Optimization of X-ray (XR) based Protocol for the Detection of Retained Surgical Items (RSI) in the Operating Room (OR)

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Conflict of Interest : RaPID Medical Technologies LLC

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Intro

- Affordable Care Act - Quality - prevention of errors and performance improvements.

- In 2012, the total number of surgeries in the US exceeded 110,000,000.

- RSI is any surgical tool or sponge inadvertently left in a patient's body.

Background

- Morbidity and even mortality may result from direct injury, repeated surgery, or a prolonged hospital stay in addition to excess cost and loss of hospital credibility.
- To prevent RSI, patient safety measures include
  - effective OR communication,
  - mandatory counts of all surgical instruments and sponges,
  - methodical wound examination
  - XR of the surgical field before closing the wound.
- Miscounts occur in up to 12.5% of all surgeries, often requiring XR of the surgical field.
- Because up to 88% of RSI occur with "correct surgical counts", many hospitals mandate XR at the end of the complex surgeries.
- Possible Limitations
  - Lack of formal training for RSI detection
  - Duration for complete image acquisition and analysis
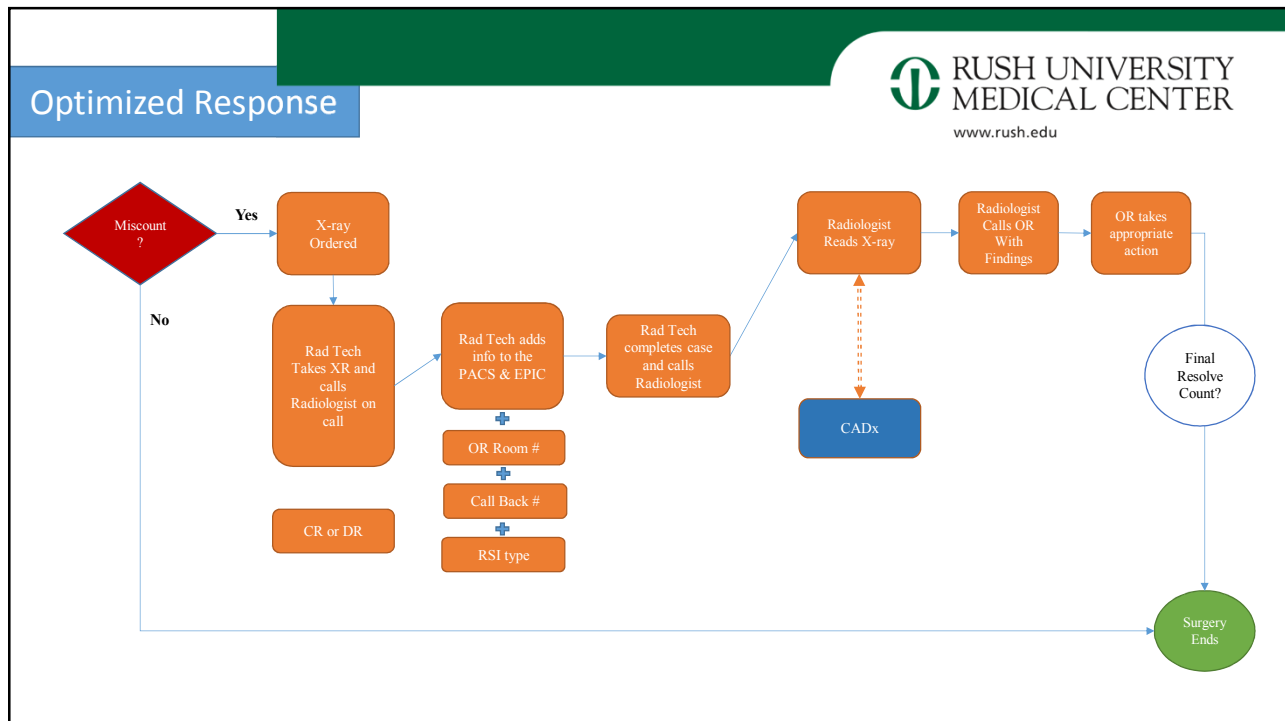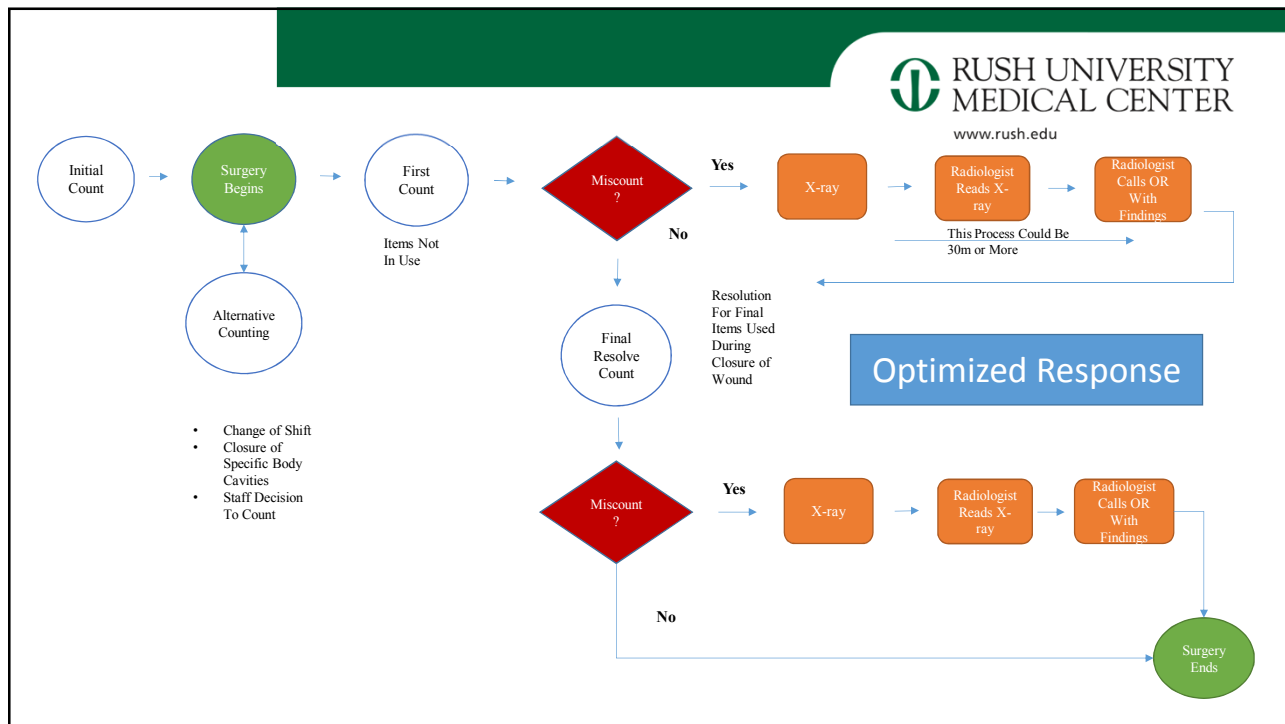 - Lapses in comminication

Methods

- Business process modeling (BPM) methods
  - Focused on process functionality, properties, and quality in the OR workflow.
  - These inputs were analyzed to provide guidance for protocol optimization and application developers to develop more effective workflow
- For the development of CADe software, we utilized advanced coding languages and algorithms that included - RSI detection
  - Image enhancement designed
  - Artifacts removal
  - Contrast improvement
  - Candidate detection using machine learning and spatial clustering,
  - Feature extraction and selection for RSIs recognition
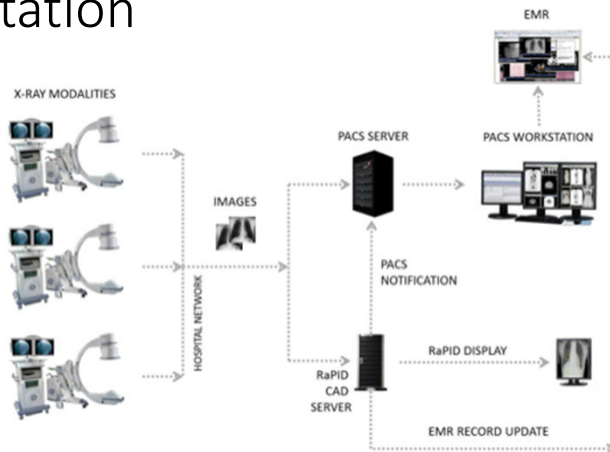 - RSIs classification system.

BPM RESULTS

- DR versus CR - Faster transfer of the image to the PACS
- Radiological technician training - specific settings (kV and mAs) of the portable XR machine to provide optimal contrast for detection,
- Information: Image denominators – PACS & EPIC
  - RSI flag
  - OR room number
  - Call-back phone number
  - RSI type
- Prioritize radiology workflow queue for RSI's –hierarchy of 'stat' cases.
- Improve radiologist tech – Radiologist communication
  - Tech calls radiologist before image acquisition ('Heads-up')
  - Tech calls radiologist after image acquisition and close-out cases

BPM RESULTS

- Computer Assisted Detection (CADe) software to assist with image analysis, and effective critical information alert upon identification.
  - Simulations of the optimized protocol on the OR phantom have showed detection rates approaching 99% with time to rule out RSI and findings reported back to the OR consistently within = 2min upon XR acquisition. Testing of the beta prototype of the CADe software for ray-tec sponge
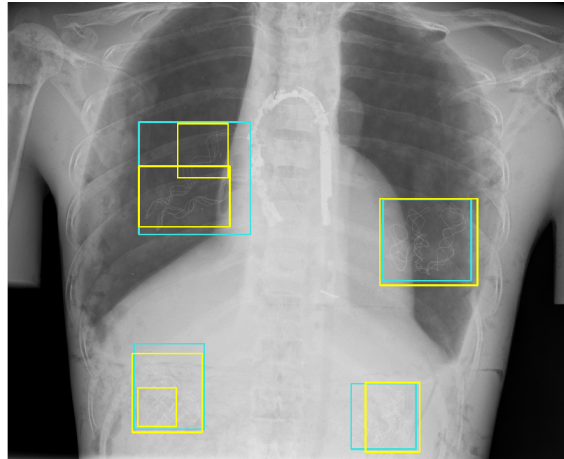
Optimized Response

Slide 1:

- Initial Count → Surgery Begins → First Count (Items Not In Use) → Miscount?
  - Yes → X-ray → Radiologist Reads X-ray → Radiologist Calls OR With Findings (This Process Could Be 30m or More)
  - No → Final Resolve Count → Miscount?
    - Yes → X-ray → Radiologist Reads X-ray → Radiologist Calls OR With Findings
    - No → Surgery Ends

- Surgery Begins ↔ Alternative Counting
  - Change of Shift
  - Closure of Specific Body Cavities
  - Staff Decision To Count

Resolution For Final Items Used During Closure of Wound

Slide 2:

Optimized Response

- Miscount?
  - Yes → X-ray Ordered → Rad Tech Takes XR and calls Radiologist on call → Rad Tech adds info to the PACS & EPIC → Rad Tech completes case and calls Radiologist → Radiologist Reads X-ray ↔ CADx → Radiologist Calls OR With Findings → OR takes appropriate action → Final Resolve Count? → Surgery Ends
  - No → Surgery Ends

- CR or DR
- OR Room #
- Call Back #
- RSI type

Optimized Response DICOM Server Implementation

CADe Software

CADe Software

CADe for needles

The 3 E's

- Measurable Improve Efficiency (Efficiency)

- Quality Educate Staff (Education)

- Improvement Technical Tools (Engineering)

CONCLUSION

- Implementation of BPM optimized XR protocols for RSI detection and with CADe software fully integrated into the PACS have the potential to increase:
  - OR time utilization
  - RSI detection rates and patient safety in the ORs.
- In the environment where demand for surgical services has been be steadily increasing while margins are declining, BPM optimization of the radiology protocols to exclude RSI may streamline and automate processes, improve decision-making, and make better use of available resources - ultimately resulting in significant cost savings.