Portable Digital X-Ray

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Before we start

Mayo Clinic
AHRA
Certified Radiology Administrator (CRA)
Disclosure

- I am an employee of Carestream Health, Inc
- Carestream designs and manufactures the DRX-1 detector
- Former employee of Philips, Fujifilm and Agfa
- My wife is an RT and consultant for Carestream
- We have 3 daughters
Today’s Talk:

1. Describe the need for productivity gains in general x-ray

2. Describe results from facilities who used portable DR in a clinical test environment

3. This will include experiences using a wireless cassette-sized DR detector. Such a system changes the transition to digital in some key ways:

   • The room in which it is used is already familiar to the radiographers.

   • The detector can be removed from the Bucky for easy positioning of difficult exams much like a CR cassette.

   • Image feedback is immediate (5-7) sec. Vs. ~1 minute for CR studies. This changes how the radiographer can perform the examination.

   • The same detector was used for the table and wall bucky to reduce cost
The need for speed

Some potential reasons why productivity gains are so important
Healthcare demand

- As we age..
  - Require 3.6 times as many hospital visits
  - Stay 4.1 times as long

Source: CDC&P National Center for Health Statistics
USA’s rapid demographic shifts

- People between 20 and 64 years old for each person over 64
  - In 2010: 4.6 people
  - In 2025: 3.2 people
- Net result, nearly 2X the work with proportionately 30% fewer workers
- Answer: **Productivity**

Where can we find productivity?

DR option – a comparative workflow analysis
DR can provide significant improvements

<table>
<thead>
<tr>
<th></th>
<th>Patient Throughput</th>
<th>Retakes</th>
<th>Patients Waiting</th>
<th>Average Wait Time</th>
<th>Average Exam Time</th>
<th>Average Time in Department</th>
<th>Average Tech Time with Patient</th>
<th>Average Tech Time without Patient</th>
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</thead>
<tbody>
<tr>
<td>Analog</td>
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<td>7</td>
<td>22</td>
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<td>17.12</td>
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<td>2.98</td>
<td>14.13</td>
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<td>34</td>
<td>3</td>
<td>15</td>
<td>97.92</td>
<td>13.46</td>
<td>107.23</td>
<td>2.41</td>
<td>11.04</td>
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<td>DR</td>
<td>50</td>
<td>3</td>
<td>0</td>
<td>11.37</td>
<td>5.62</td>
<td>17.00</td>
<td>2.24</td>
<td>3.39</td>
</tr>
</tbody>
</table>

Average Exam Time = Average tech time with and without patient
Average Time in Department = Average Time Waiting + Average Exam Time

Independent studies report that DR improves productivity
By a factor of 30 – 71%\(^1\).

\(^1\) Andriole et al., UC San Francisco; Roper St Francis, Charleston, SC
Barriers to adoption of DR

DR is chosen for maximum workflow benefit:
- DR System: $200K -> $450K
- Room Prep: $25-50K
- Service 10%: $20K-$55K
- Total Cost: $245K -> $655K
  - As a result, it tracks the room replacement market

CR is chosen for versatility to fit existing rooms:
- CR System $35-$75K
- Service 10%: $3.5K-$7.5K
- Total Cost: $38.5K-$82.5K
  - As a result it tracks the much faster growing Healthcare IT markets

The optimal solution has DR workflow with CR versatility at the right price.
Our expectation – DR makes us faster

- UC San Francisco showed that fixed detector DR is 30% faster than an upright automatic film changer for ambulatory chest exams\(^1\)

- Roper St Francis, Charleston, SC showed an average of 71% improvement (± 16\%)\(^2\) Using DR vs. CR
  - minimum of 50% to a maximum of 91% difference.

2. Health Group Digital Transformation Series. Improved Productivity
Roper St. Francis Healthcare, Charleston, South Carolina. Eastman Kodak Company
Various portable ~35x43cm DR products are available

**Canon CXDI-50G**
- 35x43 cm wired detector
- Flat panel GOS
- CSI version available
- 160 micron pixel
- Tethered
- 4.8kg [+ cable]
- 23 mm thick

**Canon CXDI-55G**
- 35x43 cm wired detector
- Flat panel GOS
- CSI version available
- 160 micron pixel
- Tethered
- 3.4kg [+ cable]
- 15mm thick

**GE portable detector**
- 41x41 cm wired portable detector
- Flat Panel CsI
- 200 micron pixel
- Tethered
- >6 kg [+ cable]
- 25 mm thick

**Trixell Pixium Portable 3543**
- 35x43 cm wireless detector
- Flat Panel CsI
- 144 micron pixel
- Battery operated 2 hr charge
- 4.8 kg (10.6 lbs.)
- 24.8 mm thick

**Carestream DRX-1**
- 35x43 cm wireless detector
- Flat Panel GOS
- Battery, 4 Hrs/90 images/charge
- 15 mm thick
- 8.5 lbs .with battery
The trial

• DR in the size of a x-ray cassette was tested in several locations including
  – Guelph, Ontario
  – Brantford, Ontario
  – Frankfurt, Germany

• Our goals were to understand the dynamics of its use, robustness and test the solution for commercial viability

• Also we needed to establish that this had advantages over CR as expected
Premise

• The speed of a DR system would be complemented by the flexibility positioning possible with a cassette

• For table top, wheelchair, stretcher, and many lateral examinations, positioning flexibility would be improved and thus time to shoot would be improved

• Patients would have a better experience if the tech stayed in the room

• This would be greater than the productivity that existed using CR

So we funded independent research…
Productivity - University Hospital

Klinikum der Johann Wolfgang Goethe Universität
Institut für Interventionelle und Diagnostische Radiologie
Frankfurt, Germany
Conventional Room Upgraded

- Conventional analog x-ray room
- Philips (CS 2/4) Overhead Tube Suspension
- 4 way float (TH) elevator table
- Vertical Stand (VE)
- Originally Installed in 2007
- Maximum usage: 117 images/day
Overview

• Begin with a fast multi-plate CR, wireless DR cassette
• Compare time to position and image
• Stopwatch measured

• Address the question:
  – We know DR is faster, now that we have it in a cassette, how much faster is it in clinical use?
Materials and Methods – Frankfurt, Germany

DR System
- Carestream DRX-1 System – wireless 35x43 cm cassette-sized detector. Specified Image availability 5 -7 seconds Image recycle 18-20 seconds

CR System
- Fujifilm Profect CS 4 plate dual side reader, 18x24cm, 24x30cm and 35x43cm cassettes. Specified Image availability 39 seconds, recycle time 42-60 seconds
- Cassette type C
- ST-VI standard type IP’s
- Standard Pixel density mode

• Consoles for both systems were located side by side in the control area. Both utilize DICOM Work List Management with pre-programmed procedure code mapping. CR reader was located 2m from x-ray control console.
Materials and Methods

Process:
1. Printed patient req from the RIS & patient is brought to room
2. Select patient from worklist on CR/DR console
3. Position for first view
4. Expose first view
5. CR:
   - Barcode ID cassette
   - Process cassette – image sent to console
6. DR: Image automatically transmitted to console
7. Review and approve image
8. Position for next view
9. Timing is measured steps 2-7

Note
• Image quality was judged as very good on both systems
• Strict Dose control is implied throughout the department per strict German laws.
Practical Matters

• **Battery**
  – Lithium Ion polymer

• **Battery life**
  – 4 hours use
  – 70-90 exposures

• **Charger**
  – 3 hour charge cycle
  – 3 battery simultaneous
Detector Details

**Carestream DRX-1**

- 35x43 cm nominal ISO 4090 standard cassette size
- 3.8 kg
- aSi/ GOS
- 139 micron pixel pitch
- 6 second preview image
- Battery or tether powered
- 802.11n Ethernet (WiFi) communication
- WPA encrypted image data
- Aluminum Back
- Carbon fiber front
Preliminary Results

• This is a sneak peak – Full results at ECR in Vienna : ]

• Frankfurt University Hospital compared CR vs. Portable DR.

• Preliminarily- Average time savings in first exposure: 23 seconds
  • (Very Early results)
    – CR ~102 seconds
    – DRX-1 ~79 seconds

• Primary area of savings is processing CR cassette

• If this extends to all exams as expected, time will be significantly reduced

• More to come…
Practical experience – General Hospital

Guelph General Hospital
Guelph, Ontario
Canada
Guelph General Hospital

- Guelph General Hospital
  - 165 bed hospital
  - 224 Staff Physicians
  - 1200 total staff
  - Serves 180,000 people throughout Guelph and Wellington counties
  - Guelph, Ontario is located 105 km west of Toronto
Manager’s Impressions

- Been very happy with the performance
- Throughput is very good
- Radiographers like it
- Held up well in normal usage
Conventional Room Upgraded

- Conventional analog x-ray room
- Siemens Overhead Tube Suspension
- 4 way float (Multix) elevator table
- Polydoros LX50 Generator
- Vertical Stand (Vertix)
- Peak usage: 67 images/day
Non-grid work

• **Comments:**
  Pro:
  – Table top, wheelchair and stretcher work
  – Wireless is convenient
  – Saves processing and waiting

Con:
  – “nothing else really – it is nice to be able to move it around”
Bucky exposures

- **Comments**
  - Very fast image presentation
  - Image quality as good or better than previously
  - Need to occasionally rotate cassette
  - Needed to re-cock Bucky
    - OEM agreed that they would turn off double exposure interlock for permanent installation
Handling of the cassette

- **Durable in normal use**

- **Recalibration done weekly**
  - Approximately 10 minutes

- **About twice the weight of a CR cassette**
  - Reduced handling needed (DR)
    - 3.8kg vs. 2.0kg

Guelph – Ontario, Canada
Radiologist’s Impressions

- Quality at least as good as our other two systems
- It’s all there

Dr. John McKinstry – Radiologist Guelph – Ontario, Canada
Experience of others - General Hospital

Brantford General Hospital
Brantford, Ontario
Canada
Brantford Community Healthcare System

- Brantford General Hospital
  - 300 Beds
  - Serving 120,000 people in Brant county
  - 175 Physicians on staff
  - 1282 Employees
  - Located 112 km west of Niagara Falls
Conventional Room Upgraded

- Conventional analog x-ray room
- Philips (CS 2/4) Overhead Tube Suspension
- 4 way float (TH) elevator table
- Vertical / Tilting Stand (VT)
- Originally Installed in 2007
- Maximum usage: 150 images/day
Flexibility – Used for both Buckys

- **One DR Cassette used for Table and Wall**
  - 3 of 4 test sites used for both Buckys

**Pro:**
- Cost savings
- [No complaints on moving as needed]

**Cons:**
- Need to move DR Cassette
  - Time: ~20-30 seconds

Brantford – Ontario, Canada
Ease of use

• **Comments:**
  - Positioning similar to 35x43 CR cassette
  - Much easier than fixed DR
  - GUI Same as existing Carestream CR & DR
Image Quality

- DR has inherently higher quality than CR
- Flat field correction/ Fixed noise
- Tested unit is GOS / aSi
- Dr. Miller’s Comments:
  - Much better than what they had before [CR]
  - Very good ‘clarity’
Patient Care

- Faster turn around should improve patient care
- Less waiting
  - In waiting room
  - For results
  - Potentially for treatment (may be lost in the scheduling ‘noise’ for many patients)

Dr. Lewis Miller - Director of Radiology, Brantford, Ontario
Summary and Discussion

Points to consider
Three virtues that address the need

**Portable Detector DR**

**Concept**

- Fits
  - The bucky (cassette sized version)
  - The workflow

**Potential Benefit**

- Fast
  - It’s DR
  - It’s flexible to position
  - It’s quick to install

- Cost Effective
  - No room renovation
  - Frees resources for other rooms

Summary of experience
Portable detectors are reaching beyond room upgrades…

DRX1 / AMX 4+

Siemens Mobilette

AMX-700
Conclusion
Conclusion

Consistent feedback from multiple test sites

- Technologist noted increased time with patients
- Positioning was easier than fixed DR for many exams
- Productivity was improved over CR in time to image with two caveats:
  - Auto collimation was always 14x17 - requiring manual collimation for smaller sizes
  - Double exposure protection may need to be turned off as it can be an annoyance
- Training time was short
- Image quality was considered very good
- May enhance department’s potential to offer improved patient care
References for future study

- Population projections from US Census office [www.census.gov/](http://www.census.gov/)
Thank You!

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