

Scenario Overview

Summary

Mr Smith is a 59-year-old man undergoing a surgery in the sitting position for removal of a cervical spinal cord tumor. His medical history is unremarkable. He has no known drug allergies. His preoperative laboratory studies, chest radiograph, and electrocardiogram (EKG) were within normal limits.

Vital signs:

- Blood pressure (BP) 100/72
- Heart rate (HR) 78 beats per minute (bpm)
- Respiratory rate (RR) 18
- Peripheral capillary oxygen saturation (SPO₂) 99%
- End-tidal carbon dioxide (ETCO₂) 35
- Temperature 37° C (98.6° F)

The scenario begins three hours after induction of general anesthesia with endotracheal tube (ETT).

Setting

Simulation operating room (OR) or OR not in use.

Time

Pre-brief: 5 minutes
Simulation: 10 minutes
Debrief: 20 minutes

Participants

Multidisciplinary team
Embedded simulation personnel (ESP)
Surgeon or ESP
First assistant (RN or MD) or ESP
Anesthesiologist or ESP
Certified registered nurse anesthetist (CRNA)
RN circulator
Scrub person
Nurse assistant or perioperative care technician

Potential Systems Explored

- Roles of the perioperative team members during a VAE event
- Supporting technical and developmental skills
- Interprofessional training in communication and professionalism

Learning Objectives

1. The learner will recognize the initial signs and symptoms of VAE in a surgical patient.
2. The learner will identify the appropriate treatment for a patient having a VAE in the OR.
3. The learner will demonstrate interprofessional communication and professionalism with respectful interactions.

Participant Preparation

Pre-Simulation

- Read the article: Mirski MA, Lele AV, Fitzsimmons L, Toung TJ. Diagnosis and treatment of vascular air embolism. *Anesthesiology*. 2007;106(1): 164-177. doi:00000542-200701000-00026
- Review the crisis checklist on Air Embolism – Venous. The OR crisis checklists are available at no charge with registration at <http://www.projectcheck.org/crisis-checklist-download.html>
- Review the facility policy on managing VAE events.
- Review contents of the emergency cart.

Standard Introduction

1. Sign in and obtain participant consents for video or research, if necessary
2. Have participants introduce themselves
 - a. Specialty
 - b. Experience and role
 - c. Something personal
3. Orient participants to simulation process
 - a. Briefing
 - b. Case (simulation)
 - c. Debriefing-Discuss and review what went well and where there are opportunities for improvement
 - d. Feedback and closing
4. Discuss course objectives
5. Describe learning environment
 - a. Simulation is a safe and confidential learning environment
 - b. Acknowledge anxiety
 - c. Assure confidentiality of participants performance and case
 - d. Obtain buy-in for simulation activities. Treat as a real-life situation, given the limitations of working with a mannequin, simulated medications, etc.
 - Treat this patient as if it was your perioperative patient.
 - Inject medications as usual
 - e. You will be video recorded for purposes of debriefing. The video will be destroyed/deleted per the simulation lab guidelines.
6. Discuss expectations of participants
 - a. Clinical role (be yourself)
 - b. Assure participants that the embedded simulation people are there to help them and there are no tricks.
 - c. Agree on a code word for a real event (Simulation will end immediately)
7. Identify equipment that is live or partially functional and explain any related safety issues
 - a. Mannequin
 - b. Defibrillators/emergency equipment
 - c. Electrosurgical units
 - d. Cameras
 - e. Vital signs displayed on monitoring devices
 - f. Phone list
 - g. Documentation
8. Orient participants to patient situation and assumed roles; provide role cards if applicable
 - a. "It is 10:00 am on a Thursday and you are taking care of a patient with..."
 - b. "Your table is set up and all items have been counted..."
 - c. "You will start with conducting a time out...."
9. Ask participants if there are any questions before beginning
 - a. Answer any additional questions/clarify shared mental model
 - b. Announce that the simulation is starting

Set-up

Room

- Simulation operating room (OR) or OR not in use
- Post a door sign with preoperative information and the history & physical

Equipment

OR table with neuro headrest sitting position equipment

Mannequin

Identification band for the mannequin

IV solution and tubing

2 L IV fluid

Back table basic set up including

- lap sponges
- 1 L normal saline for irrigation in labeled basin
- Irrigation bulb syringe, labeled
- bone wax
- hemostatic clips
- luer-lock syringe

Mayo stand basic set up

Electrosurgical unit

Emergency cart (will be requested by the team)

Anesthesia machine equipped with

- O₂
- Suction
- bag valve mask
- cardiac monitor
- 20 mL syringe

Medications*

Vasopressin 40 units IV

**Consider the simulation environment when preparing medications. Be sure that all medications are clearly labeled and identified as simulated if applicable. Simulated medications should not be available in any patient care areas.*

Simulator Preparation

Mannequin

- Intubate with an ETT
- Place central line in left subclavian vein
- Place IV in right arm
- Drape in the sitting position with suction and electrosurgical active electrode (in holster) in place at the surgical field

Sequence of Events

The patient has been in the OR for three hours. A left subclavian central line is in place.

Vital signs

BP 120/72

HR 78 bpm

RR 18

SPO₂ 99%

ETCO₂ 35

Temperature 37° C (98.6° F)

The anesthesia professional states, “The patient’s ETCO₂ and SPO₂ have dropped to 30 and 88% and he is hypotensive at 86/40. He might have an air embolism.”

- The RN circulator should move to head of bed.
- Call for help and the emergency cart.
- Administer 100% oxygen (O₂) at high flow (10 L/minute).
- Stop nitrous oxide anesthetic.
- Ask the surgeon to fill surgical field with irrigation or cover the surgical field with saline-soaked sponges.
- Place the patient in left lateral and Trendelenburg position (surgical site lowered below the level of heart).
- Attempt to aspirate entrained air from the right atrium.
- Initiate chest compressions with the patient in supine and Trendelenburg position.
- Begin IV fluid resuscitation with 1 L normal saline.
- Administer vasopressin (40 units IV).
- Obtain additional IV access if required.
- Apply intermittent bilateral jugular venous compression.
- Call for transesophageal echocardiography (TEE)

Sequence of Events

Skills Assessment - VAE

**Continue with the simulation until the following actions/treatments are completed.
Treatment action time points are referenced from time of crisis announcement**

Action/Treatment Checklist	Time	Skill met	Skill not met
Announces crisis			
Calls for help and the emergency cart within 3 minutes			
Increases O ₂ to 100% within 3 minutes			
Stops nitrous oxide anesthetic within 3 minutes			
Asks the surgeon to fill the surgical field with irrigation or cover the surgical field with saline-soaked sponges within 5 minutes			
Places patient in left lateral and Trendelenburg position			
Attempts to aspirate entrained air from the right atrium			
Initiates chest compressions with the patient in supine and Trendelenburg position			
Begins IV fluid resuscitation with 1 L normal saline			
Prepares vasopressin (40 units IV)			
Applies intermittent bilateral jugular compression			

Debrief

Begin debriefing by soliciting the participant's reactions to the simulation experience.
Clarify with the team the patient situation so that everyone is on the same page.

Clarify confidentiality and expectations.

Review the learning objectives.

Discuss what happened in the simulation.

Review what went well.

Consider opportunities for improvement.

Encourage expression of reactions.

Ask participants:

- "How did participating in this simulation make you feel?"
- "Describe your thinking when...?"
- "Were there performance gaps?"
- "What could be changed in the OR?"

Review the participant's roles and team expectations.

Review principles of effective interprofessional teamwork.

Review expectations for effective communication.

Discuss appropriate post-event actions:

- Consider keeping the patient intubated and sedated.
- Monitor the patient for 24 hours post-recovery.

Identify learner issues.

Resources

VAE Pre/Post Test

1. Venous air embolism (VAE) occurs when air or gas is drawn into the circulation by the veins above the level of the heart.
 - a. True
 - b. False
2. VAE is most likely to occur during neurosurgery or open shoulder surgery in the sitting or semi-sitting position.
 - a. True
 - b. False
3. If not diagnosed and treated immediately, VAE can be fatal.
 - a. True
 - b. False
4. The goal of VAE management is to prevent further air entry, reduce the volume of entrained air, and provide hemodynamic support.
 - a. True
 - b. False
5. Filling the surgical field with saline or covering the surgical field with saline-soaked sponges helps to prevent further entrainment of air.
 - a. True
 - b. False
6. Moving the patient into a left lateral and Trendelenburg position may help prevent air from traveling through the right side of the heart into the pulmonary arteries.
 - a. True
 - b. False
7. Initiating cardiac compressions helps break large bubbles into smaller ones and forces air out of the right ventricle into the pulmonary vessels, thus improving cardiac output.
 - a. True
 - b. False
8. Infusion of IV fluids optimizes myocardial perfusion and helps push the blocked airlock into the lungs where it can be absorbed.
 - a. True
 - b. False
9. Administration of vasopressors supports force and speed of ventricular contractions.
 - a. True
 - b. False
10. Applying jugular compression may be effective in limiting the entry of air into the chest and right atrium from sources in the face and head by increasing venous pressure; however, increased intracranial pressure and subsequent decreased cerebral perfusion may be a direct consequence of this technique.
 - a. True
 - b. False

Resources

VAE Test Answers

1. T
2. T
3. T
4. T
5. T
6. T
7. T
8. T
9. T
10. T

Acknowledgments

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Special thanks to members of the 2016 Simulation Task Force for their assistance in the development of this simulation scenario.