HIGH FIDELITY CONTRAST REACTION SIMULATION TRAINING

A Single Department's Experience in Training all Faculty, Fellows, and Residents to Improve Patient Care and Satisfy PQI requirements

Yale School of Medicine, Department of Radiology and Biomedical Imaging

D Asch, MD; KE Pfeifer, MD; J Cavallo, MD; L Kappus, MEd; J Arango, MPH; J Kirsch, MD; J Pahade, MD

BACKGROUND & PURPOSE

- Contrast reactions are one of the few medical emergencies that radiologists must be prepared to manage
  - Severe reactions are relatively rare (0.005-0.01% of all injections)
  - Most radiologists have limited experience treating these patients
  - Knowledge of treatment algorithms is poor
  - Significant risk in event of a reaction – potentially fatal patient outcomes
condense all the prior studies stuff into one slide
Jay Pahade, 10/21/2015
BACKGROUND & PURPOSE

• Prior studies have shown that we are not prepared…

  • Most recent single center study of radiology attending physicians, fellows, residents and found\(^1\):
    • 50% correctly identified the proper dose of IM epinephrine for anaphylaxis
    • 29% knew the proper dose/rate of administration of IV epinephrine for anaphylaxis
  
  • 2009 survey of radiologists\(^2\): 91% chose epinephrine as the initial drug of choice in a contrast-related reaction.
    • 41% gave the correct administration route and dose
    • 11% knew what concentrations were available to them and what equipment was needed
    • 17% of radiologists administered potentially fatal overdoses
  
  • England survey\(^3\):
    • 41/284 (14%) diverse MDs knew correct epinephrine dose

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\(^1\) Nandwana, et al. AJR. 2015; 205:90-94. 10.2214/AJR.14.13884

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BACKGROUND & PURPOSE

• High-fidelity simulation has arisen as an effective model to address this issue as it allows practice of high acuity but low frequency clinical events

• Our institution implemented a department-wide quality improvement program designed to increase patient safety and radiologist education on the recognition and management of contrast reactions

• The quality improvement project was developed using the PDSA (Plan – Do – Study – Act) cycle advocated by the American Board of Radiology (ABR).
METHODS-DESIGN

• Participants:
  • Mandatory for all radiology residents and fellows
  • Optional for faculty, but integrated into bonus eligibility to encourage completion

• Instructors:
  • Four radiology staff (3 faculty, 1 resident)
  • Completed an 8-hour course on simulation development and instruction

METHODS-TESTING

• Pretest
  • 20-question multiple-choice test assessing participants’ knowledge of contrast reactions/management and departmental contrast policies (developed based on ACR contrast manual) Test questions
  • 10 questions assessing participants’ demographics, ACLS/BLS status, and comfort level in responding to contrast reactions using a Likert scale Test Questions
  • Test completed prior to simulation training to allow assessment of knowledge prior to the intervention

• Posttest
  • Same test retaken at 1 month and 6 months after course to assess effectiveness of course and retention of knowledge
  • 1 month posttest was mandatory. Testing at 6 months was optional
  • Testing was completed via participant-specific online links distributed by email via Qualtrics survey/testing software (Qualtrics ®, Provo, Utah).
METHODS-TRAINING

- Participants completed a 1-hour course in our institution’s high-fidelity simulation lab
- Mixed groups of 8-10 participants including radiology nurse, with 2-3 people serving as “initial responders”, while others watched via live video feed
- Three simulations were completed with predetermined end-points:
  - A moderate severity contrast reaction requiring use of IM epinephrine
  - A high severity, anaphylaxis-like, contrast reaction requiring use of IV epinephrine
  - A hypoglycemic event mimicking a contrast reaction requiring blood sugar assessment and administration of an ampule of D50 IV

METHODS-SIMULATION SET UP

- Simulation room mimics our department’s recovery area
- During the simulation, participants were instructed to interact with the manikin (SimMan, Laerdal Medical, Wappingers Falls, NY) as if it were an actual patient.
- Manikin capabilities/features:
  - Can receive medications
  - Displays continuous real-time vital signs (which were easily changed during scenarios)
  - May manifest wheezing, crackles, tongue/laryngeal edema, and diaphoresis
  - Technician operating the manikin able to provide verbal responses to questions asked by responders via built-in speakers and could hear/see participants via live video feed.
METHODS-
CONTRAST REACTION KIT

• Modeled after ACR guidelines
• 1 standard kit across entire institution, including outpatient facilities
• Key components:
  • Albuterol nebulizer and MDI
  • 100 mg Hydrocortisone
  • 50 mg Diphenhydramine
  • 1 mg Atropine
  • 10 ml (1 mg) of 1:10,000 concentration epinephrine vial/bristojet
  • 1ml (1mg) vial of 1:1000 concentration epinephrine
• Actual kit used in simulation course
  • Allows participants to interact with the kit, learn medication locations, practice how to administer meds

SIMULATIONS MODELED TO PRACTICE KEY STEPS IN CONTRAST REACTION MANAGEMENT

11 core competencies on contrast reaction management.

<table>
<thead>
<tr>
<th>#</th>
<th>Core competency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Oxygen: proper route and dose</td>
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<tr>
<td>2</td>
<td>Management of vasovagal reaction</td>
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<tr>
<td>3</td>
<td>Avoidance of diphenhydramine hydrochloride in the hypotensive patient</td>
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<tr>
<td>4</td>
<td>Avoidance of subcutaneous epinephrine in the hypotensive patient</td>
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<tr>
<td>5</td>
<td>Alternative route of epinephrine administration if no intravenous access</td>
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<tr>
<td>6</td>
<td>Correct dosing of epinephrine via different routes of administration</td>
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<tr>
<td>7</td>
<td>Management of a contrast reaction in the pediatric patient</td>
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<tr>
<td>8</td>
<td>Recognition and management of contrast reactions in the sedated patient</td>
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<tr>
<td>9</td>
<td>Management of bronchospasm</td>
</tr>
<tr>
<td>10</td>
<td>Management of upper airway/laryngeal edema</td>
</tr>
<tr>
<td>11</td>
<td>Code team activation</td>
</tr>
</tbody>
</table>

Wang et al. AJR 2011; 196:1288–1295
METHODS-SCENARIO 1

- Mild Contrast reaction progressing into a moderate contrast reaction:
  - Urticaria unresponsive to diphenhydramine with development of bronchospasm with wheezing, cough, and declining oxygen saturations
- Treatment Algorithm:
  - Obtain a past medical history
  - Place patient on monitor and obtain a vital signs
  - Recognize the scenario as a contrast reaction and administer 25-50 mg of diphenhydramine IV or PO
  - After no relief and progression of symptoms to diminished oxygen saturations, administer Albuterol nebulizer and 0.3 mg epinephrine 1:1000 IM
  - Know how to, and initiate hospital’s code team

METHODS-SCENARIO 2

- Hypoglycemic event:
  - Diaphoresis, slight tachycardia with normal BP, altered mental state
- Treatment Algorithm:
  - Obtain past medical history from patient/technologist
  - Place patient on monitor and obtain vital signs
  - Recognize hemodynamic stability and possible contrast reaction mimic
  - Check finger stick glucose (Value=25)
  - Administer 1 amp of D50 IV push available in kit
METHODS-SCENARIO 3

- Severe contrast reaction:
  - Tongue and laryngeal edema, wheezing/coughing, hypotension, falling oxygen saturations, tachycardia, tachypnea, and declining consciousness

- Treatment Algorithm
  - Obtain a past medical history
  - Place on monitor and obtain vital signs
  - Recognize severe/"anaphylactic" contrast reaction
  - Administer oxygen via non-rebreather for hypoxia
  - Due to hypotension administer epinephrine 1:10,000, 0.1-0.3 mg via slow IV push +/- Albuterol nebulizer
  - Know how to, and initiate hospital code team

METHODS-DEBRIEFING

- 3 D’s of debriefing
  - Diffuse- Recap, vent, elicit reactions and emotions
  - Discover- Evaluate performance through reflection (what went well, what didn’t)
  - Deepening- Connect simulation event to clinical practice

- 5-10 minute debriefing session followed each simulation
  - Events/actions of team discussed and appropriate treatment algorithms were reviewed.
  - Crucial part of simulation- allows reflection and re-enforces appropriate response and algorithm

- Prior studies have shown effectiveness in medicine
  - 2014 study* showed statistically significant improvement pretest to posttest in performance of technical and nontechnical skills

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METHODS

• Analysis
  • Pretest, posttest (1 month after) and delayed posttest (6 months after) multiple choice test scores were compared with paired two-tail t-tests, and Likert scores were compared using the Wilcoxon signed rank test.

RESULTS

• 151 out of 161 available participants completed the simulation with 1 faculty participant opting to have their results removed from data analysis
• 150 participants completed the pre and posttest
  • 102 (68%) males
  • 48 (32%) females
• Average age = 40 years (range 27-83)

<table>
<thead>
<tr>
<th>Experience Level</th>
<th>Pretest and Posttest N (%)</th>
<th>Delayed Posttest N (%)</th>
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</thead>
<tbody>
<tr>
<td>First year residents (PGY1)</td>
<td>12 (8)</td>
<td>9 (9)</td>
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<tr>
<td>Second year residents (PGY2)</td>
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<td>8 (8)</td>
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<tr>
<td>Third year residents (PGY3)</td>
<td>13 (9)</td>
<td>4 (4)</td>
</tr>
<tr>
<td>Fourth year residents (PGY4)</td>
<td>13 (9)</td>
<td>10 (10)</td>
</tr>
<tr>
<td>Fellows</td>
<td>24 (16)</td>
<td>17 (18)</td>
</tr>
<tr>
<td>Faculty 6-5 years in practice</td>
<td>27 (18)</td>
<td>23 (23)</td>
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<tr>
<td>Faculty 6-10 years in practice</td>
<td>9 (6)</td>
<td>7 (7)</td>
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<tr>
<td>Faculty 11-15 years in practice</td>
<td>9 (6)</td>
<td>6 (6)</td>
</tr>
<tr>
<td>Faculty &gt;15 years in practice</td>
<td>29 (19)</td>
<td>21 (20)</td>
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<tr>
<td>Total</td>
<td>150</td>
<td>105</td>
</tr>
</tbody>
</table>
RESULTS

Table: Mean multiple choice test scores for all participants and by level of training. Numbers in () indicate % correct out of 20. * Indicates statistically significant results.

<table>
<thead>
<tr>
<th></th>
<th>Pretest Score</th>
<th>Posttest Score</th>
<th>Delayed posttest score</th>
<th>P-value: Pretest vs. posttest</th>
<th>P-value: Posttest vs. delayed posttest</th>
<th>P-value: Pretest vs. delayed posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>All participants (n=150)</td>
<td>14.1 (70)</td>
<td>16.0 (80)</td>
<td>15.6 (78)</td>
<td>&lt;0.0001*</td>
<td>0.01*</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td>1st year residents (n=12)</td>
<td>12.9 (65)</td>
<td>15.5 (78)</td>
<td>16.6 (83)</td>
<td>0.03*</td>
<td>0.12</td>
<td>0.012*</td>
</tr>
<tr>
<td>2nd year residents (n=14)</td>
<td>12.7 (63)</td>
<td>15.9 (80)</td>
<td>13.9 (69)</td>
<td>0.001*</td>
<td>0.09</td>
<td>0.02*</td>
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<tr>
<td>3rd year residents (n=13)</td>
<td>13.7 (68)</td>
<td>15.5 (78)</td>
<td>15.0 (75)</td>
<td>0.003*</td>
<td>0.39</td>
<td>0.68</td>
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<tr>
<td>4th year residents (n=13)</td>
<td>14.8 (74)</td>
<td>16.9 (85)</td>
<td>14.9 (75)</td>
<td>0.002*</td>
<td>0.01*</td>
<td>0.54</td>
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<tr>
<td>Fellows (n=24)</td>
<td>14.3 (72)</td>
<td>16.3 (81)</td>
<td>15.3 (76)</td>
<td>0.06</td>
<td>0.70</td>
<td>0.24</td>
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<tr>
<td>Faculty &lt;5 years (n=27)</td>
<td>14.4 (72)</td>
<td>16.3 (82)</td>
<td>16.0 (80)</td>
<td>0.0001*</td>
<td>0.13</td>
<td>0.0001*</td>
</tr>
<tr>
<td>Faculty 6-10 years (n=9)</td>
<td>14.0 (70)</td>
<td>15.9 (79)</td>
<td>15.0 (75)</td>
<td>0.13</td>
<td>0.63</td>
<td>0.08</td>
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<tr>
<td>Faculty 11-15 years (n=9)</td>
<td>15.2 (76)</td>
<td>16.1 (81)</td>
<td>16.0 (80)</td>
<td>0.30</td>
<td>0.61</td>
<td>0.17</td>
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<tr>
<td>Faculty &gt;15 years (n=29)</td>
<td>14.2 (71)</td>
<td>16.3 (81)</td>
<td>16.0 (80)</td>
<td>&lt;0.00001*</td>
<td>0.20</td>
<td>0.001*</td>
</tr>
</tbody>
</table>

Mean multiple choice test scores for all participants and by level of training. Numbers in () indicate % correct out of 20. * Indicates statistically significant results.

- Mean overall score on pretest was 14.1 / 20
- Score increased significantly to 16.0 on posttest (p=0.00001)
RESULTS

- The delayed posttest had 105 participants (69%)
- The ratio of residents, fellows, and faculty who participated in the delayed posttest (n=105) was not statistically different (p=0.93) from the pretest or posttest (n=150)
- Overall test scores increased from 14.1 pre-simulation to 15.6 on delayed posttest (p=0.00001)

<table>
<thead>
<tr>
<th></th>
<th>Mean Score</th>
<th>Standard Deviation</th>
<th>P-value (Pretest vs. Posttest)</th>
<th>P-value (Pretest vs. Delayed Posttest)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All participants</td>
<td>14.1 (70)</td>
<td>0.98</td>
<td>0.00001</td>
<td>&lt;0.00005</td>
</tr>
<tr>
<td>1st year residents</td>
<td>12.9 (65)</td>
<td>1.55</td>
<td>0.03</td>
<td>0.32</td>
</tr>
<tr>
<td>2nd year residents</td>
<td>12.7 (65)</td>
<td>1.59</td>
<td>0.01</td>
<td>0.39</td>
</tr>
<tr>
<td>3rd year residents</td>
<td>13.7 (65)</td>
<td>1.55</td>
<td>0.003</td>
<td>0.39</td>
</tr>
<tr>
<td>4th year residents</td>
<td>14.8 (70)</td>
<td>1.69</td>
<td>0.002</td>
<td>0.56</td>
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<tr>
<td>Fellows</td>
<td>14.3 (72)</td>
<td>1.56</td>
<td>0.06</td>
<td>0.70</td>
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<tr>
<td>Faculty 0-5 years</td>
<td>14.4 (72)</td>
<td>1.65</td>
<td>0.00001</td>
<td>0.15</td>
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<tr>
<td>Faculty 6-10 years</td>
<td>14.4 (72)</td>
<td>1.65</td>
<td>0.00001</td>
<td>0.15</td>
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<tr>
<td>Faculty 11-15 years</td>
<td>15.2 (70)</td>
<td>1.68</td>
<td>0.00001</td>
<td>0.17</td>
</tr>
<tr>
<td>Faculty &gt;15 years</td>
<td>14.7 (71)</td>
<td>1.64</td>
<td>0.00001</td>
<td>0.20</td>
</tr>
</tbody>
</table>

RESULTS

- Overall decrease in test scores across all subgroups when comparing the posttest with the delayed posttest (16.0 to 15.6, p=0.01)
- By subgroup analysis, only the 4th year residents demonstrated a significant decrease in test scores comparing the posttest with the delayed posttest.
RESULTS

- Comfort level in managing reactions demonstrated a significant positive increase (p<0.001) when comparing the pretest to the posttest (all Likert scale questions).
- Delayed posttest overall comfort level in managing reactions remained significantly improved from pre-simulation (p<0.001) but showed a significant decline (p=0.03) compared to the posttest.

<table>
<thead>
<tr>
<th></th>
<th>Pretest comfort level</th>
<th>Posttest comfort level</th>
<th>Delayed posttest comfort level</th>
<th>P value: pretest vs. posttest</th>
<th>P value: post vs. delayed posttest</th>
<th>P value: pre vs. delayed posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall comfort in managing reactions</td>
<td>2.9</td>
<td>3.7</td>
<td>3.5</td>
<td>0.03</td>
<td>0.001</td>
<td>0.001</td>
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<tr>
<td>Managing mild reactions</td>
<td>3.7</td>
<td>4.4</td>
<td>4.3</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>Managing moderate reactions</td>
<td>3.0</td>
<td>3.9</td>
<td>3.7</td>
<td>0.001</td>
<td>0.004</td>
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<tr>
<td>Managing severe reactions</td>
<td>2.6</td>
<td>3.4</td>
<td>3.1</td>
<td>0.03</td>
<td>0.001</td>
<td>0.001</td>
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<tr>
<td>Comfort level: differentiating a contrast reaction from another medical emergency</td>
<td>3.1</td>
<td>3.9</td>
<td>3.9</td>
<td>0.001</td>
<td>0.36</td>
<td>0.001</td>
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<tr>
<td>Comfort level: differentiating a mild from a severe reaction</td>
<td>3.6</td>
<td>4.1</td>
<td>4.2</td>
<td>0.001</td>
<td>0.4</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Mean comfort values in managing contrast reactions (1 being not comfortable at all and 5 being very comfortable).

RESULTS-FEEDBACK

- Simulation sessions were well received
  - 86% of participants asked for other forms of simulation within our radiology department.
  - 93% of the participants felt that the group size was adequate
  - 57% of participants felt that the simulation should be completed annually
- There was a significant increase in support of high fidelity simulation training as an effective learning tool for contrast reaction management after completing the simulation (4.0 to 4.5, p<0.001) that persisted at 6-month delayed posttest (4.0 vs. 4.5 p<0.001)
KEYS ISSUES TO IMPLEMENT A SIMILAR PRACTICE QUALITY IMPROVEMENT PROJECT AT YOUR INSTITUTION

• Institutional access
  • Work with your institution to gain access to simulation lab
    • These are now available at most academic centers
  • Must get “buy in”
    • Support of departmental leadership is key to promote participation
  • Participants
    • Train everyone
      • Can not just limit to residents- ALL residents, fellows, faculty
      • Include ancillary staff
        • Having nursing and technologist participate is key to mimic natural environment and work on team communication skills

KEYS ISSUES TO IMPLEMENT A SIMILAR PRACTICE QUALITY IMPROVEMENT PROJECT AT YOUR INSTITUTION

• Group size
  • Will vary on how many simulations you develop and size of your department
  • Try to mimic what typical size is for responding to an event in your department
  • We had to compromise slightly for our project due to size of our department and limited time available in our simulation lab
KEYS ISSUES TO IMPLEMENT A SIMILAR PRACTICE QUALITY IMPROVEMENT PROJECT AT YOUR INSTITUTION

- Simulation creation and content
  - A good session imparts stress/chaos
  - Needs to feel like real life
  - Actually administer medications
    - People may memorize a dose but having them actually draw up and give the medicine is important as it is a leading source of error
    - Include mimickers of contrast reactions
      - Important to practice normal clinical assessment and recognize adverse events
      - Use different mimics each year

Contrast Reaction Mimics
- Hypoglycemia
- Acute Coronary Syndrome
- Seizure
- Drug (pain medication) overdose
- Nausea/Vomiting
- Stroke
- Air Embolism

KEYS ISSUES TO IMPLEMENT A SIMILAR PRACTICE QUALITY IMPROVEMENT PROJECT AT YOUR INSTITUTION

- Minimize disruption for participants-Length of course
  - Our course was designed to last one hour and occur during normal work hours
  - Made it much easier for everyone to attend and eliminated need to take time off

- Scheduling
  - Our IT dept. built online schedule site (below)
    - Allow users to pick date/time that works best

Yale University Diagnostic Radiology
Contrast Simulation Scheduler

![Yale University Diagnostic Radiology Contrast Simulation Scheduler](image)

SCHEDULING YOUR TRAINING: Click "Log off" button in the top right corner if someone else’s username/shows above it. Select from the dates below by clicking on one, continue if in progress above the table, and then visit an any available slot in the table to book it. If the slot is full, please check back at a later time.

RE-SCHEDULING: Please remove your old reservation first. Click on your old booking to display it, then click Delete, and confirm deletion.

Tuesday, September 29 2015

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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<th>VS-2</th>
<th>VS-3</th>
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<th>VS-7</th>
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LOCATION: East Pavilion 9th floor, SYRASE simulation center, left of elevators

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KEYS ISSUES TO IMPLEMENT A SIMILAR PRACTICE QUALITY IMPROVEMENT PROJECT AT YOUR INSTITUTION

• Frequency of training
  • Is annual training adequate?

• Our study showed decline in test scores and comfort levels at 6 months
  • Prior study with small sample of showed decay in knowledge and comfort in managing contrast reactions at 6-9 months

• We have now added in-situ simulation training 6 months after the course to refresh knowledge, skills and improve comfort treating reactions


HOW TO IMPLEMENT PRACTICE QUALITY IMPROVEMENT PROJECT

• Until recently, the ABR emphasized that projects should be completed via the PDSA (Plan – Do – Study – Act) cycle
  • 3 phases:
    • Phase 1: baseline PDSA cycle
      • Plan: identify area needing improvement and a measure to assess need; develop a target and plan
      • Do: set plan in motion, collect data
      • Study: compare results with desired goal, explore deficiencies
      • Act: develop improvement plan for next cycle
    • Phase 2: Implementing improvement plan
    • Phase 3: Post-improvement plan cycle (cycle 2)
  • Cycle can be used continuously to reach goal

PLAN
- Objective
- Questions/Predictions
- Plan to carry out cycle

DO
- Carry out plan
- Document problems and observations
- Begin analysis

STUDY
- Compare analysis of data
- Compare data to predictions
- Summarize what was learned

ACT
- What changes are to be made
- Next cycle


Our PDSA

PLAN
- Objective: improve radiologist education on recognition and management of contrast reactions
- Design simulation course

DO
- Administer pretest
- Execute simulation course
- Administer posttest

ACT
- Design simulation course sessions to address weaknesses
- Added in-situ re-training sessions later in year

STUDY
- Analyze data from pretest and posttest
- Collect participant feedback
RECENT ABR CHANGES TO PQI PROJECTS

- Recent changes implemented in September 2015

- While designing PQI projects with PDSA approach is still recommend recent changes by the American Board of Radiology have greatly diversified activities a radiologists can complete to meet PQI requirements as part of the MOC cycle

- We recommend all interested parties review recent commentary for more information and consult the American Board of Radiology website
  - ABR website: http://www.theabr.org/moc-ro-pqi-guidelines

CONCLUSION

- High-fidelity simulation is an effective tool to improve radiologists’ knowledge and comfort in managing contrast reactions

- Training has now become an ongoing quality improvement project in our department, with all residents, fellows and faculty participating in the course annually

- As comfort level declined at 6 months, in-situ simulation training in various locations within our actual department has been incorporated to allow knowledge refreshment 6 months after the simulation course

- Development of a high-fidelity simulation project to improve education on contrast reaction management is a high-yield initiative that also allows completion of a departmental wide PQI project
KNOWLEDGE-BASED TEST QUESTIONS

There are 20 multiple-choice questions which are designed to test your knowledge on contrast reactions, contrast policy, and contrast reaction mimics. Please answer to the best of your ability without using any additional reference material.

1. Which of the following is a symptom of a moderate severity contrast reaction?
   a. Hives
   b. Mild hypotension
   c. Nausea
   d. Severe hypotension

2. Which of the following is considered an allergic-like reaction to IV contrast administration?
   a. Epinephrine
   b. Flushing
   c. Hypotension
   d. Immediate hypotension

3. Which of the following is a symptom of a moderate severity contrast reaction?
   a. Nausea
   b. Itching
   c. Hives
   d. Flushing

4. Which of the following is the most likely sequela of contrast related urticarial reactions?
   a. Hypotension
   b. Hypoglycemia
   c. Bronchospasm
   d. Anaphylactic shock

5. What is the most likely sequela of contrast related urticarial reactions?
   a. Anaphylactic shock
   b. Hypotension
   c. Bronchospasm
   d. Cardiac arrest

6. Which of the following is true regarding contrast reactions to IV iodinated contrast media?
   a. Less contrast reaction-related deaths are associated with ionic compared to non-ionic agents.
   b. Patients with all contrast reactions are at high risk of developing severe reactions on subsequent exposure.
   c. Some agents have lower risk of allergic-like reaction than ionic agents.
   d. Reactions may progress from mild to severe rapidly.

7. What is the treatment of choice for severe contrast reactions?
   a. IV Antihistamines
   b. IV Dexamethasone
   c. IV Atropine
   d. IV Epinephrine

8. Initial manifestations of a delayed contrast reaction have been reported to occur as long as 7 days after IV contrast administration?
   a. 1 day
   b. 1 week
   c. 1 month
   d. 30 days

9. What is the best first-line medication for treatment of anaphylactic shock?
   a. Diphenhydramine
   b. 1:1,000 epinephrine IM or SC
   c. 1:10,000 epinephrine IM or SC
   d. 1:10,000 epinephrine IV

10. Which of the following is NOT an appropriate intervention in a patient with acute bronchospasm after receiving IV contrast who is otherwise stable, what is most appropriate initial treatment?
    a. 100mg IV Solucortef
    b. Epinephrine (1:10,000) 0.3 mg IV administered slowly
    c. 50mg PO diphenhydramine
    d. IV epinephrine (1:10,000) 0.1-0.3 mg administered slowly

11. In a patient with acute bronchospasm after receiving IV contrast who is otherwise stable, what is the most appropriate initial treatment?
    a. Epinephrine (1:10,000) 0.3 mg IV administered slowly
    b. 100mg IV Solucortef
    c. 50mg PO diphenhydramine
    d. IV epinephrine (1:10,000) 0.1-0.3 mg administered slowly

12. In a patient with acute bronchospasm after receiving IV contrast who is otherwise stable, what is the most appropriate initial treatment?
    a. Epinephrine (1:10,000) 0.3 mg IV administered slowly
    b. 100mg IV Solucortef
    c. 50mg PO diphenhydramine
    d. IV epinephrine (1:10,000) 0.1-0.3 mg administered slowly

13. In a patient with acute bronchospasm after receiving IV contrast who is otherwise stable, what is the most appropriate initial treatment?
    a. Epinephrine (1:10,000) 0.3 mg IV administered slowly
    b. 100mg IV Solucortef
    c. 50mg PO diphenhydramine
    d. IV epinephrine (1:10,000) 0.1-0.3 mg administered slowly

14. In a patient with acute bronchospasm after receiving IV contrast who is otherwise stable, what is the most appropriate initial treatment?
    a. Epinephrine (1:10,000) 0.3 mg IV administered slowly
    b. 100mg IV Solucortef
    c. 50mg PO diphenhydramine
    d. IV epinephrine (1:10,000) 0.1-0.3 mg administered slowly

15. In a patient with acute bronchospasm after receiving IV contrast who is otherwise stable, what is the most appropriate initial treatment?
    a. Epinephrine (1:10,000) 0.3 mg IV administered slowly
    b. 100mg IV Solucortef
    c. 50mg PO diphenhydramine
    d. IV epinephrine (1:10,000) 0.1-0.3 mg administered slowly

16. In a patient with acute bronchospasm after receiving IV contrast who is otherwise stable, what is the most appropriate initial treatment?
    a. Epinephrine (1:10,000) 0.3 mg IV administered slowly
    b. 100mg IV Solucortef
    c. 50mg PO diphenhydramine
    d. IV epinephrine (1:10,000) 0.1-0.3 mg administered slowly

17. In a patient with acute bronchospasm after receiving IV contrast who is otherwise stable, what is the most appropriate initial treatment?
    a. Epinephrine (1:10,000) 0.3 mg IV administered slowly
    b. 100mg IV Solucortef
    c. 50mg PO diphenhydramine
    d. IV epinephrine (1:10,000) 0.1-0.3 mg administered slowly

18. In a patient with acute bronchospasm after receiving IV contrast who is otherwise stable, what is the most appropriate initial treatment?
    a. Epinephrine (1:10,000) 0.3 mg IV administered slowly
    b. 100mg IV Solucortef
    c. 50mg PO diphenhydramine
    d. IV epinephrine (1:10,000) 0.1-0.3 mg administered slowly

19. In a patient with acute bronchospasm after receiving IV contrast who is otherwise stable, what is the most appropriate initial treatment?
    a. Epinephrine (1:10,000) 0.3 mg IV administered slowly
    b. 100mg IV Solucortef
    c. 50mg PO diphenhydramine
    d. IV epinephrine (1:10,000) 0.1-0.3 mg administered slowly

20. In a patient with acute bronchospasm after receiving IV contrast who is otherwise stable, what is the most appropriate initial treatment?
    a. Epinephrine (1:10,000) 0.3 mg IV administered slowly
    b. 100mg IV Solucortef
    c. 50mg PO diphenhydramine
    d. IV epinephrine (1:10,000) 0.1-0.3 mg administered slowly

Click to return
**COMFORT-BASED TEST QUESTIONS AND DEMOGRAPHICS**

1. Please list your age: 
2. What is your sex? 
   - Male  
   - Female  
3. What is your level of training?  
   - First year radiology resident  
   - Second year radiology resident  
   - Third year radiology resident  
   - Fourth year radiology resident  
   - Fellow  
   - Faculty attending (0-5 years experience)  
   - Faculty attending (6-10 years experience)  
   - Faculty attending (11-15 years experience)  
   - Faculty attending (>15 years experience)  
4. Please rate the following statement (1 not very comfortable to 5 very comfortable):  
   - I feel comfortable managing contrast reactions on my own  
   - I feel comfortable differentiating a contrast reaction from another medical emergency.  
   - I feel comfortable differentiating a mild from a severe contrast reaction.  
   - I feel comfortable diagnosing and managing mild contrast reactions.  
   - I feel comfortable diagnosing and managing moderate contrast reactions.  
5. Please rate the following statement (1 not very comfortable to 5 very comfortable):  
   - I feel comfortable diagnosing and managing severe contrast reactions.  
   - I feel that simulation sessions are an effective teaching tool to learn how to manage contrast reactions.  
   - I felt that the size of the simulation group was ideal to foster a learning environment.  
   - I would like to see other forms of simulation utilized in the radiology department.  
6. Please rate the following statement (1 not very comfortable to 5 very comfortable):  
   - I would like to complete the simulation:  
   - I am not sure if I will complete the simulation:  
   - I do not know if I will complete the simulation:  

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**Note:** Click to return.