Acute Contrast Reactions: Rapid Identification, Appropriate Response, and Potential Pitfalls

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Objectives-

• Review types and incidences of adverse contrast reactions
• How to identify, treat, and manage reactions
• Review errors and pitfalls
• Discuss benefits of simulation training and other learning aids

Gad agents and reactions

• Overall=0.09%
  • 0.015-0.16% for any type of reaction
  • Severe=0.005%
• 81% (539 of 662) were mild, 13% (86 of 662) were moderate, and 6% (37 of 662) were severe reactions.

Mild Contrast Reactions 75-90%

Allergic-Like
• Limited urticaria/pruritis
• Limited cutaneous edema
• Limited itchy/scratchy throat
• Nasal congestion/rhinorrhea
• Conjunctivitis

Physiologic
• Limited nausea/vomiting
• Transient flushing/warmth
• Headache/dizziness/anxiety
• Altered taste
• Mild hypertension
• Spontaneously resolving vasovagal

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Mild Contrast Reactions

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Management</th>
<th>Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limited Urticaria / Pruritus</td>
<td>If symptomatic, Diphenhydramine 25-50mg can be offered to those driving home.</td>
<td>Foxphenadine 180mg PO can be offered to those driving home.</td>
</tr>
<tr>
<td>Limited Cutaneous Erythema</td>
<td>No treatment necessary</td>
<td>Outline erythema to monitor possible progression.</td>
</tr>
<tr>
<td>Nasal Congestion/Sneezing/ Conjunctivitis</td>
<td>Usually self-limited</td>
<td>If needed, can offer Diphenhydramine or Fexofenadine.</td>
</tr>
<tr>
<td>Nausea / Vomiting</td>
<td>4mg IV Ondanestrile, if needed.</td>
<td>Physiologic reaction.</td>
</tr>
</tbody>
</table>

Risk factors for adverse event

- Prior reaction to agent is most important RF
  - up to 5x higher risk than general population
  - 10-35% of high risk pts WITHOUT premedication will develop repeat reaction
  - 10% will develop "breakthrough" reaction WITH premedication

- Other RF's are known to increase risk slightly, but not enough to warrant added steps
  - Atopy, asthma

Should we pre-medicate?

- Data supports use for low and moderate type reactions
  - Similar break-through reaction possible
  - Associated with increased costs, length of stay and delays

- High number to treat to prevent one severe reaction (n=569)

Should we pre-medicate or just switch to another LOCM?

Initial Assessment

1. Upon entering the room
   - Ask technologist what the scan was for and course of events
   - Hook to monitor

2. Obtain quick medical history from patient, if possible:
   - Any prior issues with reactions? Current symptoms
   - Quick medical history
   - Medications taken earlier in the day (SSRIs/BHC)?

3. Targeted Physical Exam
   - Inspect oropharynx and airway
   - Listen to lungs
   - Survey skin for hives

4. While assessing the situation:
   - Grab contrast reaction kit
   - Administer oxygen if appropriate
   - Ensure IV access is still available
   - Move the patient out of room if possible (very important with MRI)
   - Activate "code team" or 911/EMS

Yale Current Policy

For Planned Administration of Contrast Agents:
- Previous reaction to allergens (eg shellfish, peanuts, medications etc.):
  - Mild None
  - Moderate None

- Previous reaction to same class of contrast agent going to be given:
  - Mild (Including hives/facial swelling/itching): Moderately (including hives/facial swelling/itching): Pre-medicate and use different agent.
  - Severe Don't give contrast.

- Previous reaction to a different class of Contrast agent than type to be given:
  - Mild
  - Moderate
  - Severe

- Switch agent to alternative LOCM and GBCA if prior agent is known.
**Where do errors occur?**

- Utilization of epinephrine
  - Ex: bypassing albuterol for bronchospasm in otherwise stable patient
- Form of epinephrine - IM vs IV
- Dose of epinephrine
- Administration of epinephrine
  - Location, rate, technique

**This medication is designed for**

- 1. IV use
- 2. IM use
- 3. No Clue

**This medication is designed for**

- 1. IV use
- 2. IM use
- 3. No Clue

**This medication is designed for?**

- 1. IV use
- 2. IM use
- 3. No clue

**This medication is designed for?**

- 1. IV use
- 2. IM use
- 3. No clue

**Pitfall 1**

SOB, chest tight, tongue feels funny
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Rapid Identification, Appropriate Response & Pitfalls
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Moderate Contrast Reactions
10-20%

<table>
<thead>
<tr>
<th>Allergic-like</th>
<th>Physiologic</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Diffuse urticaria/pruritus</td>
<td>• Protracted nausea/vomiting</td>
</tr>
<tr>
<td>• Diffuse erythema</td>
<td>• Hypertensive urgency</td>
</tr>
<tr>
<td>• Facial edema (No dyspnea)</td>
<td>• Chest pain</td>
</tr>
<tr>
<td>• Throat tightness/hoarseness</td>
<td>• Vasovagal responsive to</td>
</tr>
<tr>
<td>• Wheezing/bronchospasm</td>
<td>treatment</td>
</tr>
<tr>
<td>(mild hypoxia)</td>
<td></td>
</tr>
</tbody>
</table>

- Almost always require intervention
- May progress if not appropriately treated

How bad are we?

• Surveys
  • 16-50% of radiologists know proper dose of IM epinephrine

Intramuscular (IM) Epinephrine Administration

• Vial has 1mg of drug in 1ml solution
  • Adults 0.3ml (<0.3mg)
  • Peds 0.15ml (<0.15mg)
  • 15-30kg (33-66lbs)

• Concentration is 1:1000

Pitfalls with IM Epinephrine vials

• Wrong route
  • Given IV instead of IM
    • 1mg IV = 100x overdose
      • expect MI, arrhythmia, stroke (...and lawsuit)
    • Prevalence - 2.5% in ED, 8-10% in Radiology

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Pitfalls with IM Epinephrine vials
• If I can leave with one teaching point it is this one
• Giving 1:1,000 concentration Epinephrine intravenously has the potential for terrible consequences!!
  • This a true NEVER EVENT

Pitfalls with IM Epinephrine vials
• Right route but wrong dose
  • Because vial is 1mg...everything drawn up and given IM
    • 3x overdose
• Right route and right dose but wrong location
  • Anterolateral thigh preferred location due to best absorption
  • Given SubQ instead of IM
  • Slower absorption
  • In obese pts. IM may not be possible
  
  Asch et al. AJR 2017
  Wang et al. Abdominal Imaging 2014

Pitfall 2
• HR=110
  O2 sat=90%
  R=35
  BP=87/69

How bad are we?
• Surveys
  • 29-39% know proper dose and rate of IV epinephrine

Severe Contrast Reactions <1%

<table>
<thead>
<tr>
<th>Allergic-Like</th>
<th>Physiologic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diffuse facial edema with dyspnea</td>
<td>Vasovagal refractory to treatment</td>
</tr>
<tr>
<td>Diffuse erythema with hypotension</td>
<td>Arrhythmia</td>
</tr>
<tr>
<td>Laryngeal edema/Stridor and hypoxia</td>
<td>Seizure</td>
</tr>
<tr>
<td>Bronchospasm with severe hypoxia</td>
<td>Hypertensive emergency</td>
</tr>
<tr>
<td>Anaphylactoid shock (Hypotensive/tachycardic)</td>
<td>Pulmonary edema</td>
</tr>
</tbody>
</table>

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Intravenous (IV) Epinephrine Administration

- **Dosage**
  - Adults: 1-3 ml (0.1-0.3 mg)
  - Peds: 0.1 ml/kg

- Give as slow push with flush (over 1-2 minutes) or into running saline

- Only recommended in patients with shock

- Dose can be repeated up to 1 mg total

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Pitfalls with IV Epinephrine

- **Wrong Dose**
  - Entire 1 mg (10 ml) given
  - DO NOT do this in a patient who still has a pulse (cardiac arrest dose)
  - Common error with code teams responding to reactions

- **Wrong clinical presentation**
  - Reserve this for anaphylaxis with symptoms of shock

- **Wrong Route**
  - Given IM or SubQ
  - 1:10,000 only used for IV administration

- **Right dose wrong rate of administration**
  - When given as rapid IV push creates catecholamine surge
  - Arrhythmia, rapid rise in BP
  - Always flush
  - 0.15-0.3 ml dead space in IV tubing

- **Opening the box**—medical engineering at its best

  - Top of box - where a normal human would try to open medication
  - Bottom of box - where you are actually supposed to open this medication

- **Pitfall 3**
  - *Scratchy throat. Wheezing. Mild tongue edema*
How can we decrease errors?

- Automated injectors
  - Pre-loaded with 0.3mg (adult) or 0.15 mg (pediatric) doses
  - Essentially impossible to give IV
  - Benefits
    - Cut times to administration- 109s vs 39s
    - Cut error rate
    - Improves provider comfort
  - BUT.........about 100x cost

Asch et al. AJR 2017

EpiPen Administration

Self-administration of Epi

- “White thumb”
  - 15,190 unintentional injections reported to US Poison Control Centers (1994-2007)
  - Doctors (Rads and Non-rads) can be equally as dumb
  - 16-22% of physicians tested would have injected own thumb

Gardner et al. AJR In Press

Pharmacists See National U.S. Epinephrine Shortage, Non-Profit Calls for Government Action

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Anaphylactoid reaction guidelines

- Steroids and Antihistamines
  - DO NOT wait too long with these!
  - Administer under the supervision of an allergist or emergency medicine specialist
- Prompt and early use of IM epinephrine (with fluids) is key
  - NO contra-indications
  - Sys. ± HR, BP, etc
  - Mean time to death
  - 30 minutes food
  - 15 minutes vomiting
  - 5 minutes anaphylaxis
  - Helps decrease change of biphasic (after 72 hour) reaction
- What about child under 15kg
  - No data driven answer but recommendations are to use 0.15 mg IM epine

Lieberman et al. Aen Allergy Asthma Immunol 2015
Lee et al. J Allergy Clin Immunol Pract 2017

What about mimics of reactions?

You are called to evaluate an unresponsive patient that just had a CT with IV contrast. The patient is unresponsive, appears pale and is diaphoretic. The technologist reports the patient vocalized feeling warm during the scan. The vitals are HR 48, BP 80/40, 100% O2 saturation. Physical exam is unremarkable.

Diagnosis? Anaphylactoid Shock Vasovagal Reaction

Key Points
- A patient with anaphylactoid shock will demonstrate tachycardia, not bradycardia
- Vasovagal reactions have a characteristic prodrome of nausea, palor, and diaphoresis
- Correct management is supportive including elevating the legs and administering IV fluid. If refractory, Atropine 0.5-1 mg slowly can be administered

Summary of Potential Contrast Reactions Mimics

<table>
<thead>
<tr>
<th>Reaction</th>
<th>Key Points / Differentiating Clues</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypoallergia</td>
<td>Often have previous mumps/dissease or viral. Diaphoresis, history of diabetes. Tends requiring NPO status. No pruritic, angioedema or wheezing.</td>
<td>Finger stick to confirm Oral glucose if possible, 15g oral sugar Oral glucagon IM glucagon 1mg NPO in severe cases</td>
</tr>
<tr>
<td>Vasovagal</td>
<td>Hypersensitive with diaphoresis. Nausea and vomiting common. Characteristic prodrome. No pruritic, angioedema or wheezing.</td>
<td>Lay patient down. Lift legs up. IV fluids. IV Atropine 0.5-1 mg in severe cases</td>
</tr>
<tr>
<td>Acute Cardiogenic</td>
<td>Significant cardiac history. Complaints of chest pain radiating to amnych without wheezing. SUG changes on vital signs.</td>
<td>Call for assistance and begin ACLS protocol</td>
</tr>
<tr>
<td>Pulmonary Edema</td>
<td>Can occur due to contrast load in susceptible patients. Depends on the absence of other systemic symptoms. Position dependent. Oxygen on Physical exam.</td>
<td>O2 saturation IV furosemide 20-40mg</td>
</tr>
<tr>
<td>Venous Air Embolism</td>
<td>Look of systemic anaphylactic syndrome. No response to abx. Consult imaging to confirm diagnosis.</td>
<td>Left lateral Decubitus position 100% O2 administration.</td>
</tr>
</tbody>
</table>

How can we decrease errors?

- **Visual Aides**
  - Reactions are high stress events prone to errors and panic
- **Cut need for recalling doses**
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Yale “ID size” two-sided cards

Yale Flow Chart
- Increases provider comfort
- Decreases time to Epi administration
- Can help cut rate of errors

Gardner et al. AJR. In press

www.acr.org/contrast

Apps and sites

Create standardized contrast Kit
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Simulation training to prevent errors

“Experience is a hard teacher. It gives the test first and lesson later.”

Why simulation?

• Benefits for the individual
  • Safe protected environment without harm to pts
  • Allows repeat exposure to rare events (like severe contrast rxns)
  • Customizable for person, department, scenarios
  • 6 week retention rate
    • Reading/hearing-10%-20%
    • Simulation 80%

Why simulation?

• Benefits for the institution/dept.
  • Team based learning
  • Inter-professional training

Why simulation?

• New way to learn
  • Debriefing
    • Heart and sole of simulation training
      • Allow reflection of events, positives/negatives, and then re-enforce appropriate response and algorithm
      • Identify the performance gap
    • Proper training is key to lead successful simulation training
      • Train the trainer

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Low vs high fidelity simulation

- “Fidelity” - degree to which simulation matches actual experience, and level to which skills in the real task are captured in the simulated task
- The office teaches us how to utilize low fidelity simulation

-26 Residents - Simulation to treat contrast reactions, tension ptx, hemorrhage after Bx
- Significant improvement in pre and post test scores

- n=44 (23 trainees and 21 attending s) split into computer simulation vs. high fidelity
- No difference b/w groups in test scores or simulation performance
- Any change in practice over time?

Method of contrast training 2010 - 32% survey response 2015 - 47% survey response

<table>
<thead>
<tr>
<th>Method of contrast training</th>
<th>2010</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-fidelity simulation</td>
<td>18%</td>
<td>30%</td>
</tr>
<tr>
<td>Computer based</td>
<td>12%</td>
<td>19%</td>
</tr>
</tbody>
</table>

Any change in practice over time?

Around 84% of programs offer training but most still using didactic lectures

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Diagnostic Radiology High-Fidelity Contrast Simulation Program Creation

How we built our program

• Simulation- 1hr, during workday, “seamless integration”
  • 2-3 different simulated scenarios

• All radiology MDs, LIPs, Nurses trained annually
  • Trained 200 staff this fall

• In years past also offered in-situ simulation refresher training 6-8 months after

Our simulation set-up

Scheduling

Biggest changes we have made

• More hands on times with meds
  • BY FAR the area we see most errors in
  • Most MDs have little to no experience drawing up and giving these meds
  * In our program the mannequin responds like a patient would if given wrong medication

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Conclusion

• Radiologist knowledge to reaction management is poor (ample room for improvement)
• Knowledge can help prevent pitfalls and avoid mismanagement of mimics
• High-fidelity simulation is an effective means of training radiologists in contrast reaction management

On behalf of my team-Thanks for your attention

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