

Human Factors Evaluation – Interventional Trauma OR Suite Simulation Scenarios

Scenario 1

Intra-abdominal bleeding with hemodynamic instability

Background information:

A 22 year old male is involved in a motor vehicle crash on the Deerfoot. He is transferred by Calgary EMS ground ambulance to the ER front door but is recognized to be in shock. He is taken directly to the Interventional Trauma OR Suite (ITOR) to undergo resuscitation bypassing the regular trauma bay in the ER. IN the ITOR he requires intubation, resuscitation, vascular access, and rapid diagnosis of the site of his haemorrhage.

Personnel

Trauma surgeon
Trauma resident
OR nurses
Anesthesiology team (resident, RT)
Interventional Radiology team (radiologist and techs)
Perfusionist
Cardiac Surgeon
Cardiac Nurses

Equipment

Laparotomy set-up
Major vascular set-up
Biomedicus pump
Cell saver
Fibrin glue cooker
Portable X-ray machine
Ultrasound
IV pumps including level I infuser
IV tubing and 36 inch tubing extension
Anesthesia equipment including ventilator

Sequence of the simulation

**Call comes in for OR room booking – E0
OR Nurses to prepare for potential laparotomy.**

- a) He is diagnosed to have a hemoperitoneum on FAST ultrasound exam – he thus requires an urgent conversion to an open laparotomy with resultant splenectomy (trauma surgeon or DI?)

Interventions

1. Patient arrives in ITOR and is transferred to the universal OR table with arms splayed out.
 - i. Surgical lights are properly positioned over patient.
 - ii. Equipment carriers and other equipment (i.e. anes machines) are set up.
2. Patient is intubated (**Anesthesia**) – requires *endotracheal tube and laryngoscope*. Anesthesia assumes control of airway and physiology.

3. Patient requires 2 peripheral intravenous's in each antecubital fossae (**Anes**) – *IV's required , need to be attached to IV infusion pumps preferably the Level I*
 4. Portable CXR and PXR are required (**radiology tech**) – *portable X-ray machine*
 5. **Trauma surgeon** arrives
 6. FAST exam is performed (**trauma surgeon**) – *portable US machine*
 7. Positive FAST examination generates decision to perform laparotomy – laparotomy setup
 8. Cell-saver is required – (**Anesthesia OR team**) – *cell saver*
 9. Patient is prepared for standard trauma procedure (sterna notch to med-thighs)
 10. Standard trauma laparotomy (**trauma surgeon and trauma resident**)
 - i. Procedure – splenectomy – *fibrin glue cooker*
 - b) **Major source of bleeding appears to be the liver** (damaged). The bleeding appears to respond to packing, however given the Grade V degree of the liver injury the team decides to perform an angiogram prior to leaving the operating room in order to rule out intra-hepatic arterial injury.
 - c) Surgeon maintains pressure while DI sets up their equipment.
10. Angiography equipment and **angiography team** take over the main intervention to perform an angiography.
 - a. All surgical equipment (lights, cauterizing equipment, equipment carriers) are moved out of the way to allow for positioning of the C-arm.

Sub-scenario

11. The bleeding does not respond to packing or a Pringle manoeuvre, thus the team has to decide whether to perform total vascular isolation of the liver with intra-pericardial infra-caval clamping, infra-renal IVC clamping, and a Pringle with veno-venous hepatic bypass using the Biomedicus pump VS a retrocaval shunt.
12. **Cardiac Surgeon** called to cannulate the patient.
13. **Perfusionists** are called to assist with the *Biomedicus pump*

Scenario 2

Retroperitoneal bleeding with exsanguinations and cardiac arrest

A 42 year old female is crushed by a horse as the horse is stampeded by a coyote. She is brought in profound shock to a peripheral hospital that recognizes the gravity of her situation. She is intubated and massive transfusions of blood products are initiated. She is urgently transported by STARS to the roof-top helicopter pad and transported urgently to the ITOR Suite for resuscitation. She has a massively distended abdomen.

Previous tasks performed in the ED: (not part of the current scenario)

- 1) Airway is checked – blood gasses are taken from the groin
- 2) Breathing is checked by the ER resident – markedly decreased air entry on the right
- 3) Chest tube placed by the trauma surgery resident
- 4) A,B,C,D,E examination by ER resident reveals shock and distended abdomen and unstable pelvis – patient is logrolled with full spine precautions - no blood on rectal examination
- 5) ER nurse inserts foley catheter which reveals gross hematuria
- 6) CXR and PXR are taken concurrently with both the FAST and central line insertion with clinical team wearing lead aprons – portable X-ray machine
- 7) PXR reveals open book pelvic fracture

Personnel

Trauma surgeon
 Trauma resident
 Respiratory therapist (2)
 OR nurses (2 scrub and circulating)
 Anesthesiology team
 Interventional Radiology team
 Vascular surgery team
 Orthopedic surgery team

Special Equipment

Iv infusion pumps including level I infuser
 IV tube extension
 Laparotomy set-up
 Major vascular set-up
 Vascular Stents
 External Orthopedic Pelvic Fixators
 Cell saver
 Chest tubes and thoraclex (water seal container for chest tube)
 Central lines including 8 French cordis catheter
 Lead aprons for all team participating in the resuscitation

For an additional challenge the orthopaedic team might try and place an external pelvic fixator during this whole procedure.

Sequence of the simulation:

ED calls OR booked for E0

Patient arrives in the ITOR with chest tubes in place, IV pump infusion level 1 etc.

- 8) **Angiography team** asked to perform tomographic evaluation of as much of torso as possible looking for the site of bleeding. Most desired area is the abdomen/pelvis to include liver, spleen, kidneys, and pelvis.
 - a. Tomographic angio evaluation of abdomen performed.
- 9) The abdominal evaluation suggests that the bleeding is retroperitoneal and not intra-peritoneal.
- 10) **Angiography team** assumes the primary control and performing an angiographic evaluation and potential angioembolization becomes the primary activity

- 11) **Angiographic team** performs diagnostic angio and notes massively bleeding superior gluteal artery as the main source of uncontrolled exsanguination.
- 12) At exactly this moment the patient suffers a *cardiac arrest*. **Surgery team** must perform CPR while DI equipment is moved out of the patient area. *Surgical lights need to be relocated above the patient*.
- 13) The trauma surgery team (**trauma surgeon + trauma resident**) assumes control of the case again and has to perform a resuscitative left thoracotomy with pericardiotomy, open CPR, and cross clamping of the descending aorta (trauma team does and angiography team has to back out). *Aortic clamps and chest spreader*.
- 14) Once the aorta is cross-clamped the **angiography team** should try to continue the angioembolization while the patient is undergoing open CPR (**trauma resident**). *Surgical lights need to be removed again*.
- 15) If it is possible to do the angioembolization the patient survives, if not she dies.
- 16) While the chest is open the trauma surgeon notes a disrupted thoracic aorta just distal to the ligamentum arteriosum which corroborates the CXR showing the wide mediastinum.
- 17) The angiographers are asked to confirm the suspicion of a disrupted thoracic aorta (**angiography team**).
- 18) The vascular surgery team is called and assumes care to perform a stenting of the thoracic aorta (**vascular team or open heart team**) *vascular stents*.

Scenario 3.

Thoracic case with cardiac and cervical injury – We skipped this scenario

A 44 year old off duty police officer is stabbed in the left chest (right at the left nipple) and left neck by his estranged wife. He is found to be pale, obtunded and diaphoretic at the scene, but has a heart rate of 100 and a systolic blood pressure of 100 mmHg. He has a zone II left neck penetrating injury and also cannot move his right side and has a blown left pupil. He is transported to the emergency room where he is intubated and is detected to have reduced breathe sounds on the left chest. A chest tube is placed and 2.5 litres of blood is drained. It is then recognized that he has a severe injury and is transported to the ITOR from the ER.

Personnel

Trauma surgeon / resident
 OR nurses
 Anesthesiology team
 Interventional Radiology team
 Vascular surgery team
 Cardiac surgery team
 Perfusionist

Special Equipment

Laparotomy set-up
 Major vascular set-up
 Vascular Stents – aorta and carotid
 Cell saver
 Cardiac bypass pump
 Finochetto chest spreader
 Linear staplers

Conduct of the Scenario

- 1) Patient is wheeled into the ITOR on a standard ER stretcher and must be transported to the Macquette table (**Trauma surgeon, trauma resident, OR Nurses**)
 - a. Patient has been intubated and had a chest tube inserted in the ER.
- 2) Central venous access (**anesthesia**)
- 3) Arterial lines (**anesthesia**)
- 4) Cell saver
- 5) Patient remains unstable with a systolic blood pressure of 80 mmHg.
- 6) A left antero-lateral thoracotomy is performed without waiting for the completion of (3-5) due to time constraints, (**Trauma surgeon, Trauma Resident** +/- Thoracic team if available, *Finochetto chest spreader, linear staplers*)
- 7) TEE is performed synchronously with **anesthesia and surgery** (Echocardiographer, TEE probe)
- 8) Diagnosis of hemopericardium and tamponade is made before the left chest is formally closed
- 9) The patient remains unstable and either (rehearse both options)
 - a. The anterior thoracostomy is extended across the sternum as a “clamshell” procedure (**trauma surgeon**)
 - b. Time is available and a median sternotomy is performed (**trauma surgeon**).
- 10) No matter how the mediastinum is accessed a free wall penetration of the right ventricle is detected. (**trauma surgeon**)
- 11) An initial attempt at a pledgeted suture causes the laceration to increase in size and control is obtained by direct pressure (**trauma surgeon**)
- 12) while the patient is put on cardiac bypass (cardiac team is called, and cardiac bypass machine is used).
- 13) Inflow and outflow lines are placed into the aorta and right ventricle (cardiac team)
- 14) A formal pericardial patch is used to close the right ventricular wound (cardiac surgeon)
- 15) Formal closure of the aortotomy and the ventriculotomy (cardiac team)
- 16) The patient now needs a computed tomographic angiogram of his neck to rule out injuries to the esophagus, airway, and major vasculature given his Zone II injury through the platysma.
- 17) The **IR team** is called and ideally should get into do this imaging before formal closure of the chest, in case access to the origin of the great vessels is required (**IR team – angiography catheters**) at the same time or right after cardiac is closing the sternotomy.
- 18) Angiography of his neck reveals a pseudoaneurysm with contained laceration of his left common carotid artery.
- 19) Vascular surgery is therefore required (Vascular team)
- 20) The left carotid must be dealt with which may involve either
 - a. Attempt an endovascular stent (**Vascular surgery – vascular stents**)
 - b. Perform a direct operative neck exploration with inflow and outflow control and vein patching of the lacerated carotid.
- 21) Formal closure of all incisions and ensure stability (All involved)

Scenario 4.

Ruptured diaphragm, femoral-popliteal artery transection with pulseless leg, and closed head injury

Personnel

Trauma surgeon
Trauma resident
OR nurses
Anesthesiology team
Interventional Radiology team
Vascular surgery team
Orthopedic surgery team
Neurosurgery team

Special Equipment

Laparotomy set-up
Major vascular set-up
Cell saver
Orthopedic External Fixation hardware

A 30 year old male is T-boned by a semi-truck in Red Deer and resuscitated in their emergency department where he is hemodynamically unstable. He has a right chest tube placed for decreased air entry in the right chest which drains 2 litres of blood. He has an open fractures of his femur and tibia with soft tissue loss of the popliteal fossae and a pulseless right leg. He is also comatose with a dilated right pupil, no movement to his left side and extensor posturing to his right.

As he continues to be unstable, he is transported by STARS and admitted directly into the RAPTOR for a RAPTOR resuscitation. In the RAPTOR he requires further vascular access and rapid diagnosis. An angiographic CT of the head, neck, chest, abdomen, pelvis, and vascular runoff of his femoral and popliteal vessels is required.

This angiographic CT reveals an epidural hematoma, a ruptured right diaphragm with herniated lacerated liver into which the chest tube has been placed. There are open comminuted fractures of the right femur, tibial, and fibula, with a transected popliteal artery.

He requires

- a) laparotomy and diaphragmatic repair and a damage control laparotomy
- a) Craniotomy and evacuation of the epidural hematoma
- b) Re-vascularization through a reversed saphenous vein bypass graft with completion angiography
- c) Orthopaedic stabilization of the “floating knee” with fluoroscopic control of the repair