Tumor Assessments: ENABLE RECIST with More Informative Multimedia Radiologist Reports

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Disclosures/ Disclaimer

• Presenter has a research agreement with Carestream Health
  – Rochester, NY

• Presenter has an issued patent on combined CT Window/ Level

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Background, Overview

• How our process differs: technology and workflow

• Highlights from oncologists and radiologists survey results*
  – To improve radiologist report quantification in cancer trials
  – Our “process” was previously inadequate with discrepancies

• Share our first year of experience using multimedia reports
  – Reports with hyperlinked measurements, tables and graphs
  – Interface to export measurement data to RECIST forms, databases

How our process differs: technology and workflow

• Within PACS tumor data management (eliminate handwriting)
  – Carestream Health v 12.0

• Ideal workflow: radiology report includes RECIST calculations
  – Radiologists measure consistently with Radiologist Assistant (RA)
  – RA verifies baseline date and target lesions, measures, relates
  – This allows for oncologists to have same day tumor response

• Although vendor dependent, some may be generalizable
  – We have scripted open-source (pending) interface* to export data

Experience with Multi media radiology reporting

– Have been using now for over one year (started Feb 2015)
– Radiologists measure previously linked annotations (stand out)
– Improved tumor assessment process and concordance
  • Now more consistent radiologists measurements, oncologists use them
  • Reduced duplicate efforts with improved efficiency
– Radiologists have fewer interruptions
  • Radiologist assistants measure / close oncology communications gaps
    – E.g. for tedious measurement discrepancies
NIH Clinical Center Oncologist, Radiologist Survey*

• We aimed to improve prior tumor assessment “process”
  – Surveyed radiologists and oncologists preferences on reporting
  – Prior schema was disjoint, inconsistent, tedious, inefficient
    • Oncologists would handwritten measurements, slice/image # on paper forms

• We found oncologists often measure lesions independently
  – Or search for measurements buried in our prior text only reports
  – It was tedious trying to match target lesions on images in PACS

• Survey verified oncologists and radiologists prefer hyperlinks
  – The report hyperlinks take clinicians to annotated measurements

Are Radiologists' Reports Adequate for Oncology Assessment?

*Folio LR. Quantitative Radiology Reporting in Oncology: Survey of Oncologists and Radiologists. AJR. 2015*
Radiologists’ Satisfaction with Current Clinical History

Question:
Current clinical history on imaging requests is satisfactory for radiologists to provide tumor assessments.

![Bar chart showing satisfaction levels with current clinical history]

- **Strongly agree**
- **Agree**
- **Neutral**
- **Disagree**
- **Strongly disagree**

**CLINICAL INDICATION:** flu, per protocol.

**TECHNIQUE:** CT scan, whole body protocol.
Question:
How would you prefer tumor measurements presentation in radiology reports?

* Folio LR. Quantitative Radiology Reporting in Oncology: Survey of Oncologists and Radiologists. AJR. 2015
Tumor Data Management

• Most oncologists surveyed (93%) would prefer to manage measurements and calculations within PACS
  – Now can directly export to RECIST forms, EMR and databases (C3D)

* Folio LR. Quantitative Radiology Reporting in Oncology: Survey of Oncologists and Radiologists. AJR. 2015
Radiology Reporting Revitalized


**FINDINGS:**

Chest CT:
Mediastinum: Small mediastinal adenopathy for example subcarinal measured 2.6 cm by 1.6 cm in series 2 slice number 27. Also, there is a right hilar adenopathy measuring approximately 5 cm on its long diameter. There is an another lymph node more inferiorly measuring about 2 cm by 1.8 cm. No pericardial or pleural effusions. Lung window portion of this examination demonstrates unchanged lung nodules for example right upper lobe measuring 1.2 cm by 1 cm in its shortest diameter. Heart and great vessels are apparently unremarkable. Abdomen: Celiac artery and SMA origins are enhanced normally. Pancreas is normal, right kidney and left kidney are seen without apparent abnormalities. Right and left adrenal are normal. Liver parenchyma has similar hypodensity to the prior study. Retroperitoneal periaortic regions have tiny lymph nodes, non measurable. Pelvis: Along central pelvis, all structures look normal; whereas, sidewalls show an anterior pelvic mass unchanged on size compared with prior pelvic examination. Osseous structures: there is a lucency in the left iliac bone with sclerotic margins unchanged.

**IMPRESSION:**
1. Unchanged lung nodules
2. Stable mediastinal and hilar adenopathy/masses
3. Stable anterior pelvic wall mass
4. No new soft tissue mass

**FINDINGS:**

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Mediastinum: Small mediastinal adenopathy for example subcarinal measuring 2.6 cm by 1.6 cm in series 2 slice number 27. Also, there is a right hilar adenopathy measuring approximately 5 cm on its long diameter. There is another lymph node more inferiorly measuring about 2 cm by 1.8 cm. No pericardial or pleural effusions. Lung window portion of this examination demonstrates unchanged lung nodules for example right upper lobe measuring 1.2 cm by 1 cm in its shortest diameter. Heart and great vessels are apparently unremarkable. Abdomen: Celiac artery and SMA origins are enhanced normally. Pancreas is normal, right kidney and left kidney are seen without apparent abnormalities. Right and left adrenal are normal. Liver parenchyma has similar hypodensity to the prior study. Retroperitoneal periaortic regions have tiny lymph nodes, non measurable. Pelvis: Along central pelvis, all structures look normal; whereas, sidewalls show an anterior pelvic mass unchanged on size compared with prior pelvic examination. Osseous structures: there is a lucency in the left iliac bone with sclerotic margins unchanged.

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**FINDINGS:**

Chest CT:
Lungs, pleurae: Unchanged lung nodules for example right upper lobe (0.8 cm x 0.4 cm) (series 4, image 84)
Mediastinum, heart, great vessels: Unchanged mediastinal adenopathy for example subcarinal (2.5 cm x 1.4 cm) (series 2, image 27) and right hilar adenopathy for example (5.1 cm x 2.4 cm) (series 2, image 32) and (2.1 cm x 1.4 cm) (series 2, image 25)
Abdomen CT:
Lymph nodes, abdominopelvic vascular: unremarkable
Liver, spleen, biliary, gallbladder, pancreas: unremarkable
GU Kidneys, ureters, adrenal glands: unremarkable
GI Small and large bowel, mesentery, peritoneum: unremarkable
Pelvic CT: Central pelvis, sidewalls: Unchanged anterior pelvic wall mass.
Osseous structures, spine, body wall, soft tissues: unremarkable

**IMPRESSION:**
1. Unchanged lung nodules
2. Stable mediastinal and hilar adenopathy/masses
3. Unchanged anterior pelvic wall masses
4. No evidence of new soft tissue mass
**FINDINGS:**

Chest CT:
Lungs, pleurae: Unchanged lung nodules for example
right upper lobe (1.9 cm x 1.5 cm) (series 4, image 81)

Minimizes crosscheck

Metadata automatically included
x, y, z location, who measured, when, relation and designation, name, lesion type
FINDINGS:
Chest CT:
Lungs, pleurae: Unchanged lung nodules for example right upper lobe (0.8 cm x 0.4 cm) (series 4, image 84)
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### RECIST 1.1

**Evaluation of target lesions**

<table>
<thead>
<tr>
<th>Status</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete Response (CR)</td>
<td>Disappearance of target lesions (LN&lt;1cm)</td>
</tr>
<tr>
<td>Partial Response (PR)</td>
<td>$\geq 30%$ decrease from baseline sum of target lesions size</td>
</tr>
<tr>
<td>Progressive Disease (PD)</td>
<td>$\geq 20%$ increase from baseline or best response + absolute increase $\geq 5\text{mm}$ on target or Non target lesions / New lesions</td>
</tr>
<tr>
<td>Stable Disease (SD)</td>
<td>Neither CR or PD</td>
</tr>
</tbody>
</table>

Radiology Report Impression:

“Stable metastatic lesions”

Patients often get conflicting messages in Patient Portal

This number is what “counts”
Body CT Hyperlink Usage

PACS upgrade

Feb  5%
Mar  14%
Apr  44%
May  62%
Jun  69%

April 2015 - 2016

88%
Oncologist time savings to assess tumor burden

- Text only reports:
  15.4 minutes (+/Std Dev 5.9 minutes).
- Multimedia reports
  6.2 minutes (+/Std Dev 2.9 minutes)

Mean time savings with multimedia report
8.9 minutes (P<0.001)

* Folio L. Multimedia Reports. RSNA 2015.
Preliminary: Efficiency Results*

- At least twice as fast to extract measurements
  - Opposed to hunting for measurements buried in text only reports
    - Hyperlinks immediately direct clinicians to the measured tumors
- Synergistic effects with direct data exportation and management
  - Currently evaluating, drastic efficiency improvement: 5 times faster?
  - Undoubtedly will have less data transfer errors**
  - Proposing resource shift from data “management” to acquisition
    - Initially cost-neutral, eventually cost savings by assuring correct data at the start

* Take out “Preliminary” and Ref AJR In press?
Concordance and Data Study Preliminary Results

• There was improved target lesion selection concordance
  – From about half to nearly 80% (easier to correct to 100%)

• Why this is important:
  – Response is based on oncologic records (not radiology reports)
  – Improved concordance allows verified data to be managed in PACS

• Discrepant PACS data was corrected to 100%
  – Since PACS can now be used to manage all response data
  – It is even more efficient to bring 80% to 100% (opposed to 50%)

* Machado L, Folio L. Multimedia Radiology Reports are More informative in Oncology. ARRS 2016
Current Study: Data Management

• Most cancer teams at NIH continue to handwrite
  – On paper RECIST forms, thousands of data points
  – All data then typed from forms to EMR
  – Most are retyped into research databases
  – > 200 NCI oncologists treating > 40 primary cancers

• An NIH Student Intern developed interface*
  – Exports tumor measurements and data
  – No more handwritten measurements on forms
  – One trial is managing all measurements in PACS

* Goyal N. Managing tumor measurements and data in PACS. NIH Student Poster Day. 2016
Limitations

• Annotations on images can be distracting
  – For radiologists or ordering providers, can be toggled off however

• Incompatibility of hyperlinks, tables and graphs with EMR
  – Also patient portal and outside institutions with other PACS vendors
  – Exported data with open source interface can be transferred
  – Annotation Image Markup* (AIM) to address incompatibilities

• Vendor specific (not yet available in many PACS)
  – However, there are technical and workflow options

• Data management interface requires programing to modify

*Mongkolwat P. NCIP AIM Model J Digit Imaging. 2014
Additional Technical Solutions (in alphabetical order)

• **Click*View 7i Analytics**
  http://www.clickview.com/web-analytics/

• **Median Technologies**
  http://www.mediantecnologies.com/

• **Mint Medical**
  https://mint-medical.com/

• **Philips PACS Lesion Tracker**
  http://philips-intellispace-pacs-lesion-tracker.software.informer.com/

• **Siemens Syngo.via for Oncology**
  https://www.healthcare.siemens.com/medical-imaging-it/syngoviaspecialtopics/syngo-via-for-oncology
Summary

• Multimedia radiology reports are more informative and efficient
  – Saving time for both radiologists and oncologists, with “living” reports
  – Fewer transcription errors (handwriting can be eliminated)

• Radiologists quickly adopted use of hyperlinks
  – Convinced it saves us time; with universal acceptance from oncologists.
  – Supporting time savings

• All measurement data can be managed in PACS (at the source)
  – Exported into RECIST forms and batch filed for trial analytics, auditing

ENABLE rather than resist (RECIST)!
• Acknowledgements
  – Deneise Francis, Elizabeth Lamping, Dr Rosie Kaplan (NCI)
  – Dr Andrew Dwyer

• Also, with contact info:
  – Nik Goyal (NIH student that developed the interface)
  – Laura Machado, MD (postdoc demonstrating improved concordance)
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    301.451.4368
  – Les Folio, DO, MPH
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    301.435.8622

Thank you....
References


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