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OBJECTIVES

The participant should recognize and be able to discuss:

Hemorrhagic shock and the diagnostic pathways for traumatic hemorrhage.

Anesthetic support of the trauma patient undergoing emergency surgery, including intravenous access, invasive monitoring, laboratory measurements, and transfusion therapy.

The pros and cons of deliberate hypotension for the patient with uncontrolled hemorrhage, including familiarity with the published evidence supporting this approach.

The anesthetic approaches to traumatic coagulopathy, including the use of recombinant Factor VIIa in desperate cases.

STEM CASE - KEY QUESTIONS

The time is 2 AM. You are the only anesthesiologist in-house at a large community hospital when you are paged to the Emergency Department for the imminent arrival of the seriously-injured victim of a motor vehicle collision. Radio report states that the patient is a 22 year old male who was the unbelted driver of a small car that left the road at a high rate of speed and impacted a tree. The patient is awake, intermittently combative, and complaining of chest, abdomen, and left leg pain.

EMS response, extrication from the vehicle, and transport to your facility have taken approximately 30 minutes. The patient is conscious on arrival, breathing spontaneously, and agitated. He appears to be intoxicated. He is following commands intermittently, and is able to move all extremities. Vital signs: Blood pressure 110/88 by automated cuff, heart rate 110, respiratory rate 25, oxygen saturation not obtainable. The trauma surgeon requests that you anesthetize and intubate the patient.

Key Question 1: What are the indications for emergency airway management in this patient?

Key Question 2: What medications are appropriate for induction of anesthesia?

FAST exam is positive for free fluid in the abdomen. Repeat blood pressure, following intubation, is 62/42. CXR shows a left-sided hemo-pneumothorax. The patient has an obvious left femur fracture, but further orthopedic work-up has not occurred. The surgeon posts the patient for immediate surgery.

Key Question 3: What are the indications for emergency trauma surgery?

Key Question 4: What are your goals for initial fluid resuscitation? What monitors or laboratory information will guide you?

The patient continues to be hypotensive following placement of a left tube thoracostomy and transport to the OR. Initial exploratory laparotomy reveals 2+ liters of free intraperitoneal blood,

with obvious lacerations of the spleen and liver. The surgeon packs the abdomen in all four quadrants.

Key Question 5: How can you best facilitate a damage control laparotomy?

Key Question 6: What is your plan for anesthesia during this case?

One hour after arrival in the OR the spleen has been removed and the splenic vessels ligated. Persistent hepatic bleeding is present despite packing with hemostatic materials, and the surgeon intends to leave the abdomen open and transport the patient to angiography. The patient has received 14 units of PRBC (including 6 uncrossmatched O+ units), 12 units of plasma, and a single pheresis unit of platelets. The patient continues to be hypotensive and volume dependent, and coagulopathic bleeding is observed from the surgical wound and needle puncture sites. The prothrombin time is 18.5 seconds.

Key Question 7: What are the options for achieving hemostasis, and what evidence is available in support?

Key Question 8: What happens to this patient?

PROBLEM BASED LEARNING DISCUSSION

I will organize the suggested discussion of this case around the key questions listed above.

What are the indications for emergency airway management in this patient? Trauma patients require emergency intubation for a number of reasons, including inadequate oxygenation or ventilation, aspiration, airway injury or hemorrhage, and decreased level of consciousness. Patients who are agitated or combative, but breathing well, present a particular challenge. In this case, there is sufficient evidence that the patient may have a serious injury (brain trauma or hemorrhage) that early intubation is appropriate, in order to speed diagnosis of any life-threatening condition and facilitate resuscitative care.

What medications are appropriate for induction of anesthesia? This question is a trick, in order to bring out a key teaching point. The induction agent used in a patient in hemorrhagic shock is less relevant than the dose administered and the fluid therapy provided. Even “cardiac friendly” agents such as etomidate or ketamine will precipitate a dramatic decrease in blood pressure in this patient if given at the normal intubating dose. I hope to discuss both the identification of risk factors in this patient’s case (the mechanism of injury, the physical findings, the vital signs) and the routine components of the emergency intubation following trauma (cricoid pressure, manual in-line cervical stabilization, multiple contingency plans).

What are the indications for emergency trauma surgery? It should be obvious that this patient needs to go to the OR (hypotensive + free fluid). Because an understanding of the surgical priorities is essential for good perioperative care, I plan to briefly review the OR indications for trauma patients, including the relative urgency of various conditions (brain decompression, hemorrhage, open fractures, etc.), and how to sequence diagnostic studies such as CT or MRI with therapeutic procedures.

What are your goals for initial fluid resuscitation? What monitors or laboratory information will guide you? I will begin this portion of the discussion with the basics from the ATLS manual: large bore IV access and crystalloid infusion. Participants will most likely identify the common supportive maneuvers of ordering blood products, keeping the patient warm, placing an arterial line, following electrolytes (especially calcium), and calling for cell salvage and/or rapid infusion support. If any of these points are missed I will make sure they are mentioned, and then move the conversation to discuss resuscitation in terms of the physiologic principles of tissue perfusion. This will involve discussion of the shortcomings of blood pressure as a guide to resuscitation, and the importance of following base deficit and/or lactate as markers for hypoperfusion.

How can you best facilitate a damage control laparotomy? In the patient with ongoing hemorrhage resuscitation must be both rapid and precise. I will extend the conversation from the prior question to talk about cutting edge material: deliberate hypotensive therapy (probably good), induced hypothermia (probably bad), deep anesthetic levels (no data, but interesting), and even suspended animation, if the conversation gets that far. The concept of maintaining a deep anesthetic level and a systolic pressure of 70mmHg during active hemorrhage is well supported in animal studies, but controversial in humans. We will review as much of this data as we can. The two large human trials to date are referenced.

What is your plan for anesthesia during this case? One question that the anesthesiologist must face in the bleeding patient is the need for anesthesia – or at least amnesia – during resuscitation and surgery. Without making this the focus of the discussion, I plan to review the trade-offs between anesthesia, sympathetic blockade, volume status, perfusion, and blood pressure, with particular reference to whichever agents are proposed by the participants. I will encourage the participants to think as much as possible of goals (amnesia, hemodynamic stability, analgesia) and physiology (vasoconstrictive responses to hemorrhage, drug effects on inotropy, pharmacologic half-life) in answering this question, so that it does not become a recommendation for any single drug or technique.

What are the options for improving hemostasis, and what evidence is available in support? The final question will lead inevitably to a discussion of recombinant human factor VIIa. Before getting there, I hope to have a reasonably complete review of the conventional hemostatic approach (surgery, angio, plasma, platelets, cryo, etc.), to emphasize that FVIIa is a last resort. That said, my center has the world's largest experience with this drug in trauma patients. Our early experience has been published (and is referenced), while other articles are in press. As time allows, we will discuss my own and the participants' experience with this novel agent, and I will offer my thoughts on future indications and applications.

What happens to this patient? I will conclude the case discussion with two scenarios: in one the patient dies of acute hemorrhagic shock with intractable coagulopathy, acidosis, and circulatory collapse, while in the other the patient miraculously survives as the result of damage control surgery, angiography, deliberate hypotension, and FVIIa. This case was deliberately written to be right on the razor's edge between these outcomes, and my final teaching point will be a "reality check" of likely results in this difficult patient population.

REFERENCES

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- Dutton RP, Mackenzie CF, Scalea TM. Hypotensive resuscitation during active hemorrhage: impact on in-hospital mortality. J Trauma 52: 1141-1146, 2002.
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LEARNING SUMMARY

Diagnosis of hemorrhagic shock.

Anesthetic support of the trauma patient undergoing emergency surgery.

Pros and cons of deliberate hypotension for the patient with uncontrolled hemorrhage.

Anesthetic approaches to traumatic coagulopathy, including the use of recombinant Factor VIIa.