Assessing Portable Chest Radiographs in a Trauma Hospital's Intensive Care Units:

A Quality Improvement Initiative Focused on Appropriateness, Safety, and Imaging

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Quality Storyboard for RSNA 2015

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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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It takes a village to improve quality

Radiology

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- Tanya Conger
- Dan Hippe
- Bruce Lehnert
- Joe Marotta
- Stephanie Pardee
- Becky Pierce (HMC)
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HMC QI Team / partners

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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)

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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

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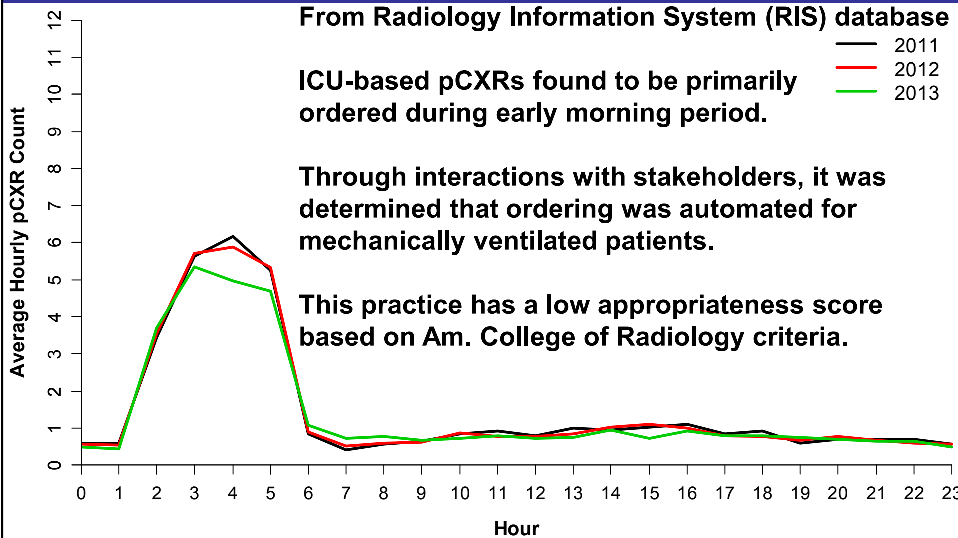
QI pilot data: mean hourly pCXR volumes



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

Date of origin: 1995
Last review date: 2011

American College of Radiology
ACR Appropriateness Criteria®

very low appropriateness

Clinical Condition: **Routine Chest Radiographs in ICU Patients**

Variant 1: **Monitoring stable patient.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray chest portable admission and/or transfer with specified indication	9		☢
X-ray chest portable clinical indications only	9	Clinical worsening only.	☢
X-ray chest portable routine monitoring	1		☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 2: **Respiratory failure. Patient receiving mechanical ventilation.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray chest portable clinical indications only	9		☢
X-ray chest portable routine daily	3	Some subgroups may benefit from a daily chest radiograph.	☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

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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**

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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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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

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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

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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

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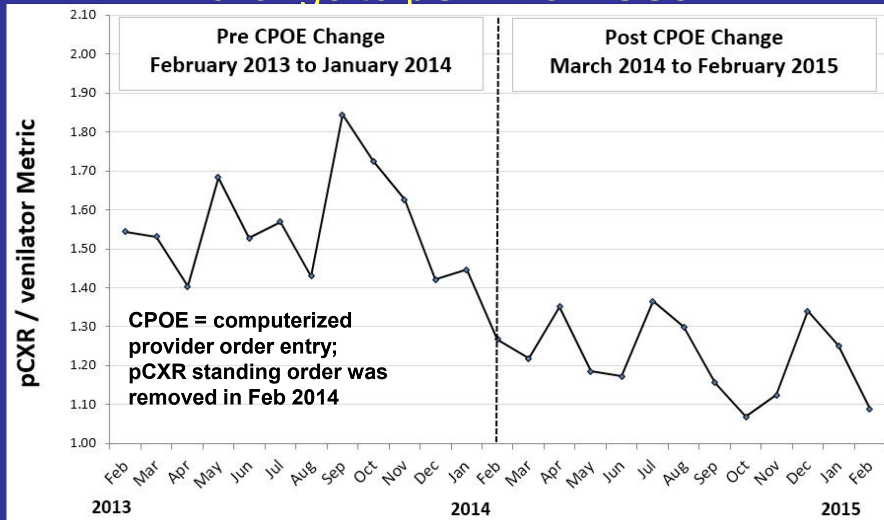
Findings snapshot: pre-change and post-change to pCXR: all ICUs



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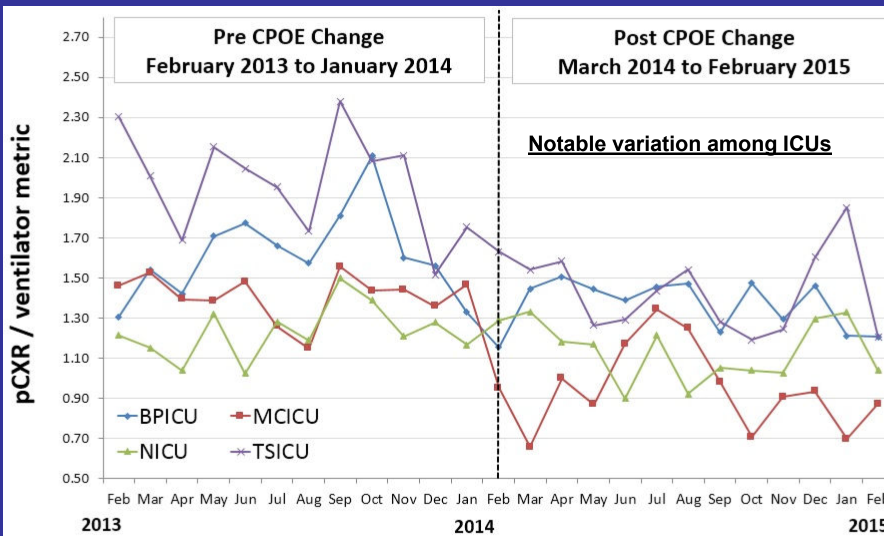
Example of A2E Metrics: individual ICUs



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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**

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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)

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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

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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

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QI Findings

Variable	Pre-Intervention Period Admissions (N=1907)	Post-Intervention Period Admissions (N=1896)	P-value*
Females	31.8%	31.7%	0.93
Age – years	52 ± 18	52 ± 18	0.91
DRG weight/CMI	4.1 ± 3.6	4.3 ± 3.8	**0.033**
Hospital LOS – days	14 ± 22	14 ± 19	0.63
ICU LOS – days	6.1 ± 10	6.0 ± 9	0.71
Days on MC	4.8 ± 7.8	4.6 ± 6.4	0.70

***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.

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Results

Variable	Pre-Intervention Period Admissions (N=1907)	Post-Intervention Period Admissions (N=1896)	P-value*
Females	31.8%	31.7%	0.93
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DRG weight/CMI	4.1 ± 3.6	4.3 ± 3.8	**0.033**
Hospital LOS – days	14 ± 22	14 ± 19	0.63
ICU LOS – days	6.1 ± 10	6.0 ± 9	0.71
Days on MC	4.8 ± 7.8	4.6 ± 6.4	0.70

- **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**

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Results: Imaging

Variable	Pre-Intervention Period Admissions (N=1907)	Post-Intervention Period Admissions (N=1896)	P-value
Chest XR (total from all days)	6.3 ± 8.0	5.0 ± 6.3	**<0.001**

- **21% drop in chest radiographs**

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Chest XR (total from all days)	6.3 ± 8.0	5.0 ± 6.3	**<0.001**
On 1st day of stay	1.6 ± 1.0	1.5 ± 1.0	0.12
After 1st day of stay	4.8 ± 7.7	3.4 ± 6.0	**<0.001**

- **21% drop in chest XRs after ordering rule change**
  - **Little change on day 1 but 29% drop after day 1**

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On 1st day of stay	1.6 ± 1.0	1.5 ± 1.0	0.12
After 1st day of stay	4.8 ± 7.7	3.4 ± 6.0	**<0.001**
Chest CT (total from all days)	0.4 ± 0.8	0.4 ± 0.7	0.34
On 1st day of stay	0.2 ± 0.4	0.2 ± 0.4	0.18
After 1st day of stay	0.2 ± 0.6	0.2 ± 0.5	0.83

- **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**

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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**

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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

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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.

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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

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Thank you!

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