Reducing Functional MRI Scan Times By Optimizing Workflow

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RSNA ID: 15009122
Presentation: QS112-ED-MOA3
Station #3

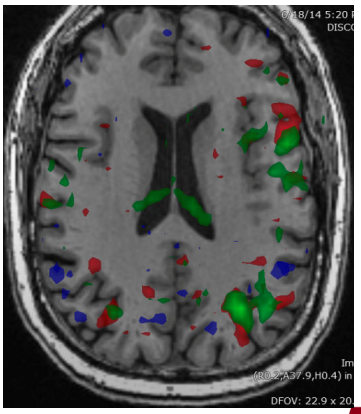
Disclosures

- Michael Zeineh receives research funding from GE Healthcare

BACKGROUND

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**

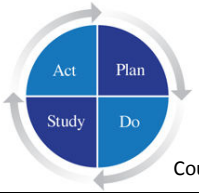
METHODS

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



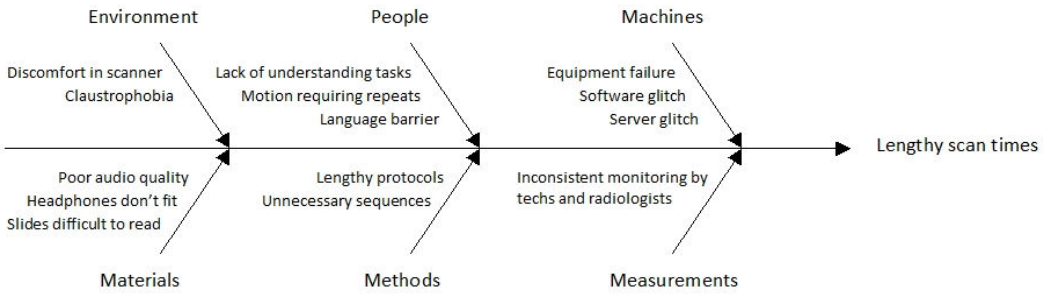
Courtesy of The W. Edwards Deming Institute®

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

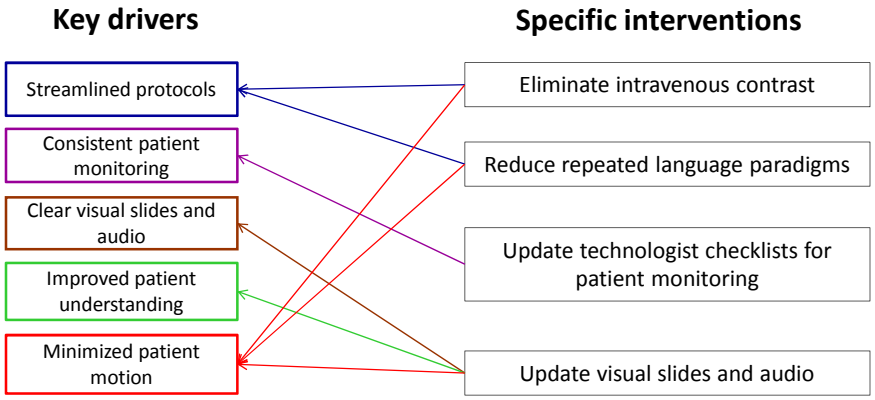
Methods: Quality improvement process

- 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



Methods: Quality improvement process

- 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

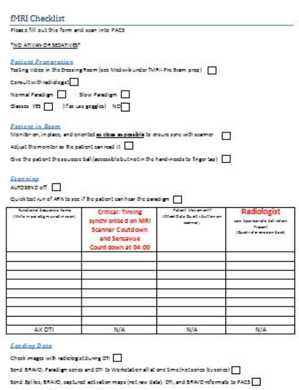
Typical old protocol	**Typical new protocol**
3-plane localizer	3-plane localizer
T1 BRAVO	T1 BRAVO
R hand motor	R hand motor
L hand motor	~~L hand motor~~
VRN x 2	VRN ~~x 2~~
ARN x 2	ARN ~~x 2~~
OBJ x 2	OBJ ~~x 2~~
DTI	DTI
T1 BRAVO post-gad	~~T1 BRAVO post-gad~~

(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


fMRI Checklist

Please fill out this form and scan into PACS

NO ATIVAN OR SEDATIVES

Patient Preparation

Testing Video in the Dressing Room (see Medwiki under fMRI-Pre Exam prep) ☐

Consult with radiologist ☐

Normal Paradigm ☐ Slow Paradigm ☐

Glasses YES ☐ (if so use goggles) NO ☐

Patient in Room

Monitor on, in place, and oriented as close as possible to ensure sync with scanner ☐

Adjust the monitor so the patient can read it ☐

Give the patient the squeeze ball (accessible but not in the hand-needs to finger tap) ☐

Scanning

AUTOSEND off ☐

Quick test run of ARN to see if the patient can hear the paradigm ☐

Functional Sequence Name (Write in paradigm used in scan)	Critical: Timing synchronized on MRI Scanner Countdown and Sensavue Count down at 04:00	Patient Movement? (Check Data Quality button on scanner)	Radiologist sees Appropriate Activation Present (Quick dimension Look)
AX DTI	N/A	N/A	N/A

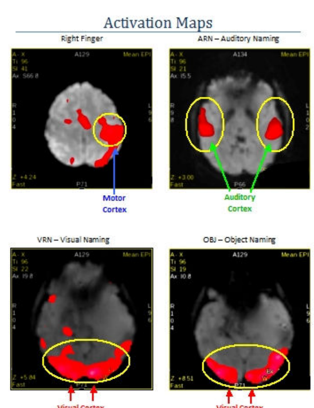
Sending Data

Check images with radiologist during DTI ☐

Send BRAVO, Paradigm series and DTI to Workstation all at one time (not series by series) ☐

Send 3pl loc, BRAVO, captured activation maps (not raw data), DTI, and BRAVO reformats to PACS ☐

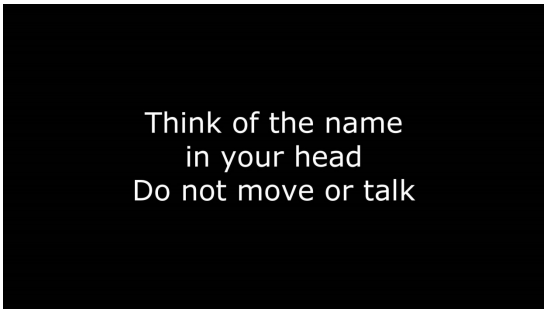
Send Paradigm series to Backup ☐



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

Methods: Interventions

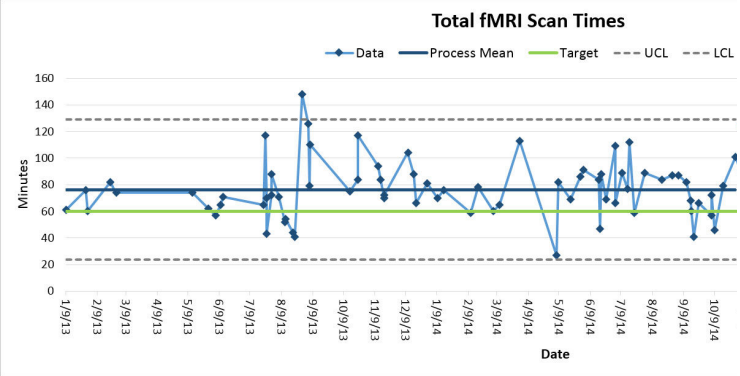
- 4) Updated visual slides and audio



- 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

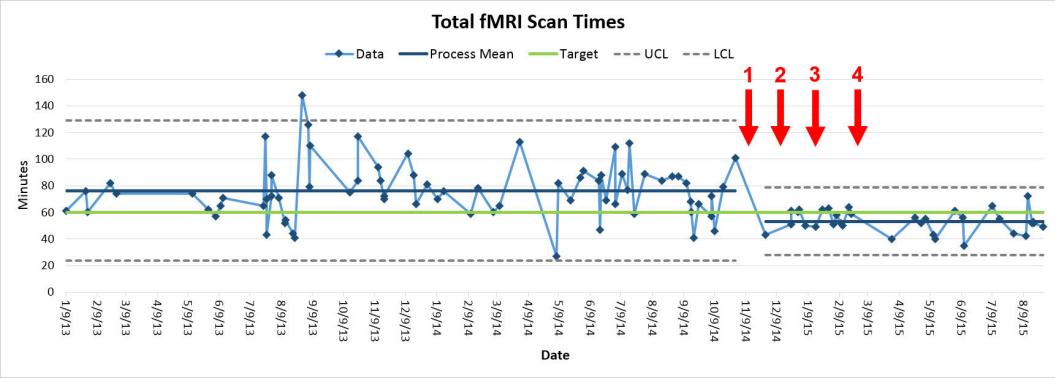
RESULTS

Results: Pre-intervention



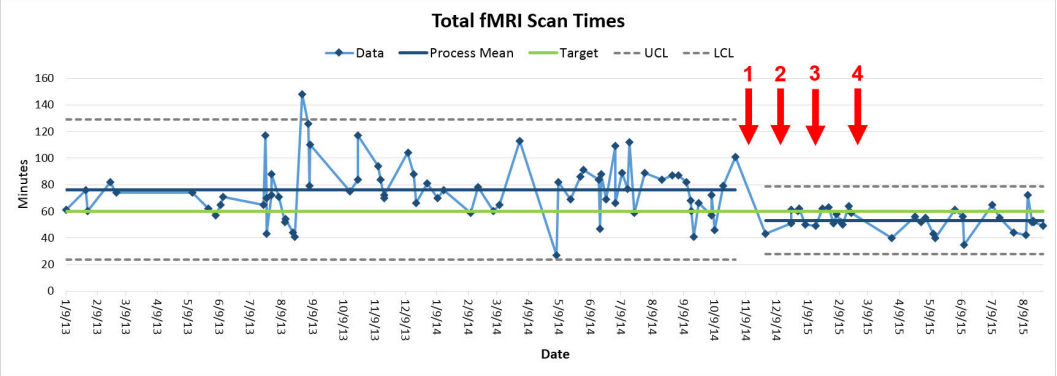
Annotated control chart (individual chart, or I-chart). Each individual point represents an fMRI examination performed, with date on the x-axis and scan length in minutes on the y-axis.

Results: Pre- and post-intervention



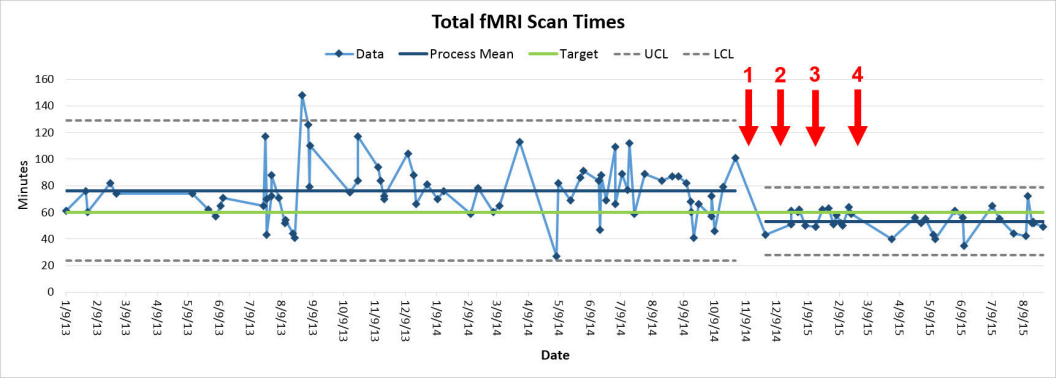
- Pre-intervention and post-intervention mean scan times (horizontal blue lines)
- Goal (horizontal green line)
- Four interventions (vertical red arrows): 1) eliminated intravenous contrast, 2) reduced repeated language paradigms, 3) updated technologist checklists, and 4) updated visual slides and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

Results: Pre- and post-intervention



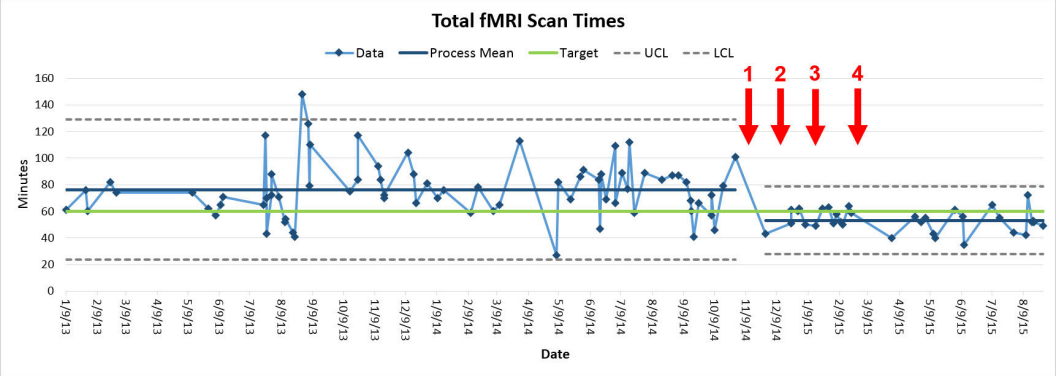
- The outcomes data met criteria to indicate a shift in the process mean on November 28, 2014

Results: Pre- and post-intervention



Pre-intervention		Post-intervention
72 fMRI exams		33 fMRI exams
Mean: 76.3 min	(30% reduction) →	Mean: 53.2 min
Stdev: 21.5 min	(61% reduction) →	Stdev: 8.4 min

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!