Reducing Functional MRI Scan Times by Optimizing Workflow

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Disclosures

- Michael Zeineh receives research funding from GE Healthcare
Background

- Functional MRI (fMRI) is a specialized, noninvasive exam of brain function
- fMRI is typically performed for pre-operative neurosurgical planning
- Performing fMRI is a complex undertaking requiring the coordinated efforts of an entire health care team
Background

- In our practice, we noticed inefficiencies in our fMRI workflow, leading to lengthy scan times
- Our purpose was to reduce fMRI scan times by increasing the efficiency of our workflow
- Our specific goal was to consistently reduce scan times to a mean of 60 minutes or less

METHODS
Methods: Institutional review board

- Our institutional review board (IRB) determined that our project does NOT meet the federal definition of “research” or “clinical investigation”
- Our project does not require formal review by our IRB

Methods: Multidisciplinary team

- We assembled a multidisciplinary team of Radiology faculty, fellows, technologists, administrators, and quality improvement managers
- The team had regular biweekly to monthly meetings from October 2014 to August 2015
- Multiple cycles of plan-do-study-act (PDSA) were conducted
Methods: Control chart and statistical methods

- We retrospectively reviewed all fMRI exams at our institution from January 2013 to August 2015
- We calculated the scan time of each exam, and plotted them on a statistical process control chart
- Process data were evaluated in real time using statistical process control methods to evaluate for a significant change in the process mean

Methods: Quality improvement process

- We performed root-cause analysis, using a cause-and-effect (fishbone) diagram to visualize factors contributing to lengthy fMRI scans
Methods: Quality improvement process

- We identified five key drivers, or intermediate goals to help guide specific interventions

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<th>Key drivers</th>
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<td>Minimized patient motion</td>
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As a balancing measure, we reviewed each fMRI exam to determine whether it was of diagnostic quality.
Methods: Interventions

• 1) Eliminated intravenous contrast
• 2) Reduced repeated language paradigms

**Typical old protocol**
- 3-plane localizer
- T1 BRAVO
- R hand motor
- L hand motor
- VRN x 2
- ARN x 2
- OBJ x 2
- DTI
- T1 BRAVO post-gad

**Typical new protocol**
- 3-plane localizer
- T1 BRAVO
- R hand motor
- L hand motor
- VRN x 2
- ARN x 2
- OBJ x 2
- DTI
- T1 BRAVO post-gad

(Protocols are individualized for the patient as needed)

VRN = visual responsive naming; ARN = auditory responsive naming; OBJ = object naming

Methods: Interventions

• 3) Updated checklists for patient monitoring

Step-by-step checklists were provided along with examples of activation maps for each of the patient tasks
Methods: Interventions

4) Updated visual slides and audio

- Visual slides were updated to be easily readable, in large font size
- Audio files were re-recorded and edited so they could be heard easily

RESULTS
Results: Pre-intervention

Annotated control chart (individual chart, or I-chart). Each individual point represents an fMRI examination performed, with date on the x-axis and scan length in minutes on the y-axis.

Results: Pre- and post-intervention

- Pre-intervention and post-intervention mean scan times (horizontal blue lines)
- Goal (horizontal green line)
- Four interventions (vertical red arrows): 1) eliminated intravenous contrast, 2) reduced repeated language paradigms, 3) updated technologist checklists, and 4) updated visual slides and audio
- UCL, upper control limit; LCL, lower control limit
Results: Pre- and post-intervention

The outcomes data met criteria to indicate a shift in the process mean on November 28, 2014.

Pre-intervention
72 fMRI exams
Mean: 76.3 min
Stdev: 21.5 min

Post-intervention
33 fMRI exams
Mean: 53.2 min
Stdev: 8.4 min

(30% reduction) (61% reduction)
Results: Pre- and post-intervention

Pre-intervention
72 fMRI exams
57 diagnostic quality
15 nondiagnostic exams

Post-intervention
33 fMRI exams
28 diagnostic quality
5 nondiagnostic exams

Discussion
Discussion

• Our project focused on reducing fMRI scan times while maintaining diagnostic quality
• Direct benefits:
  ◦ Workflow efficiency is increased
  ◦ Less time spent conducting and monitoring exam
  ◦ Patient comfort
  ◦ Improved consistency
  ◦ Improved image quality from decreased motion
• Indirect benefits:
  ◦ Cost savings
  ◦ Increased revenue from additional fMRI that could be performed in the time saved (opportunity cost)

Discussion

• Limitations
  ◦ Difficult to prove direct causality between interventions and outcomes
  ◦ Improvement processes staggered over time; difficult to ascribe improved efficiency to a single intervention
  ◦ Calculation of scan time does not include patient setup and positioning
Discussion

- Future directions
  - Development of patient training video
  - Development of multilingual capabilities
  - Improved efficiency of monitoring, processing, and interpretation

CONCLUSION
Conclusion

- Optimizing fMRI workflow is an important part of our health care mission in Diagnostic Radiology
- By implementing specific interventions, we successfully reduced mean fMRI scan times from 76.3 minutes to 53.2 minutes (30% reduction)
- These interventions can be sustainable over time, and can be applied broadly to any fMRI practice

Thank you!