Assessing Portable Chest Radiographs in a Trauma Hospital’s Intensive Care Units: A Quality Improvement Initiative Focused on Appropriateness, Safety, and Imaging

December 2, 2015
12:15PM - 12:45PM

Quality Storyboard for RSNA 2015

Harborview Medical Center
Seattle, WA USA

Presentation Overview

• Background of hospital’s portable chest radiograph (pCXR) quality improvement project

• Multi-disciplinary team approach to chest pCXR automated-ordering QI processes

• Hospital’s QI metrics tracking process

• Multi-year QI assessment of before and after change in automated pCXR ordering

• Lessons learned in our QI project
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• Lessons learned in our QI project

It takes a village to improve quality

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QI project at Harborview Medical Center

• Harborview Medical Center (HMC) is a level one (adult and pediatric) trauma center in Seattle, Washington serving several Northwestern states

• 413 beds (89 ICU) with approximately 17,000 inpatient admissions and 65,000 emergency department visits in 2014

• HMC’s patient severity is relatively high, e.g., case-mix index greater than 2.0 in 2014 (overall hospital)

Brief Portable Chest XR (pCXR) QI pilot

• 2011-2012: HMC Radiology piloted quality improvement (QI) projects related to inpatient imaging use and efficiency
  ➢ Established inter-professional team with QI Department and imaging-ordering providers

• 2013: HMC Radiology presentations to QI teams and HMC committees
  ➢ late 2013, team selected pCXR in ICUs as QI efficiency priority based on pilot findings and clinical appropriateness
From Radiology Information System (RIS) database

ICU-based pCXRs found to be primarily ordered during early morning period.

Through interactions with stakeholders, it was determined that ordering was automated for mechanically ventilated patients.

This practice has a low appropriateness score based on Am. College of Radiology criteria.

American College of Radiology (ACR) guidelines for ICU chest films

Clinical Condition: Routine Chest Radiographs in ICU Patients

Monitoring stable patient.

Radiologic Procedure | Rating | Comments | BRL* |
----------------------|--------|----------|------|
X-ray chest portable admission and/or transfer with specified indication | 9 | | |
X-ray chest portable clinical indications only | 9 | Clinical worsening only; | |
Safety Score: L3 L3 Usually not appropriate; A5A May be appropriate; TAI Usually appropriate |

Clinical Condition: Respiratory failure, Patient receiving mechanical ventilation.

Radiologic Procedure | Rating | Comments | BRL* |
----------------------|--------|----------|------|
X-ray chest portable clinical indications only | 9 | | |
X-ray chest portable routine daily | 3 | Some subgroups may benefit from a daily chest radiograph. | |
Safety Score: L3 L3 Usually not appropriate; A5A May be appropriate; TAI Usually appropriate |

very low appropriateness
Worked with hospital councils, ordering providers, and developed QI metrics

- **Jan 2014:** Presented to HMC Critical Care Team
  - led to Feb 2014 removal of CPOE automated routine pCXR order in mechanically ventilated ICU patients
    - manual ordering by ICU providers remained an option

- **Jan - Oct 2014:**
  - finalized strategic plan for pCXR QI project
  - continued multi-departmental partnerships
  - presented preliminary QI data to teams
  - established and tracked multiple QI metrics

Primary lesson learned #1

Radiology cannot improve health systems and hospitals alone!

Radiology must work in close partnership with a hospital’s quality improvement (QI) department and imaging-ordering providers, using inter-disciplinary, team-based approaches to improve the quality of patient-centered care.
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• Multi-year QI assessment of before and after change in automated pCXR ordering

• Lessons learned in our QI project

Developed and tracked internal QI metrics

• HMC has a QI metric tracking system called Access to Excellence (A2E) (on our hospital’s intranet)
  ➢ metrics for hospital, departments, and/or QI initiatives

• We assess a monthly metric for pCXR in relation to ventilator status using multiple data sources
  ➢ Metric: monthly # of pCXRs / # of ventilated patient days per month
    Combination of Radiology Information System (RIS), procedures database, and electronic medical record data
Methods: Patient Selection

QI project inclusion criteria:

- Inpatient admission started between
  - Feb 2013 – Jan 2014 (pre-order process change) or
  - March 2014 – Feb 2015 (post-order process change)
- Inpatient in ICU and on mechanical ventilation on day one of hospital stay
  - Multiple admissions of same patient were allowed, but generally pre-change and post-change periods had distinct sets of patients

QI project methods

- We prospectively designed an assessment of pCXR trends using radiology data and procedural / billing data from the 12-month periods before and after HMC’s portable chest radiograph ordering change
  - reduction in 1-view CT chest radiograph in ICU was pre-specified expected outcome
- Our QI analysis used processed procedure billing data as a high-quality source of inpatient events (post-discharge cleaned data)
  - allowed day-of-stay level assessment
Findings snapshot: pre-change and post-change to pCXR: all ICUs

![Graph showing pre and post change in pCXR/ventilator metric](Image)

- **Pre CPOE Change**: February 2013 to January 2014
- **Post CPOE Change**: March 2014 to February 2015

CPOE = computerized provider order entry; pCXR standing order was removed in Feb 2014

Example of A2E Metrics: individual ICUs

![Graph showing variation in pCXR/ventilator metric among ICUs](Image)

- **Pre CPOE Change**: February 2013 to January 2014
- **Post CPOE Change**: March 2014 to February 2015

Notable variation among ICUs
QI Methods: primary variables

Variables obtained through procedures database

- Patient demographics
- Length of stay (hospital and ICU)
- DRG weight-based case-mix index (CMI)
- Days on ventilator
- Chest XRs (1 view) by day
- Chest CTs by day

Methods: assessed safety-related outcomes

- In-hospital morality (disposition)
- Ventilator associated pneumonia (ICD9 codes 495.7 and 997.31)
- Iatrogenic pneumothorax (ICD9 code 512.1)
- Bronchoalveolar lavage (BAL) (CPT code 31624)
- Any diagnostic bronchoscopy (CPT codes 31622-31624)
Methods: Statistical Analysis

• Pre-specified primary endpoint was change in mean number of chest radiographs (1 view) between pre- and post-intervention

• Also considered day 1 imaging trends in ICU and trends during day 2 and after in ICU

• Generalized estimating equations (GEE) models were used to account for repeated admissions by the same patient

QI Findings

• Total of 3,803 qualified hospital admissions (3,596 patients) during two-year study period

  ➢ Adults in the ICU and mechanically ventilated on first day of stay
  ➢ 1,907 admissions in the 12 mth pre-intervention period
  ➢ 1,896 admissions in the 12 mth post-intervention period
**QI Findings**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre-Intervention Period Admissions (N=1907)</th>
<th>Post-Intervention Period Admissions (N=1896)</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Females</td>
<td>31.8%</td>
<td>31.7%</td>
<td>0.93</td>
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<tr>
<td>Age – years</td>
<td>52 ± 18</td>
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<td>DRG weight/CMI</td>
<td>4.1 ± 3.6</td>
<td>4.3 ± 3.8</td>
<td>0.033</td>
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<td>Hospital LOS – days</td>
<td>14 ± 22</td>
<td>14 ± 19</td>
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<td>ICU LOS – days</td>
<td>6.1 ± 10</td>
<td>6.0 ± 9</td>
<td>0.71</td>
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<td>Days on MC</td>
<td>4.8 ± 7.8</td>
<td>4.6 ± 6.4</td>
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*Test for difference between periods, based on GEE model

Values are percentages or mean ± SD unless otherwise specified; CMI = case mix index; LOS = length of stay; MC = mechanical ventilation.

**Results**

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- CMI was higher in post-period cohort of ICU patients (CMI relates to the mix of patient severity and complexity of health status)
- No significant changes in LOS or days on ventilator
Results: Imaging

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<td>On 1st day of stay</td>
<td>1.6 ± 1.0</td>
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<td>After 1st day of stay</td>
<td>4.8 ± 7.7</td>
<td>3.4 ± 6.0</td>
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• 21% drop in chest radiographs

• 21% drop in chest XRs after ordering rule change
  • Little change on day 1 but 29% drop after day 1
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<td>Chest CT (total from all days)</td>
<td>0.4 ± 0.8</td>
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<td>0.34</td>
</tr>
<tr>
<td>On 1st day of stay</td>
<td>0.2 ± 0.4</td>
<td>0.2 ± 0.4</td>
<td>0.18</td>
</tr>
<tr>
<td>After 1st day of stay</td>
<td>0.2 ± 0.6</td>
<td>0.2 ± 0.5</td>
<td>0.83</td>
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- 21% drop in chest XRs after ordering rule change
- Little change on day 1 but 29% drop after day 1
- Little change in chest CT utilization

Results: Other Outcomes

- Assessed safety-related outcomes in relation to timing of QI change to pCXR ordering processes*

- In year after CPOE-based automated ordering change for pCXR, we found no statistically significant changes in
  - In-hospital mortality
  - Ventilator associated pneumonia (VAP)
  - Iatrogenic pneumothorax
  - Bronchoalveolar lavage
  - Any diagnostic bronchoscopy

* based on patient disposition codes, ICD9 codes, and CPT codes
Lessons learned and imaging findings

• Multi-disciplinary team needed for QI projects
  ➢ Identifying important QI targets based on pilot data
  ➢ Developing a strategic plan and objectives for QI
  ➢ Understanding multiple sources of data
  ➢ Helping with interpreting findings

• After chest XR ordering rule change, we found
  ➢ 21% drop in mean number of chest XRs
  ➢ Driven by 29% drop for day 2 and later after admission
  ➢ Some variability between ICUs

Primary lesson learned #2

Non-randomized QI projects in radiology, or in general, should be interpreted with caution and should include feedback from relevant providers caring for patients of interest (e.g., ICU patients).

Well-designed QI projects can improve processes, as well as identify areas requiring additional assessments or more tightly controlled evaluations for impacts on patients / staff.
Key QI project findings

• CMI was higher in the post-intervention period
  ➢ Suggests more complex or more severe mix of patients
• No significant changes in LOS or days on ventilator
  ➢ Also no significance in changes in mortality, ventilator-related complications, chest CT or bronchoscopies
• Non-randomized, prospectively-designed QI project
• Data collection and analysis are ongoing
• More multivariate analysis is needed to better understand relationships among key variables
• Health services research principles can be successfully applied in QI settings

Thank you!

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