**The effects of rudeness, experience, and perspective-taking on challenging premature closure after pediatric ICU physicians receive hand-off with the wrong diagnosis: a randomized controlled simulation trial**

**Supplementary Material**

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| 1. **Simulation script** 2. **OR hand-off: study intervention** 3. **Manipulation check questionnaire** 4. **Video review: coding criteria** 5. **Video review: consensus process** |

**I. Simulation script**

Case Title: Hand-off as sepsis but actually cardiac tamponade

Case Summary: 14-year-old female with a new diagnosis leukemia returning from the operating room (OR) after a tunneled right sided double-lumen Broviac line was placed. In the OR, she also had bilateral bone marrow aspirates and a lumbar puncture. Prior to the OR case she was afebrile and hemodynamically stable. Towards the end of the case she tolerated extubation, but her temperature increased to 38.0 and she became hypotensive/ tachycardic. The surgeon and anesthesiologist both believe that she is becoming septic. Sim participant is the accepting physician receiving sign out after the OR case. The sim participant is expected to identify physiology of cardiac tamponade rather than sepsis and manage accordingly.

1. **Setup:**
   1. Standard materials:
      1. Bedside code cart, bedside airway equipment, bedside defibrillator, Pediatric Advance Life Support (PALS) cards, standard code sheets with dosing for a 50kg patient.
      2. 2 cameras with auditory microphone focused on team leader, control room with audio set up into simulation room.
      3. Central monitor screen with EKG, noninvasive blood pressure (BP), arterial line BP with wave form, temperature, pulse oximetry, and respiratory monitoring (4 wave). End Tidal C02 (ETCO2) monitor (if participant intubates or a non-invasive C02 monitor is asked by participants), Central Venous Pressure (CVP) tracing.
      4. Stickers on mannequin to rapidly identify pulses, heart sounds, breath sounds, and liver.
   2. Supporting materials (as requested by participant):
      1. Blood gas (from multiple sites), chemistries, Complete Blood Count (CBC).
      2. Chest X-ray (CXR) with line into pericardium and cardiomegaly.
      3. 12 lead Electrocardiogram (ECG) with low amplitude and electrical alternans.
2. **Mannequin:**

High fidelity “Simulation Susie” with 2 IVs (saline locked), central line (attached to IV pole with running fluids of NS bolus at “999ml/hr” and D5 1/2NS at “100ml/hr”), arterial line, nasal-cannula at 2L/min, and custom-built hepatomegaly.

**C. Standardized roles with directions:**

1. Team leader (Consented research subject: resident, fellow, or attending).

2. RN role (Confederate)

* Must point out that the “PIV is locked but flushes and even draws back perfectly”.
* Must point out vital sign changes, but not offer any help with assessment.
* If instructed to give a bolus: ask, “which site?” (Peripheral IV vs central line).
* Draws labs/gases and hands them to the Respiratory Therapist (RT) for results.
* Does not synthesize information or offer diagnostic assessment.

3. Surgeon and Anesthesiologist (Confederates)

* Anesthesiologist gives anesthesia hand-off (see below).
* Actor as surgeon (randomized as rude vs neutral hand-off).

4. Respiratory therapist (Confederate)

* Will run gas and hand prepared gas value report to team leader.
* Able help participant with airway based on direction from team leader.

6. Facilitator (simulation and debriefing) – behind one-way mirror during simulation.

7. Simulation technician – behind one-way mirror .

**D. Case introduction (for participants prior to starting simulation):**

1. Facilitator gives a full orientation to the simulation mannequin, room, equipment (including time for questions).
2. Script to read prior to starting simulation: “Please try to verbalize your thought process for research and to improve your communication skills. If you want detailed tracings, films, x-rays, consults then please request them”.

**E. Background (for simulation tech and confederates):**

The learners will be given a sign-out with the incorrect diagnosis that the patient is septic. While the patient is at risk for sepsis and empiric antibiotic coverage is an acceptable decision, the patient will actually be worsening because of progressive cardiac tamponade secondary to the new line migrating to the pericardial space.

After the sign-out, the simulated patient will develop a faster heart rate, dropping systolic blood pressure, narrower pulse pressures, and a declining mental status. She will maintain her saturations until she is almost obtunded from the decline in mental status. The goal is for the learner to identify that the problem is not sepsis but rather iatrogenic cardiac tamponade caused by the line migrating to the pericardial space. Ideally, they should stop using the new central line entirely and call for subspecialty help to evaluate for pericardiocentesis and/or prepare for pericardiocentesis themselves if within their clinical skill set. They should also use fluid boluses +/- acceptable inotropes via the PIVs or an alternatively obtained IV access point. If the learner fails to act, continues to use the faulty CVC and/or intubates without prior hemodynamic stabilization then the patient will transition to Pulseless Electrical Activity (PEA) arrest. If the patient is in PEA, the learner still has an opportunity to address the cause of tamponade and follow the PALS/PEA algorithm. The simulation will stop with either the patient improved with correct management, after 2 min of PEA arrest, or 10 min after hand-off (allowing time to complete an in-progress task).

**F. Initial presentation:**

* Patient will be on nasal cannula at 2L, full monitors, irritable and confused mental status.
* New CVC attached with IV pumps running
* 2 PIVs are saline locked
* Heart rate in 120’s with slightly low and narrow blood pressures (90/40). Normal saturations.
* “QRS” monitor sound is on.

**G. Standardized responses to participant actions/requests (for confederates/facilitator):**

1. Previously drawn labs from prior to OR: Give immediately
2. Gas and CXR:

Initial presentation (when CVP 9 mmHg):

* Blood gas: RN draws -> RT (after CVP changes): hand over written labs and read out loud
* CXR: Wait until CVP increases: show CXR

After CVP changes (from 9 🡪 12 mmHg):

* Blood gas: RN draw -> RT goes to machine: get labs
* CXR: Wait 60 seconds

II. Other Labs: state: “sent to lab”, do not arrive prior to end of simulation

III. Consults, ECHO, Ultrasound: state: “they are on their way”

IV. ECG or EKG: Instant upon request

V. Pericardiocentesis, intubation, needle decompression equipment: All material is available in room. Confederates may help find material quickly and help set up but only if instructed by team leader.

**F. Maps (programing and running simulation for sim tech):**

* **Map 1** shows the specific vital signs and mannequin modifications used for navigating the simulation at the level of the simulation technician. Instructions: *Start on the “2a” stage. If sim provider does nothing that improves patient status over 1.5min then advance the map numbers. If participant gives fluid in the central line or intubates then patient declines with increased map numbers. If they take correct treatment actions then the patient improves slightly and moves to the “b” section. Once in “b” does not move from “b”, unless participant actually drains the pericardial space (“b” has higher CVP than “a”). If actions are done to improve patient in the “b” column without draining the pericardial space, the go down on the numbers (to demonstrate patient improvement).*

**(Map 1):** Demo (for orientation prior to simulation only):

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| --- | --- |
| **HR** | 70 |
| **BP** | 110/70 |
| **CVP** | 0 |
| **RR** | 10 |
| **Sats** | 100% |
| **Temp** | 37 |
| **Heart sounds** | Normal |
| **Pulses** | 2+ |
| **Mental Status** | Talking, blinking, eyes open |

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| --- | --- | --- |
| **Setting** | **Stage 1a** | **Stage 1b** |
| **HR** | N/A | 100 |
| **BP** | N/A | 95/60 |
| **CVP** | N/A | 10 |
| **RR** | N/A | 14 |
| **Sats** | N/A | 97% |
| **Temp** | N/A | 37.9 |
| **Heart sounds** | N/A | distant |
| **Pulses** | N/A | 2+ |
| **Mental Status** | N/A | Talking, blinking, eyes open |

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| --- | --- | --- |
| **Setting** | **Stage 2a \*start\*** | **Stage 2b** |
| **HR** | 120 | 120 |
| **BP** | 90/40 | 90/72 |
| **CVP** | 9 | 12 |
| **RR** | 18 | 18 |
| **Sats** | 95% | 95% |
| **Temp** | 37.9 | 37.9 |
| **Heart sounds** | normal | distant |
| **Pulses** | 2+ | 2+ |
| **Mental Status** | awake | Talking, blinking, eyes open |

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| --- | --- | --- |
| **Setting** | **Stage 3a** | **Stage 3b** |
| **HR** | 132 | 120 |
| **BP** | 85/70 | 85/72 |
| **CVP** | 12 | 16 |
| **RR** | 24 | 22 |
| **Sats** | 93 | 91% |
| **Temp** | 37.9 | 37.9 |
| **Heart sounds** | distant | distant |
| **Pulses** | 2 | 2 |
| **Mental Status** | groans | groans |

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| --- | --- | --- |
| **Setting** | **Stage 4a** | **Stage 2b** |
| **HR** | 150 | 155 |
| **BP** | 70/63 | 75/65 |
| **CVP** | 18 | 20 |
| **RR** | 34 | 32 |
| **Sats** | 87% | 88% |
| **Temp** | 37.0 | 37.0 |
| **Heart sounds** | distant | distant |
| **Pulses** | 1+ | 1+ |
| **Mental Status** | obtunded | obtunded |

|  |  |
| --- | --- |
| **Setting** | **Stage 5** |
| **HR** | 190 |
| **BP** | 59/51 |
| **CVP** | 20 |
| **RR** | 39 |
| **Sats** | 70 |
| **Temp** | 36.9 |
| **Heart sounds** | absent |
| **Pulses** | 1- |
| **Mental Status** | obtunded |

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| --- | --- |
| **Setting** | **Stage 6 (PEA)** |
| **HR** | 160 |
| **BP** | 0/0 |
| **CVP** | 20 |
| **RR** | 0 |
| **Sats** | 0 |
| **Temp** | 36.1 |
| **Heart sounds** | 0 |
| **Pulses** | 0 |
| **Mental Status** | obtunded |

**Map 2:** A timeline and clinical details for the simulation facilitator and confederates to navigate the simulation with a standard approach:

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| --- | --- | --- | --- |
| **Approximate time (status)** | **Participant action/ Trigger** | **Patient Status (Simulator response) & Operator Prompts** | **Mannequin actions** |
| 0:00  (Baseline) | No action leads to progressive worsening stage Q1.5min. | Irritable/avoiding verbalizations    Difficult to hear heart sounds    If asked: elevated Jugular Venous Distention (JVD), hepatomegaly (3cm), delayed cap refill (3-4 seconds) | Verbalizes “That hurts”, “leave me alone”, “turn off the lights” |
| 0:00 -5:00      Move to A or B state depending on simulation participant actions | Arterial Blood Gas (ABG):  - 7.29/38/109/17/-10  - 145 | --- | --- /167  4.0 | --- | ---\  - -->7.5/22.5<--    Peripheral Venous Blood Gas (VBG):  - 7.25/43/50/15/-12  - 145 | --- | --- /167  4.0 | --- | ---\  - -->7.5/22.5<--    Central Venous Catheter (CVC) VBG:  - 7.01/80/20/11/-17  - 120 | --- | --- /390  1.2 | --- | ---\  - -->0.6/2<-- | Declining mental status    Difficult to hear heart sounds    If asked: elevated JVD, hepatomegaly (3-4 cm), delayed cap refill 4 seconds | If CVP at 18, then tamponade waveform (if asked)    “moans” |

|  |  |  |  |
| --- | --- | --- | --- |
| **Approximate time (status)** | **Participant action/ Trigger** | **Patient Status (Simulator response) & Operator Prompts** | **Mannequin actions** |
| A (declining patient condition)  5:30 | No action after 5 min,  or after intubation/CVC fluid bolus | Tamponade worse | If intubation ETC02 at 12 |
| 7:00 | Intubation, continued use of CVC, norepinephrine/ phenylephrine | Tamponade worsens to PEA | PEA arrest with narrow QRS non-shockable rhythm, HR at 70. Etc02 at 0. No pulse. |
| 9:00 | Manage PEA arrest per PALS alone | Cause of PEA not addressed, then STOP simulation | PEA does not improve |
| 9:30 | Manage PEA arrest per PALS and revisit line/cardiac problem | STOP Simulation | Inform team that pericardiocentesis comes and improves patient condition |
| B (improving patient condition)  7:00 | Bolus given (not from CVC)    Epi, dobutamine, or dopamine given (not norepinephrine or phenylephrine) | HR and BP improving | Mental status improves |
| 9:30 | Call for surgical management for pericardiocentesis | Improve stage | Mental status improves |

**II. OR hand-off: rude and neutral study intervention**

**A.** **Anesthesia sign-out [Surgical additions in bold]:**

*Surgeon stage note: For rude scenarios the interruptions are abrasive, aggressive, and while anesthesia is speaking, For neutral scenarios the additions are informative, collaborative, and after anesthesia has completed a sentence.*

●   14-year-old female 50kg. Has Penicillin allergy. Presumed diagnosis of Leukemia

●   S/p Central Venous Catheter placement, Bilateral bone marrow aspiration in iliac crests, and LP **["Oncology did that”]**.

●   Easy airway. Grade I View. Intubated with a Mac 3, 6.0 cuffed, leak at 20. Tolerated extubating well.

●   EBL of ~ 20cc. **[“Minimal”]** No blood required. Continued to run the maintenance IVF during case. *Received* 1000ml of NS for the softer BPs. **["Just started”]**

●   Access: 2 PIVs that work great, new Double Lumen Broviac, left radial arterial line

●   Given concern for pain and possible fever we have just given IV Tylenol.

●   Temperature rose 37.0 -> 38.0.  He didn’t have any fevers on the floor, this is new.

●    HR rose 90-> 110, BP started at 100/60 -> now they are 90/60

●    CVP for me was 4-5

●    Ancef given per protocol, had no reaction. 

*Stage notes: Anesthesia looks at surgery to signal completion of anesthesia portion*

**Conditional Information (if asked, to be answered by anesthesiologist)**

* History: Previously healthy, fully immunized, developing normally. Parents noted several weeks of fatigue, pallor, ecchymosis. Primary Care Physician (PCP) found leukocytosis with blasts 3 days prior and sent to ED, where patient was admitted. No fevers, no Upper Respiratory Infectious (URI) symptoms, no travel history, no sick contacts.
* Hospital Course: Admitted through the Emergency Department. Has been on IV fluids and empiric allopurinol. Tumor lysis labs have been normal. She has been NPO for 8 hours prior to OR case. Type and Screen is active but patient has not received any blood products.
* OR Course: IV Tylenol given in PIV. 1L bolus currently finishing via CVC. Recent chem 14 was normal. Most recent CBC was 1.6> 8/23<150.

**B. Neutral General Surgery Sign-Out *(stage notes in italics)*:**

From a surgery stand point, she has some cancer diagnosis. You’ve got the sign-out on her. We put in a Broviac line, right side, double-lumen, subclavian, under flouro. Okay to use line. She’s septic. She should have been better resuscitated on the floor. She’s immunodeficient. She should have been started on antibiotics. *“*You know how to find me” *professional tone, leaves…*

1. **Rude General Surgery Sign-Out *(stage notes in italics):***

From a surgery stand point, she has some cancer diagnosis. You’ve got the sign-out on her. We put in a Broviac line, right side, double-lumen, subclavian, under fluoro. Okay to use line. She’s septic! She should have been better resuscitated on the floor. She’s immune…o …deficient. She should have already been started on antibiotics. I mean, come on! When I was at - *names another academic tertiary medical center-* this kind of crap never happened. They knew somethin’ if it was starin’ them in the face *… leaves abruptly…*

**III. Manipulation check questionnaire**

We tested the effectiveness of our rudeness manipulation with a survey at the end of the simulation. The following written survey statements were provided at the end of the simulation:

* I was treated in a polite manner during the simulation
* I was treated with dignity and respect during the simulation
* I was insulted during the simulation
* My feelings were hurt during the simulation

The participants could circle one of the following responses for each statement above on a Likert scale: (1) strongly disagree (2) disagree, (3) somewhat disagree, (4) neither agree nor disagree, (5) somewhat agree, (6) agree, or (7) strongly agree.

**IV. Video review: coding criteria**

Both reviewers were blinded to the initial portion of the video (the rude vs neutral hand-off was edited out). They were each given the same blinded videos to review independently. They both had a front and back view of the simulations, and where given instructions to use both or either view per their best judgment. Time zero was at the start of the video, which was immediately post hand-off from the OR team. They received the same training for video review process to identify verbalizations/actions that were highly suggestive of cardiac tamponade diagnosis and verbalization/actions that were highly suggestive of challenging the sepsis diagnosis (listed below).

**A. Criteria of verbalizations or actions categorized as highly suggestive of the cardiac tamponade diagnosis:**

* Research participant prepares to perform or performs a pericardiocentesis.
* Research participant states or describes "Pericardiocentesis".
* Research participant switches the standing maintenance IV fluids from new central line to a peripheral IV line.
* Research participant calls for Cardiologist or Cardiothoracic surgeon.
* Research participant states “Cardiac tamponade and/or pericardial effusion".
* Research participant states “Line problem or misplaced line”.
* Research participant calls for the hand-off surgeon to return.
* Research participant states "Narrow pulses, narrow pulse pressure, and/or pulsus paradoxes".
* Research participant orders a cardiac ultrasound or ECHO.

**B. Criteria of verbalizations or actions categorized as highly suggestive of challenging the sepsis diagnosis (but not necessarily the correct diagnosis of tamponade):**

* Research participant states a different diagnosis (not sepsis and not tamponade).
* Research participant states “I don’t think this is sepsis, not sepsis, not likely sepsis”.
* Research participant preforms a needle decompression of a lateral pleural space.

**V. Video review: consensus process**

A final dataset was established based on the video reviewer coding. The final dataset required agreement between two of the reviewers or one reviewer and a committee. A majority of the coded items were agreed upon by both reviewers after initial independent review. To be complete, however, a three-stage adjudication process was set up to evaluate to videos. This process is summarized in **Figure 2** of the manuscript and explained in detail below:

* Stage one (independent review): Both reviewers identified 7 simulation cases where there were no signs of the research participant challenging the incorrect diagnosis. For the other 34 cases, 184 items of highly suggestive events of challenging the incorrect diagnosis were identified. Items were counted as the same item, if they fit the exact same description and were coded within 20 seconds of each other. If the times were discrepant but within 20 seconds, an averaged time was then used for the final dataset.
* Stage two (prompted review): Each reviewer was notified about events that the other reviewer had identified, but was not in their initial independent review. They were given a 40 second window (20 seconds before and after the reported time) to re-review the video to comment on if they agree or disagree about a highly suggestive item. If they agreed, then the original time was used for the final dataset. This prompted review led to 66 additional items with mutual agreement. This stage addressed any omission errors due to the technical difficulty of video review.
* Stage three (committee review): This final stage occurred after the completion of stage two, where both reviewers still had a different opinion about whether or not an action item was truly highly suggestive of challenging the diagnostic error or identifying the correct diagnosis. For these disagreements, the entire video section was viewed by a panel of three independent board-certified pediatric emergency or critical care physicians. Two of the three committee reviewers needed to agree with a reviewer to make a final decision. The committee agreed with a reviewer for 41 additional action items.