Recognition and Treatment of Contrast Reactions in the Radiology Environment

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Disclosures

• None
Objectives

• Rationale and background
• Pathophysiology
• Treatment
• Evaluation of process
• Plan to sustain and progress
Guiding Principle

No one should manage contrast reactions better than radiology
American College of Radiology

- Opportunity to update practice
- Followed the lead of the Mayo Clinic
The Body’s Response to Contrast

• Physiologic Effects
  • Cardiovascular
  • Neurovascular
  • Renal
  • Clotting cascade

• Adverse Effects
  • Anaphylactoid
  • Non-anaphylactoid
Physiologic Effects: Cardiovascular

- Bradycardia
- Decreased contractility
- Increased pulmonary arterial pressure
Physiologic Effects: Neurovascular

- Disruption of the blood-brain barrier
- Lowered seizure threshold
Physiologic Effects: Renal

- Regional hypoxia
- Production of $O_2$ free radicals
Physiologic Effects
Clotting Cascade

Paradoxical
- Inhibits platelets
- Toxicity to endothelium may cause thrombosis
Adverse Effects

• Anaphylactoid
• Non-anaphylactoid
Adverse Effects

- Anaphylaxis
  - Known Antigen
  - IgE mediated
  - Predictable

- Contrast media
  - Antigen?
  - Antibody?
  - Idiosyncratic

Same downstream effects with vasodilator release and *identical* clinical manifestations
Clinical Manifestation

• Cutaneous
Clinical Manifestations

• Respiratory: Larynx
Clinical Manifestations

• **Respiratory:** Lower airways
Clinical Manifestations

• Cardiovascular: Peripheral vasculature
Adverse Effects
Non-Anaphylactoid

- Exaggerated physiologic effects
  - Nausea / Vomiting
- More predictable
- Vasovagal
  - Bradycardia with hypotension
- Combined reactions
Adverse Effects

• 70% reactions occur in first 5 minutes
• Majority of reactions are mild/self-limiting
• Severe reaction can have insidious onset
• Delayed reactions possible but unlikely
Management of Reactions

• Team approach
If a contrast reaction is suspected

1. Call for assistance of team members
2. Maintain IV
3. Increase IV fluids
4. Apply oxygen
5. Vital signs and pulse oximetry
6. Listen to lungs
Gauge severity

• Trust your judgment: How do they look?
• Do you need to escalate?
  – Rapid Response
  – Code
  – 911
• Have a low threshold for escalating
• Think ABCD while assessing
A is for...

Airway

• Can they speak?

• How do they sound?
  – Is there a change in their voice?
  – Are they using full sentences?
  – Do they seem in distress?
B is for...

Breathing

• Auscultate
• What is their oxygen saturation?
• Is the amount of oxygen adequate?
• Do you hear wheezing, rales, or stridor?
C is for...

Circulation

• What is heart rate?

• Can you get a blood pressure?
  – Radial pulse present: SBP at least 80 mmHg
  – Femoral pulse: SBP at least 70 mmHg
  – Carotid pulse: SBP at least 60 mmHg
D is for....
Common Diagnoses

• Cutaneous
  – Hives
  – Angioedema
  – Diffuse Erythema

• Respiratory
  – Bronchospasm
  – Laryngeal edema
  – Pulmonary edema

• Cardiovascular
  – Vasovagal reaction
  – Cardiovascular collapse

• “Other”
  – Anxiety reactions
  – Hypertensive crisis
  – Hypoglycemia
  – Rigors
  – Seizures
Cutaneous Reactions
Hives/Urticaria Signs

- Raised red welts
- May or may not be associated with pruritus
# Hives/Urticaria Treatment

<table>
<thead>
<tr>
<th></th>
<th>Treatment</th>
<th>Dosing</th>
<th>Premedicate for future studies?</th>
</tr>
</thead>
<tbody>
<tr>
<td>All forms</td>
<td>Preserve IV access</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Monitor vitals</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mild</strong> (scattered and/or transient)</td>
<td>No treatment is often needed; however, if symptomatic, can consider:</td>
<td>Diphenhydramine (Benadryl) 25-50mg PO</td>
<td>A</td>
</tr>
<tr>
<td><strong>Moderate</strong> (more numerous/bothersome)</td>
<td>Consider diphenhydramine (Benadryl) 25-50mg PO</td>
<td>Or Consider diphenhydramine (Benadryl) 25-50mg IM or IVP (do not exceed 25 mg/min)</td>
<td>B</td>
</tr>
<tr>
<td><strong>Severe</strong> (widespread and/or progressive)</td>
<td>Consider diphenhydramine (Benadryl) 25-50 mg IM or IV (do not exceed 25 mg/min)</td>
<td>Can also consider Epinephrine (IM) IM EpiPen or equivalent (0.3ml of 1:1,000 dilution, fixed); can repeat every 5-15 minutes up to three doses</td>
<td>B</td>
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</tbody>
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A: No need for premedication  
B: Premedicate prior to study  
C: Future contrast administration should be avoided
Diphenhydramine

- Do not drive after administration
- May cause dizziness, sedation, and hypotension especially in elderly patient
- Use with caution
  - Untreated narrow-angle glaucoma
  - Symptomatic prostatic hypertrophy
  - Bladder neck obstruction
Angioedema Signs

- Local swelling and erythema usually about the face, eyes, and mouth
- Affects mucous membranes
# Angioedema Treatment

<table>
<thead>
<tr>
<th>Mild/Moderate (serious situation, can progress to laryngeal edema)</th>
<th>Treatment</th>
<th>Dosing</th>
<th>Premedicate for future studies?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitor airway and vitals</td>
<td></td>
<td></td>
<td>B</td>
</tr>
<tr>
<td>O2</td>
<td>6 L/min nasal cannula or 100% non-rebreather face mask</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preserve IV access</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elevate head of bed, if possible</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consider diphenhydramine (Benadryl)</td>
<td>50mg PO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Or</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consider diphenhydramine (Benadryl)</td>
<td>50mg IM or IVP (do not exceed 25 mg / min)</td>
<td></td>
<td></td>
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<tr>
<th>Severe</th>
<th>Treatment</th>
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<tbody>
<tr>
<td>O2 by mask</td>
<td>100% non-rebreather (NRB) face mask</td>
<td></td>
<td>C</td>
</tr>
<tr>
<td>Epinephrine (IM)</td>
<td>IM EpiPen or equivalent (0.3ml of 1:1,000 dilution, fixed); can repeat every 5-15 minutes up to three times total</td>
<td></td>
<td></td>
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<tr>
<td>Or</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Epinephrine (IV)</td>
<td>Epinephrine (1:10,000)(0.1mg/ml): 0.1 – 0.3 mg IV slowly, repeat every 5-15 minutes as needed up to 1 mg total</td>
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Epinephrine

- Acts on alpha and beta receptors of sympathetic system
- Relaxes smooth muscles of bronchi
- Physiologic antagonist of histamine
- Increases blood flow and cardiac output
Epinephrine

• If you treat the patient with epinephrine, followup with post epinephrine protocol as per policy.

• IM will not work in setting of hypotension (cardiovascular collapse or pulselessness)

• Allergy to epinephrine – only a few cases worldwide
Diffuse Erythema Signs

- Often asymptomatic initially but at risk for hypotension
- “Lobster red” appearance
<table>
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<tr>
<td>All forms</td>
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<td>Monitor vitals</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pulse oximeter</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mild – Normotensive</th>
<th>No other treatment usually needed. Monitor for progression.</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Consider diphenhydramine (Benadryl) 25-50mg PO</td>
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<tr>
<th>Moderate/Severe – Hypotensive</th>
<th>O2</th>
<th>6 L/min nasal cannula or 100% non-rebreather face mask</th>
<th>C</th>
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<tbody>
<tr>
<td>IV fluids 0.9% normal saline</td>
<td>1,000 ml rapidly</td>
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<tr>
<td>Consider calling rapid response team or 911</td>
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If profound or unchanged after fluid bolus can also consider

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Or (if no IV access available)

<table>
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<tr>
<th>Epinephrine (IM)</th>
<th>IM EpiPen or equivalent (0.3ml of 1:1,000 dilution, fixed); can repeat every 10-15 minutes up to three times total</th>
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Once stabilized and en route to ICU or ER

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<tr>
<th>Consider steroid to prevent rebound in the post reaction period</th>
<th>Hydrocortisone 200mg IVP over 1-3 minutes</th>
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Respiratory reactions
Bronchospasm Signs

• Anxious patient
• Short of breath
• Often tachycardic
• Expiratory wheezing
• Or inspiratory and expiratory wheezing
<table>
<thead>
<tr>
<th>Severity</th>
<th>Treatment</th>
</tr>
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</table>
| **Mild** | Beta agonist inhaler \((\text{Albuterol})\)  
2 inhalations (90 mcg/inhalation) for a total of 180 mcg. Dose can be repeated: 2 to 4 inhalations orally every 10 minutes up to 4 hours. OR  
Albuterol inhalation solution 0.083% (2.5 mg/3 ml) nebulizer once. May repeat every 10 minutes for 6 doses.  
Consider sending patient to the ER or calling emergency response team or 911, based upon the completeness of the response |
| **Moderate** | Consider adding Epinephrine (IM)  
IM EpiPen or equivalent (0.3 ml of 1:1,000 dilution, fixed); can repeat every 5-15 minutes up to three times total  
Consider calling emergency response team or 911 based upon the completeness of the response |
| **Severe** | Epinephrine (IV)  
Epinephrine \((1:10,000)(0.1 \text{mg/ml}): 0.1 - 0.3 \text{ mg IV slowly, repeat every 5-15 minutes as needed up to 1 mg total}\)  
Or (if no IV access available)  
Epinephrine (IM)  
IM EpiPen or equivalent (0.3 ml of 1:1,000 dilution, fixed); can repeat every 5-15 minutes up to three times total  
Call emergency response team or 911 |

*A: No need for premedication  
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Laryngeal Edema Signs

• Patient distress, often panicked
• Difficulty speaking – hoarse
• Difficulty swallowing
• Inspiratory stridor
# Laryngeal Edema Treatment

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Cardiovascular Reactions
Vasovagal Reaction Signs

- Hypotension with bradycardia
- Pale
- Diaphoretic
- Decreased level of consciousness
### Vasovagal Reaction Treatment

<table>
<thead>
<tr>
<th>Hypotension (systolic blood pressure &lt; 90 mmHg)</th>
<th>Treatment</th>
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<th>PremEDIATE for future studies?</th>
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<td>Elevate legs at least 60 degrees</td>
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<td></td>
<td>Consider IV fluids: 0.9% normal saline</td>
<td>1,000 mL rapidly</td>
<td></td>
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### Hypotension with bradycardia (pulse < 60 bpm)

**Vasovagal reaction**

| Mild                                          | No other treatment usually necessary | A                              |
|                                               |                                     |                                |
| Severe (patient remains symptomatic despite above measures) | In addition to above measures: Atropine (IV) | 0.5 mg IVP; administer slowly, followed by saline flush; can repeat every 3-5 minutes up to 3mg total | C - If occurs after contrast |
|                                               | Consider calling the emergency response team or 911 |                                |                                |
Cardiovascular Shock Signs

- Hypotension with tachycardia
- Possible diffuse erythema or pallor
- Thready, rapid pulse (>100 bpm)
# Cardiovascular Shock Treatment

## Hypotension (systolic blood pressure <90 mmHg)

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## Hypotension with tachycardia (pulse > 100bpm)

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<tr>
<th>Anaphylactoid reaction</th>
<th>Treatment</th>
<th>Dosing</th>
</tr>
</thead>
<tbody>
<tr>
<td>After above interventions, if hypotension persists</td>
<td>Epinephrine (IV)</td>
<td>Epinephrine (1:10,000)(0.1mg/ml): 0.1 – 0.3 mg IV slowly, repeat every 5-15 minutes as needed up to 1 mg total</td>
</tr>
<tr>
<td>Or (if no IV access)</td>
<td>Epinephrine (IM)</td>
<td>IM EpiPen or equivalent (0.3ml of 1:1,000 dilution, fixed); can repeat every 5-15 minutes up to three times total</td>
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Other Reactions
Anxiety Reaction Signs

• Difficult to obtain history (Say yes to all symptoms)
• May hyperventilate
• Physical exam
  – Usually normal
  – May be tachycardic or tachypneic
Angina Pectoris

Signs

• Chest pressure which may radiate to left arm or jaw
• Diaphoretic
• Follow standard acute coronary syndrome protocol
Premedication

• Not a substitute for preparedness and treatment
• Contrast reactions can occur despite premedication
• Steroids are not without risks
Premedication

• Previous severe reactions should not get contrast again

• Per ACR: “It is most important to target premedication to those who, in the past, have had moderately severe or severe reactions requiring treatment.”

• No randomized controlled clinical trials have demonstrated premedication demonstrated protection against severe life threatening adverse reactions
Risks for Reactions

- History of asthma: ~3x for mild asthma
- Severely atopic individual: 2-3x
- History of shellfish allergy: No increase
- Vomiting after contrast is not an allergic reaction
- Iodine allergies are not possible
Premedication

• Category A:
  – No need for premedication

• Category B:
  – Premedicate prior to study

• Category C:
  The risk, premedication and future IV contrast administration should be carefully considered.
Premedication

• IV steroids administered less than 4-6 hours prior to contrast injection have **not** been shown to be effective.

• Diphenhydramine (Benadryl®) 50 mg intravenously 1 hour before IV contrast
Premedication Regimen

• Lasser: Prednisone 50 mg orally
  – Plus diphenhydramine (Benadryl®) 50 mg, 1 hour before IV contrast

• Greenberger: Methylprednisolone (Medrol®) 32 mg orally
  – Optional diphenhydramine

• NPO: Hydrocortisone 200mg intravenously
Premedication Breakthrough

• Breakthrough reactions after premedication
  – ~18% chance of a breakthrough reaction
  – When compared to the original reaction:
    • 12% less severe
    • 81% same
    • 8% more severe
Premedication
MRI agents

• Previous class B reaction to a gadolinium agent
  – Different gadolinium agent with premedication

• Previous class C reaction to a gadolinium agent
  – Contrast administration is discouraged, if critical, premedicate, give a different gadolinium agent, perform at the main campus.
What to do After Your Reaction to Intravenous Contrast Dye

This information explains what to do after having a reaction to the type of intravenous contrast dye checked below.

Magnetic resonance imaging (MRI) contrast:
- Gadopentetate dimeglumine (Magnevist®)
- Gadobenate dimeglumine (Multihance®)
- Gadobutrol (Gadovist®)
- Gadoxetic acid (Eovist®)

Computed tomography (CT) scan contrast:
- Iohexol (Omnipaque® 350)
- Iodixanol (Visipaque® 320)
- Iodixanol (Visipaque® 350)

What You Should Do Today:
- You are being sent to the Urgent Care Center or local Emergency Room.
- You are able to go home after your study.
- Go to nearest emergency room or call 911 if you:
  - have difficulty breathing
  - feel short of breath
  - have chest pain
- Call the doctor who ordered this scan if you have any new or concerning symptoms.
- You were given diphenhydramine (Benadryl®), which may make you sleepy.
  - Do not drive yourself home. We will help make arrangements as necessary.
  - Go to the nearest Emergency Room if you have sudden severe pain or difficulty breathing.
Sustaining Change

• Contrast Reaction QA Subcommittee
  – Multidisciplinary
• Monthly meeting to review reactions
• Post-reaction huddles
Metrics

• Type of reaction
• Appropriate pre-medication
• Use of contrast reaction documentation form
• Evidence of policy adoption
• Patient education
Lessons Learned

• Assessment
  – Initial assessment
    • Vital signs
    • Voice quality
    • Lung sounds
  – Continued assessment
Lessons Learned

• Documentation
  – Physician documentation of assessment
    • Allergic Reaction
    • Physiologic Reaction
  – Reliance on nursing documentation
Careful documentation practices
Watch handwriting
(for those still on paper)

or chart pain. 1/6 1998.
R.A. anal film was given.

notified ordered.
Review premedication carefully

Please list all medications you are currently taking:
- Prednisone 500mg (Last 17hrs)
- Diphenhydramine 50mg (Before CT scan)

7. Please initial that you have received and read the Patient Information about the

Avoid “patient premedicated per protocol”
Clarity is critical

• Don’t cram or squish
• Timeline helpful demonstrating continuous assessment
Continued Education Plan

- eLearning platform
- Annual required content and exam
- BCLS within radiology
- Education of responding departments
- All areas where contrast is used
- Simulation?
Summary

• Airway and breathing
  – Expiratory wheezing think bronchospasm
  – Inspiratory wheezes or stridor think laryngeal edema

• Circulation
  – Hypotension with bradycardia
    • Vasovagal reaction
  – Hypotension with tachycardia
    • Cardiogenic shock
Thanks to the core process improvement team

- Andy Plodkowski, MD
- Jerrold Teitcher, MD
- Matthew Kennedy, RN
- Rommel De’OCampo, RT
Thank you to ARIN

robsonp@mskcc.org