

A Multifaceted Approach to Improving Radiology Resident Proficiency in Managing Acute Adverse Reactions to Intravenous Contrast Administration

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Background

- A wide spectrum of adverse reactions to intravenous contrast media is encountered in the daily practice of radiology
 - Adverse reactions for low-osmolar IV media occur at rate of 0.2-0.7%¹
 - Per the ACR Contrast Media Guidelines², ongoing quality assurance and quality improvement program for all radiologists is recommended
- Highly variable training models for radiology residents in managing these reactions
- Prior to 2014 at our institution (UT Houston Radiology Department), the model being used consisted of one noon conference lecture with a quiz on contrast allergies
- PDSA- cycle performed from a committee of rising second year residents (Class of 2018), and multifaceted intervention was developed

¹Beckett KR, Moriarty AK, Langer JL. Safe Use of Contrast Media: What the Radiologist Needs to Know. RadioGraphics 2015 35:6, 1738-1750.

²ACR Manual on Contrast Media v 10.3. Accessed 15 October 2018. https://www.acr.org/-/media/ACR/Files/Clinical-Resources/Contrast_Media.pdf.

Objectives

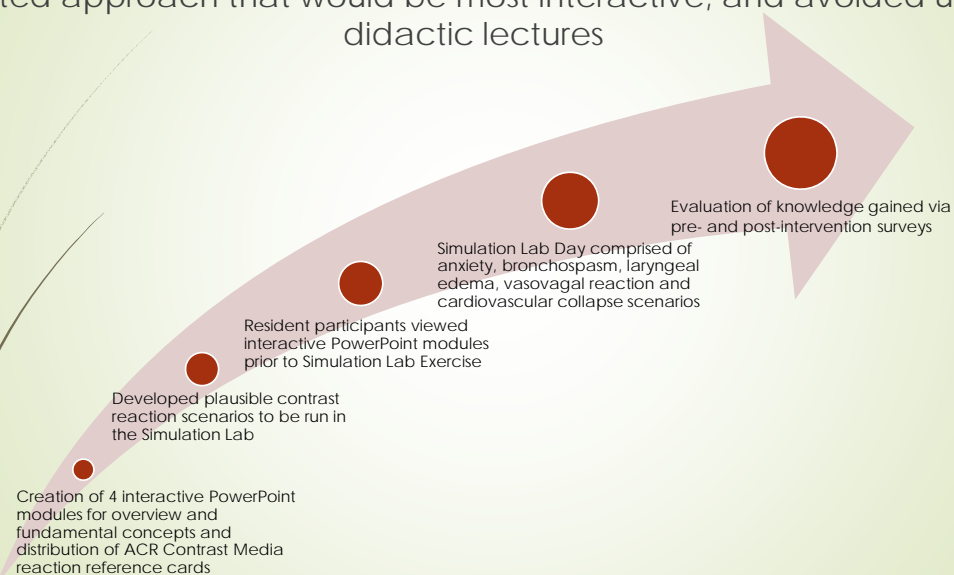
- ▶ IOM* aims addressed
 - ▶ **Safe:** Avoiding harm to patients from the care that is intended to help them
 - ▶ **Patient-centered:** Providing care that is respectful of and responsive to individual patient preferences, needs, and values and ensuring that patient values guide all clinical decisions
 - ▶ **Timely:** Reducing waits and sometimes harmful delays for both those who receive and those who give care
- ▶ ACGME Competencies* addressed
 - ▶ Practice-Based Learning and Improvement
 - ▶ Patient Care and Procedural Skills
 - ▶ Systems-Based Practice
 - ▶ Medical Knowledge
 - ▶ Interpersonal and Communication Skills
 - ▶ Professionalism

*Agency for Healthcare Research and Quality: The Six Domains of Health Care Quality
<https://www.ahrq.gov/professionals/quality-patient-safety/makingquality/create/sixdomains.html> Accessed 15 October 2018.

*The Accreditation Council for Graduate Medical Education and The American Board of Radiology. <https://www.acgme.org/Portals/0/PDFs/Milestones/DiagnosticRadiologyMilestones.pdf> Accessed 15 October 2018.

Intervention

- ▶ Created approach that would be most interactive, and avoided use of didactic lectures



Bronchospasm Scenario

Manikin person

Initial vitals:
HR 102
SpO2: 97
BP 120/80
RR 26

Have manikin wheeze

Clinical Scenario Person

"Mrs. Jones is a 44 year old female with no significant past medical history, who presents to OPID on Fannin on Friday evening for a scheduled CT scan. Halfway during your moonlighting shift, the technician comes to inform you that Mrs. Jones is experiencing shortness of breath and chest tightness. You rush to the room."

RESIDENT MUST (by speaking to pt & reviewing VS):
-Recognize **mild bronchospasm** (tachypnea, expiratory wheezing, but no hypoxia or pronounced dyspnea)

RESIDENT ACTIONS:
-Give **oxygen** 6-10L/min (via mask/NC)
-Obtain **EKG** (get **AED heart monitor**)
-Preserve **IV access**
-Give **beta-agonist inhalers** such as such as albuterol (Proventil®/Ventolin®) 2-3 puffs (90 mcg/puff); repeat as needed up to 3 times.
-**Monitor** pt: Continued physical observation, BP & SaO2
- Depending on your clinical observation, consider calling Rapid Response or 911.

30 minutes later

New vitals:
HR 105
SpO2: 87
BP 95/65
RR 32

Have manikin wheeze and cough

Turn manikin lips blue

Pt cannot speak in complete sentences, worse wheezing/coughing

RESIDENT MUST:
-Recognize **moderate-severe bronchospasm** (worsened dyspnea, hypoxia, worsened wheezing with coughing)

RESIDENT ACTIONS:
-Add **Epinephrine IM (1:1,000) 0.1-0.3 ml (=0.1-0.3 mg)**.

- If pt is <30 kg (66lb) max single dose is 0.15mg (1.5ml)
- If >66lbs, max single dose is 0.3mg (3.0ml).
- ** Epipen is an IM 1:1000 dilution.

 - If **hypotensive, Epinephrine (1:10,000) slowly IV 1 ml (=0.1 mg)** into a running IV saline infusion. Can repeat every 5-10 minutes, up to 1 mg total dose.
 - **Call for assistance**, call 911 to transport patient to ED

Yes or No | **Critical Scenario Steps**

	Initial vitals obtained, specifically:
	Pulse checked
	BP Cuff placed
	O2 monitor placed
	Cardiac monitor placed
	Resident recognizes mild bronchospasm
	O2 mask applied at 6-10L
	Albuterol given
	Continued monitoring occurs
	Resident recognizes moderate-severe bronchospasm
	Epinephrine added at correct dose, correct route (NOT IV PUSH)
	Call for assistance occurs

Post Scenario Debrief Questions:

- What reaction did this patient have?
 - Mild bronchospasm, then moderate-severe bronchospasm
- How do you tell **mild** from **moderate-severe** bronchospasm?
 - Tachypnea, expiratory wheezing, but no hypoxia or pronounced dyspnea for mild. **Hypoxia** and pronounced dyspnea for moderate-severe.
- Is IM Epinephrine 1:1000 or 1:10,000?
 - 1:1000
- What is the maximum **single** dose of IM Epinephrine?
 - 1.5mL if < 30kg (66lbs)
 - 3.0mL if >30 kg (66lbs)
- Besides activating emergency teams, what can you do if the **pt** becomes hypotensive as well as hypoxic?
 - Start IV Epinephrine **1:10,000 slowly IV**, 1ml in a **running IV** saline infusion (1ml = 0.1mg). Can continue up to 1mg total dose.

Severe Contrast Reaction Case Scenario

Manikin person

Have manikin groan

Initial vitals (when ordered):
HR: 100
SpO2: 92%
BP: 110/72
RR: 25
T: 97 F

Set manikin lungs to sound clear

Clinical Scenario Person

"Mrs. Rare is a 65 year old female who arrives for a routine CT of the abdomen and pelvis for occult hematuria discovered 2 weeks ago. She has had prior CT examinations with IV contrast.

You are called approximately 5 minutes after the administration of contrast for pt complaining of discomfort and feeling "strange and lightheaded".

Patient history (provide if resident asks):
PMH: HTN, HLD, osteoporosis. Prior cholecystectomy many years ago.
Meds: Amlodipine, atenolol, atorvastatin, vitamin D and calcium supplements
Allergies: NKDA.

Patient status: Patient is resting supine. She says: "I feel lightheaded. I'm not sure what is going on. Also, my hands and feet feel warm"

RESIDENT ACTIONS:

- Order vitals.
- Physical examination:
When resident listens to lungs, prompt that the lungs are clear. Heart has 1/6 systolic murmur.
When resident asks questions, clinical scenario person responds with clear answers (eg is AAU x 3).
The pt has no detectable urticaria.
- Place oxygen by mask
- Review vitals
- Order cardiac monitor to be placed

New vitals:
HR: 125
SpO2: 88%
BP: 80/22
RR: 25

Blood pressure raises slightly if IV fluids are started, otherwise no change

New vitals:
HR: 100
SpO2: 70%
BP: 60/32
RR: 8

Show asystole

It's approximately 3 mins later. Pt is less responsive. She says "My hands feel... I can't..."

Pt is no longer responding, except to loud voice. Extremities flushed, pulses weaker on exam

RESIDENT ACTIONS:

- Recheck vitals
- Elevate legs by 60 degrees
- Confirm IV access
- Start IV fluids (1L NS or lactated ringers)
- Give 1ml of 1:10,000 Epinephrine slowly with IVF
- At TWC OPID: Call Rapid Response team. At Upper Kirby or Bellair: Call 911 (but all help will be far away for now)

It's approximately 6 minutes after the initial encounter Pt unresponsive. All extremities pale on exam

RESIDENT ACTIONS: Recheck vitals and exam

"Pulses have just become non-palpable"

RESIDENT ACTIONS: Recheck vitals and cardiac monitor

RESIDENT ACTIONS:

- Start ACLS: chest compressions 30:2 (or bag x 5 rounds
- Give another Epinephrine 1:10,000 1mg IV
- Keep on cardiac monitor, repeat vitals
- Intubate
- Continue until pulses return, code team, RRT or EMTs arrive. If pulses return, continue IVF

END SCENARIO/Debriefing:

Students must recognize

- Severe anaphylactic contrast reaction with hypotension and tachycardia
- Severe contrast reaction proceeding to asystole
- Initial management of severe contrast reaction including: Confirming IV access, monitor vitals, pulse oximeter, O2 by mask, Elevate legs by 60 degrees, Consider IV fluids 1,000 ml rapidly of 0.9% normal saline or Lactated Ringers
- Basic ACLS protocol for asystole: Call code/911, initiate chest compressions, continuing monitoring of electrical rhythm, epinephrine 1mg IV
- Post-resuscitation management and disposition

Figure 2: Pre and Post Objective Knowledge Test

Objective Questions:

1. A 48-year-old woman complains of some "itching" of her arms after a CT Chest with contrast. Initial vital signs are within normal limits; which of the following is the best treatment option?
 - a. Benadryl 50mg PO
 - b. Epinephrine (1:1,000) 0.3 ml IV
 - c. Hydroxyzine (25mg)
 - d. Prednisone 50mg PO
2. After 20-minutes, the patient begins complaining of a cough/throat tightness. After examining the patient again, you notice some facial/laryngeal edema. Which of the following is/are the best treatment option(s)?
 - a. O2 by mask
 - b. Albuterol 2 puffs (90mcg/puff)
 - c. Atropine 1 mg IV
 - d. Epinephrine (1:10,000) 3 ml. IV
 - e. A and D
3. A 52-year-old male with no significant past medical history develops severe hypotension and tachycardia after administration of IV contrast material. The nurse calls you after she notices that patient begins to look "pale"; what of the following is/are the best treatment option(s)?
 - a. Atropine 1 mg IV
 - b. Labetalol 20 mg IV
 - c. Hydrocortisone 200mg IV
 - d. Epinephrine (1:10,000) 3 ml. IV
 - e. A and D
4. A healthy 63-year-old male begins feeling nauseous and "drowsy" after his CT Abd./Pelvis contrast. Initial vital signs are: BP: 110/80, HR: 45 bpm, RR: 18. What is the best treatment option?
 - a. Epinephrine (1:10,000) 3 ml. IV
 - b. Atropine 1.0mg IV
 - c. Careful Observation
 - d. Adenosine 10mg IV
5. A 28-year-old female complains of some vague "chest tightness" after her CT. Her physical exam is negative except for some wheezing. What is the next best treatment option(s)?
 - a. Nitroglycerin 0.4 mg tablet SL
 - b. Albuterol 2 puffs (90mcg/puff)
 - c. Labetalol 20 mg IV
 - d. Epinephrine (1:1,000) 0.3 ml. IM
 - e. B and D
6. The treatment of angina following systemic contrast injection includes which of the following:
 - a. Atropine 1.0 mg IV
 - b. Nitroglycerin 0.4 mg tablet SL
 - c. O2 by mask
 - d. Epinephrine (1:10,000) 3 ml. IV
 - e. EKG
7. CT technologist calls to inform you that the "IV malfunctioned"; correct treatment of contrast infiltration includes which of the following?
 - a. Removal of jewelry
 - b. Careful observation
 - c. Warm/Cold compresses
 - d. Compression and spread of contrast
 - e. Elevation
 - f. Phlebotomy
8. A patient calls you and states that his doctor ordered a CT Neck with contrast, but he is concerned about receiving iodinated contrast, because of a skin reaction he had when his doctor used Betadine. The doctor's nurse told him that he had a reaction to the iodine in the solution. What is the next best plan of action?
 - a. Cancel the exam and contact the ordering provider
 - b. Continue the exam without IV Contrast
 - c. Continue the exam as ordered
 - d. Pre-medicate the patient with IV steroids
9. Who should you call for a life threatening reaction at OPID (Outpatient Imaging Center)?
 - a. Code Blue
 - b. Rapid Response
 - c. Attending on call
 - d. 911
10. Patient Terry Fide asks the nurse to page you to ask about contrast reactions. When you arrive, she asks what time range the most severe reactions occur in. The best answer is:
 - a. Within the first 24 hours
 - b. Within the first 4 hours
 - c. Within the first week
 - d. Within the first 30 minutes
 - e. Usually after the attending has left for the day.

Post-intervention analysis Version 1.1

Pilot Group: July 2015

- Mean comfort level in the pilot group scored on a scale of 1-10 (1: not prepared at all for any adverse event due to use of intravenous contrast; 10: very well prepared for any adverse event)
 - Pre-intervention, the residents rated their comfort level at an average 4.9
 - Post-intervention, the residents rated their comfort level at an average 7.5
- Analysis of pre and post-intervention test consisting of ten questions
 - an improvement in knowledge in 7 of the participants
 - no change in 4 participants
 - decrease in score (by one point) in 2 participants

Version 1.2 from two subsequent classes

- Mean comfort level in two subsequent classes (n=25) to undergo training group was scored on a scale of 1-10 (1: not prepared at all for any adverse event due to use of intravenous contrast; 10: very well prepared for any adverse event)
 - Pre-intervention, the residents rated their comfort level at an average 4.2
 - Post-intervention, the residents rated their comfort level at an average 7.9
- Analysis of pre and post-intervention test consisting of ten questions demonstrated:
 - an improvement in knowledge in 14 of the participants
 - no change in 10 participants
 - decrease in score (by one point) in 1 participant

Discussion

- Modules, simulation lab and reference cards were well received by the residents
 - “Flipped classroom” model- participants benefitted by preparing for Simulation Lab Day with modules beforehand
 - Subjective feedback overwhelmingly positive for both modules and Simulations
- We were able to objectively demonstrate improvement in knowledge in 62% of residents from pre to post-intervention test over four years of implementation
- This new curriculum has been integrated into the training provided to new first year radiology residents at our institution
- Future plans include revising scenarios based on participant feedback, possibly expanding to faculty based upon interest, and evaluating how often re-training should be considered during residency

