox<br>EtOH - 0<br>ASA - 0<br>Tylenol - 0<br>Dig level - N/A<br>Osmols - normal<br><br>Other<br>B-HCG - N/A<br>**CK - 11,057** |

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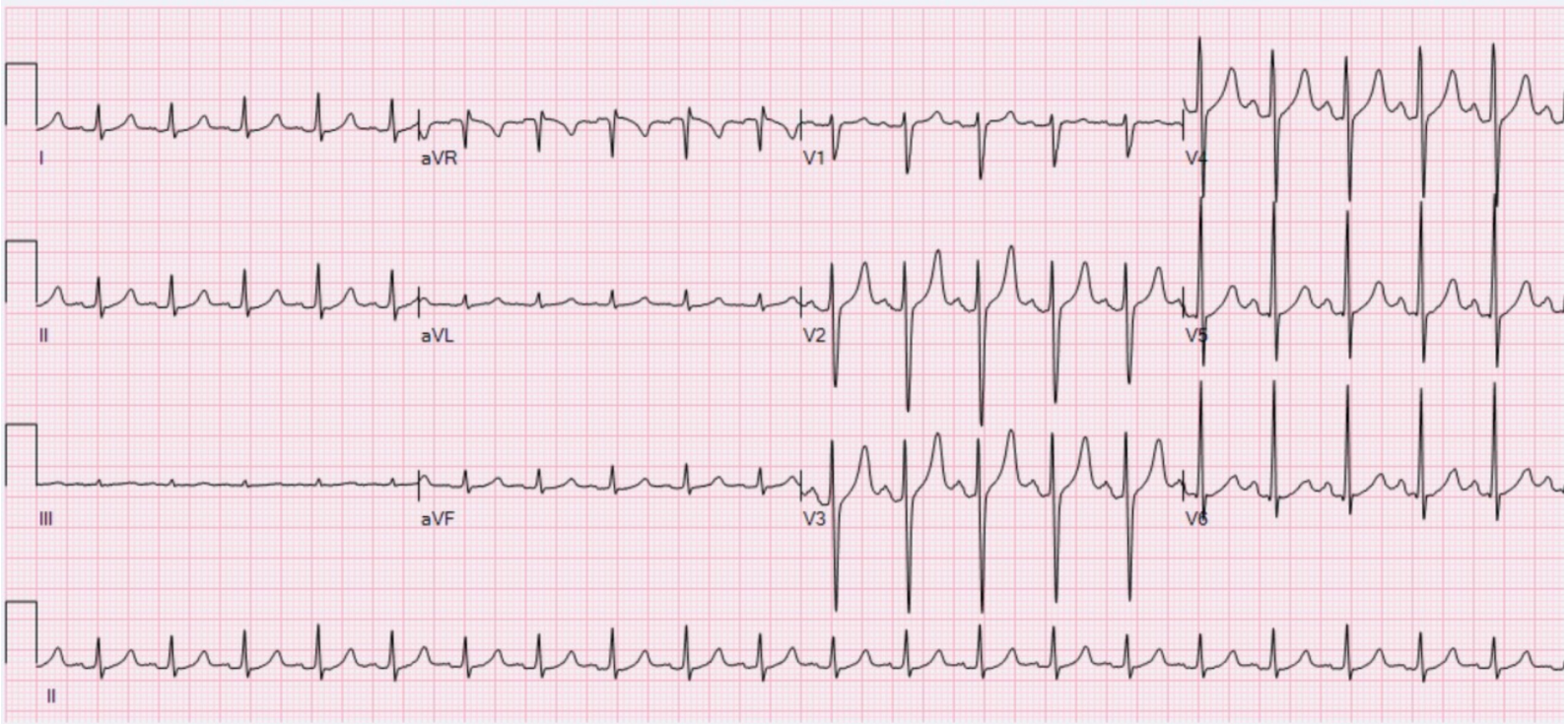
## Appendix B: ECGs, X-rays, Ultrasounds and Pictures

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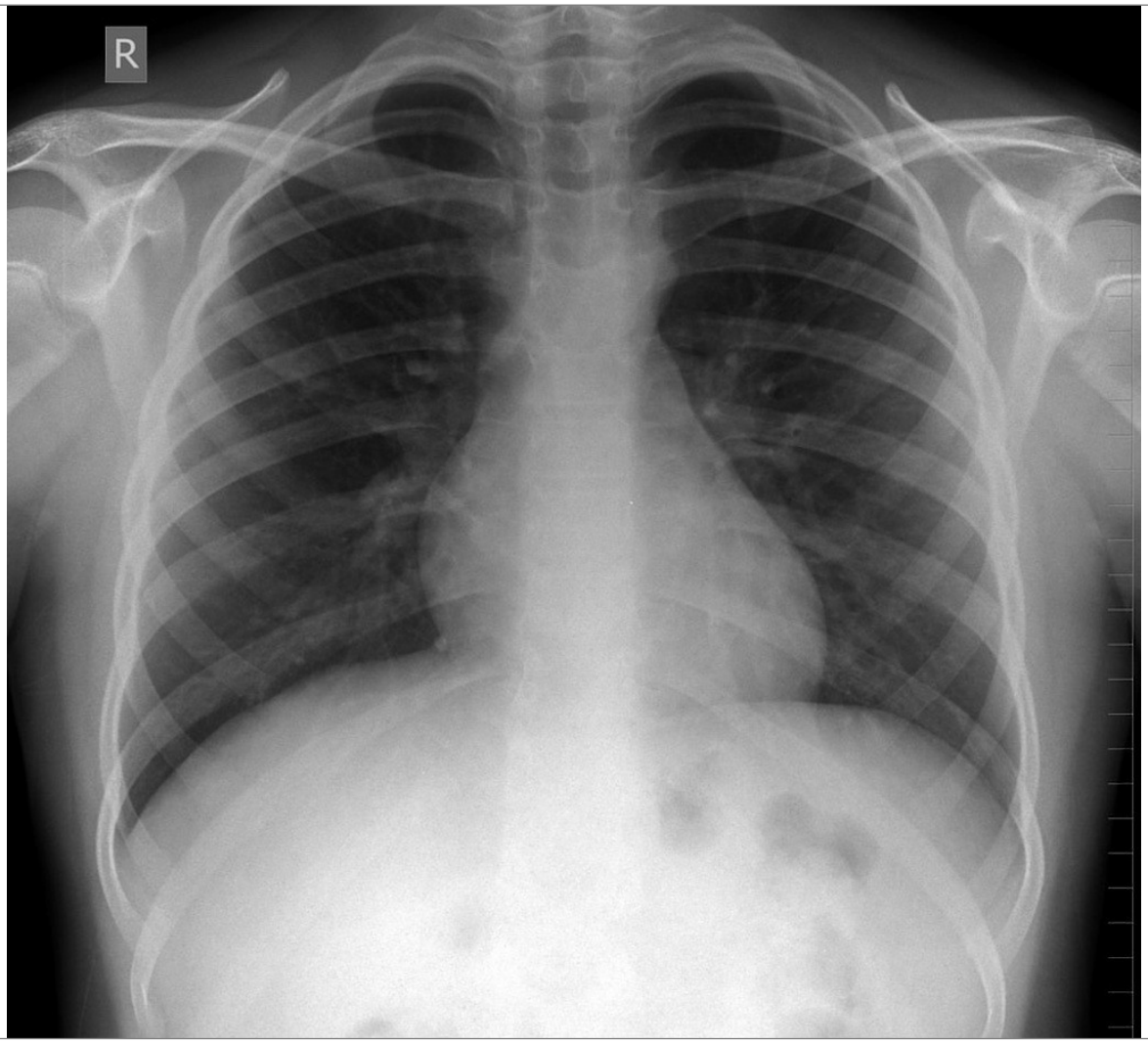


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## Appendix C: Facilitator Cheat Sheet & Debriefing Tips

General Overview
Patient presenting with core temperature >40.5 Cº. Must rule out heat stroke in this scenario.
-DDx includes: Sympathomimetic Toxidrome, Sepsis, Meningitis, Anti-cholinergic toxidrome, NMS, Serotonin Syndrome, Malignant Hyperthermia, MAOi Overdose
-In this case the patient had heat stroke. They had some sympathomimetic prior which exacerbated the heat stroke through agitation and dehydration, but didn't have an acute sympathomimetic toxidrome and this was not their PRIMARY medical issue.
-Key differentiators here are the lack of psychomotor agitation. Lack of response to benzodiazepines. Lack of diaphoresis.
-There is an element of exertion heat stroke (from psychomotor agitation from sympathomimetic)

Explanation of Physical Exam/Investigations
-Heat Stroke Related Hypotension/Sinus Tachy/Altered Mental Status. Flushed due to peripheral vasodilation.
-Heat Stroke Related Coagulopathy, Hypocalcemia, Hyponatremia, Hyperkalemia, Lactic Acidosis, and Hepatic Injury (ALT/AST)
-Rhabdomyolysis (CK)
-AKI multifactorial but mostly pre-renal/rhabdo
-normal CXR (did have mild crackles on exam due to vasodilation secondary to heat stroke)
-ECG showed sinus tach. Runs of NSVT on monitor due to heat stroke propensity for tachyarrhythmia. VTach in heat stroke often doesn't resolve with cardioversion and treatment is treatment of the heat stroke

Treatments
-Most important is early cooling. Best two options are ice water immersion (quickest but sometimes logistically challenging in real life), and evaporative cooling with fans (not quite as quick, need access to fans). Can supplement with other methods (e.g. ice packs on core)
-For evaporative cooling use WARM water (as cold water will trigger a shivering response and cause more heating paradoxically), and need to have patient stripped (evaporative cooling doesn't work if there is wet cloth covering the skin)
-Should STOP ice water immersion/evaporative cooling once temp is 38.3-38.9 (different sources have different recommendations). At this temperature the extremities are likely much cooler and the continued circulation of blood will cause the temperature to continue to drift down quickly and can lead to hypothermia. At this temperature you can just put a sheet over them and they will still continue to cool on their own.
-NO NEED for antipyretics (not a hypothalamus issue)
-It is reasonable and even recommended to cover for sepsis and/or meningitis with broad spectrum antibiotics
-It is reasonable to to treat the co-occurrent sympathomimetic toxicity with some initial benzodiazepines. These have a side bene]it in this case of helping to prevent heat stroke related seizures.
-It is reasonable to treat with calcium for the hypocalcemia and to stabilize the myocardium in the context of the hyperkalemia (even in the context of no ECG changes). Should consider shifting the potassium as well (i.e. insulin, D50, ventolin)
-For both heat stroke, and the accompanying AKI and Rhabdomyolysis in this situation fluids are a mainstay. It is okay to start with normal saline but after 1-2 litres better to go with plasmalyte or lactated ringers to avoid worsening acidosis. It is not uncommon to need >3L of IVF to adequately resuscitate these patients.
-In this case the patient needs to be intubated to protect the airway in the context of worsening clinical course and decreasing GCS.
-Should put in a foley to monitor urine output. In the case of rhabdo you should want to maintain a urine output of 2mL/Kg/hr

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Pitfalls
-Anchoring on a sympathomimetic toxidrome
-Not getting a core temperature early and/or not using continuous temperature monitoring thereafter
-Cooling past 38.3Cº as this can lead to hypothermia
-Treating the hypoperfusion/shock with pressers and not ]luids (the etiology is hypovolemia/distributive) as isn't needed and can worsen tachyarrhythmias
-Using succinylcholine for intubation (contraindicated in hyperkalemia as it can worsen this and lead to fatal arrhythmia)

Key Points
-Early detection of Hyperthermia. Non-core temperature readings are unreliable so it is important to get a prompt rectal or esophageal temp. In this case the oral/axillary/temporal temp was 39.5 Cº but the core temp is measured at 41.5 Cº
-Early cooling: this is shown to have a substantial impact on outcomes
-Not anchoring on a sympathomimetic toxidrome
-Managing complications (i.e. not just focussing on cooling)

For Debrief (space for writing)

# References


1. Rotheray, K. R., & Cattermole, G. N. (2010). Rosen's emergency medicine: concepts and clinical practice.
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3. Tintinalli, J. E., Stapczynski, J. S., Ma, O. J., Cline, D., Meckler, G. D., & Yealy, D. M. (Eds.). (2016). *Tintinalli's emergency medicine: a comprehensive study guide* (pp. 74-79). New York: McGraw-Hill Education.



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