Improving the Radiographic Evaluation of Acute Fractures in a Timely Manner with Musculoskeletal Pain Markers

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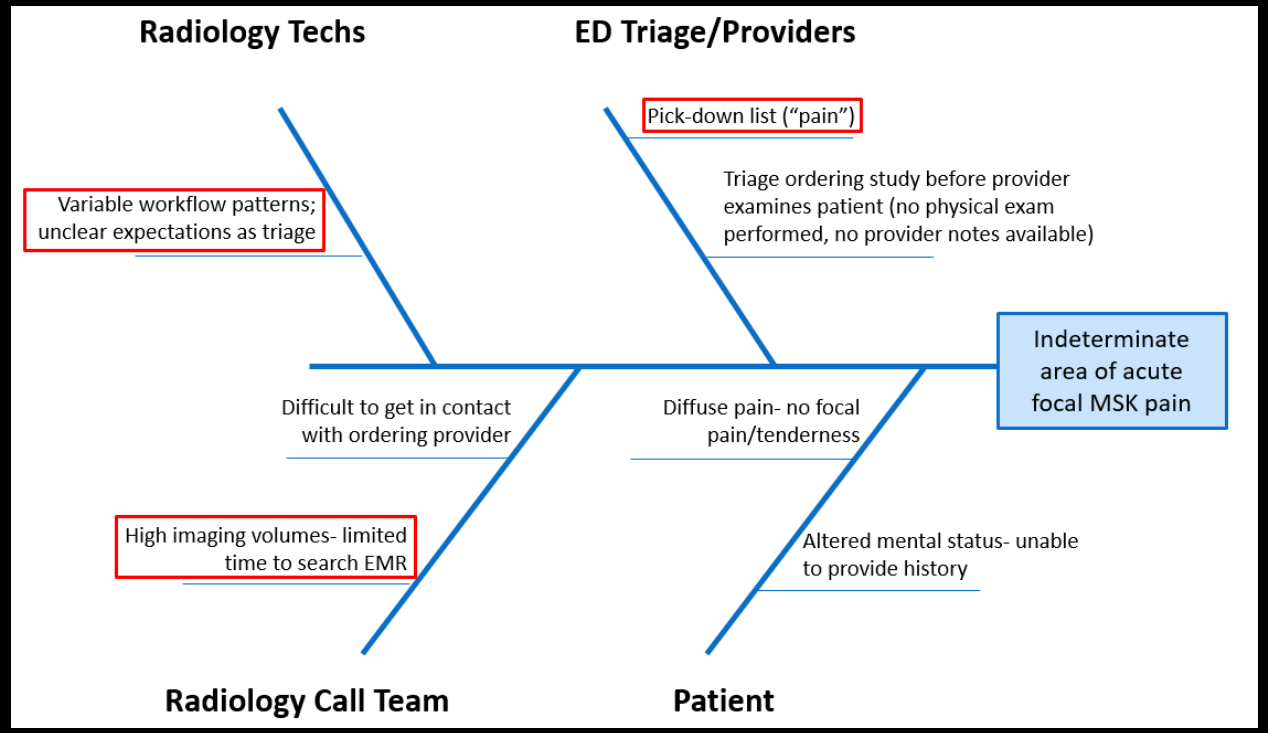
Problem Overview and Purpose

- Understanding a patient's location of focal musculoskeletal (MSK) pain is an important factor in the radiographic evaluation of acute fractures
- Berbaum (Radiology 1988): Knowledge of localizing symptoms provided in the clinical history increased accuracy in fracture detection (higher true positive rate)
  - Direct reader's attention to specific areas, increase reader confidence
- However, information on a patient's location of focal pain can be difficult to determine
  - Limited clinical information provided
  - Limited time to search EMR

- Purpose: Implement a process which would quickly provide the location of focal MSK pain to improve the radiographic evaluation of fractures
  - Improve diagnostic accuracy
  - Streamline call workflow

Berbaum KS, el-Khoury GY, Franken EA, Jr., Kathol M, Montgomery WJ, Hesson W. Impact of clinical history on fracture detection with radiography. *Radiology.* 1988;168(2):507-511.

Root Cause Analysis



- Engage radiology technologists to improve availability of MSK pain-related information
  - Technologists act as an additional triage source to help characterize locations of focal pain
  - Relatively low-complexity intervention
  - Minimize increasing call responsibilities on other stakeholders (ED providers and radiology call team)

Intervention

- X-ray technologists place a radiopaque “BB” skin marker (MSK pain marker) at the location of focal acute pain designated by the patient
  - Scope of study:
    - Acute focal pain in emergency room patients
    - Extremity radiographs (majority of diagnostic errors on MSK X-rays made on extremities rather than axial bone structures)
- MSK pain marker as a low-cost means to provide information on focal MSK pain
  - No prior quantitative analysis on impact of the use of skin markers on the radiographic detection of fractures

“BB” skin marker denoting area of focal pain. Adjacent base of 5th metatarsal fracture.

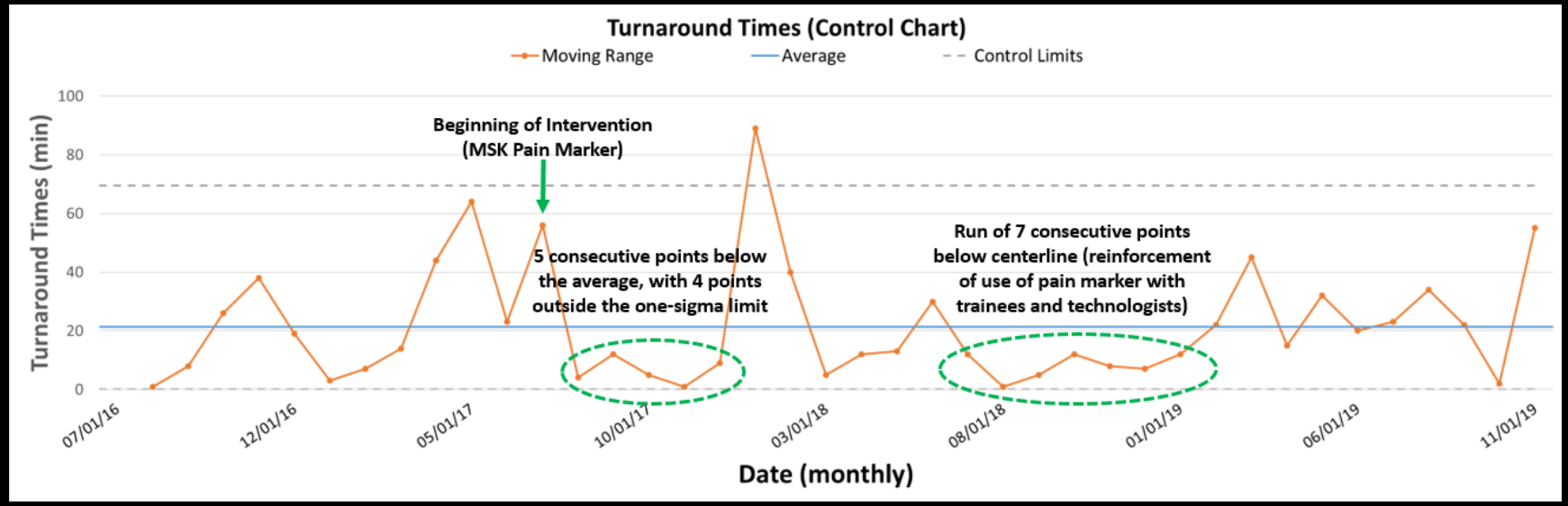
Project Design

- 30-month prospective study period (July 2017 to December 2019)
- Outcome metrics
  - Turnaround times (TAT) on trainee's preliminary reports
    - Exam completion to preliminary report time
  - # of major discrepancy reports between preliminary trainee and final attending read
- Track pain marker usage through "macro marker"
  - Radiology report macro designating the presence of a MSK pain marker
- Multiple small pilots with X-ray technologists for direct feedback
  - Digital PACS-based pain marker initially proposed until technologists reported inefficient workflow practices with digital marker
  - Address issue of decreased supplies of MSK pain markers
  - Regular follow-up in staff meetings with emphasis on clinical impact

Results

	Without Pain Marker	With Pain Marker
Major Discrepancy Rate	1.2%	1.1%
# Major Discrepancies	108	6
# Preliminary Reports	8,799	569

Summary of Results Evaluating Diagnostic Accuracy Without and With Pain Marker



Control Chart: Turnaround Times

Control chart displaying average turnaround times in minutes on preliminary MSK X-ray reports (y-axis) by monthly intervals (x-axis) from August 2016 to November 2019

Key Takeaways

- Trends of higher utilization of MSK pain markers associated with shorter turnaround times and improved diagnostic accuracy
  - Results not statistically significant likely due to confounding variables

- <u>Limitations</u>
  - Inconsistent usage of pain marker → small % of call cases with marker
  - Major discrepancies
    - Variability in designation of “major discrepancies” by attendings
    - 1 out of 6 major discrepancies of MSK X-ray’s with a pain marker was for osteomyelitis
  - Turnaround Times
    - Data captured from exam completion (not report creation) to preliminary report
    - Confounding factor of overall call volumes and # of studies in other modalities (CXR, CT’s)

Online Simulation: Overview

- Controlled testing environment to measure direct impact of pain marker on radiology performance
  - Minimize confounding variables
- Simulation captures radiologist's accuracy and speed in detecting acute fractures with and without a pain marker
- Pilot: "X marks the spot!"
  - 26 unique, randomized cases (half with pain marker, other half without marker)
    - Includes normal MSK X-rays
    - 1 view per case
  - Matched cases based on similar fracture patterns and difficulty

Online Simulation: Results

- Pilot simulation with preliminary results from 8 radiologists
  - PGY-4 and above

- Statistically significant improvement in diagnostic accuracy (p = 0.036) and turnaround times (p = 0.038) with use of MSK pain marker [two-tailed t-test]

	Without Pain Marker	With Pain Marker
Sensitivity*	74%	90%
Average time spent per case	19 seconds	15 seconds

*Radiologist correctly identifies an acute fracture

- Average score of 4.4 for helpfulness of MSK pain marker at end of simulation
  - Scale of 1-5 (with 5 = very helpful)

Conclusion

- Use of a MSK pain marker to designate location of focal pain is a low-cost means to obtain clinically relevant information
- Online simulation demonstrates that MSK pain markers are associated with statistically significant shorter turnaround times and improved diagnostic accuracy
- Lessons learned
  - Simple solutions can have a big clinical impact!
  - Engage stakeholders early on for effective change management
    - Identify project champions
    - Constant communication and frequent reminders
    - Get feedback
  - Carry out mini-pilots and gather data on a frequent basis
    - Determine early on where and how intervention should be modified