Improving Cancer Diagnosis and Care:

Patient Access to Oncologic Imaging and Pathology Expertise and Technologies

Summary of the February 2018 NCPF workshop
A Call to Action

The diagnostic process is complex, collaborative, and involves clinical reasoning and information gathering.
Today, diagnostic tests influence an estimated 60-70% of all treatment decisions *

*V. J. Dzau: Realizing the Full Potential of Precision Medicine; NAM Perspective, Sept. 2016

Imaging is essential for initial and follow-up treatment decisions for nearly every cancer
Oncologic Imaging

At every step of Cancer Care

• Cancer Screening
  (Ca Breast & Lung)

• Cancer Detection/Localization

• Treatment Planning
  Imaging is a Road Map (GPS)
  Exploratory Laparotomy
  is no longer used for diagnostics

• Treatment Follow-up
  o Monitoring Treatment Response
  o Detection of Tumor Recurrence

Virtual Laparotomy by Imaging
Molecular Imaging

Imaging Biology of Prostate Cancer Metastasis

Precision in Therapy Selection

Imaging as In Vivo Companion Diagnostics

Hricak H.: Oncologic Imaging: A Guiding Hand of Personalized Cancer Care; Radiology 2011
F-FES PET/CT was used as a biomarker of ER suppression during Phase I dose escalation trial showing ER downregulation with >90% decrease in SUV for BRD = 600mg/day – dose chosen for Phase II trial.
Theranostics: Molecular Imaging & Therapy

Metastatic NET - Targeting Somatostatin receptors

Before therapy

After Lutetium-177 (177Lu) DOTA-TATE

Imaging (\(^{68}\text{Ga}\)) DOTA-TATE

Therapy (\(^{177}\text{Lu}\)) DOTA-TATE Lutathera

Hricak H: Beyond Imaging-Radiology of Tomorrow; Radiology 2018
# Diagnostic Errors

## Imaging & Surgical Pathology

- **Pathology – 6%***

- **Radiology 18%***

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<table>
<thead>
<tr>
<th>TOP CLINICAL JUDGMENT FACTORS</th>
<th># CASES*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure/delay in ordering diagnostic test</td>
<td>457</td>
</tr>
<tr>
<td>Misinterpretation of dx studies (X-rays, slides, films)</td>
<td>375</td>
</tr>
<tr>
<td>Narrow dx focus, failure to establish differential dx</td>
<td>246</td>
</tr>
<tr>
<td>Failure/delay in obtaining consult/referral</td>
<td>235</td>
</tr>
<tr>
<td>Failure to rule out abnormal finding</td>
<td>167</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TOP COMMUNICATION FACTORS</th>
<th># CASES*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication among providers regarding pt's condition</td>
<td>164</td>
</tr>
<tr>
<td>Patient/family communication - follow up instructions</td>
<td>159</td>
</tr>
<tr>
<td>Failure of provider to read medical record</td>
<td>61</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TOP CLINICAL SYSTEM FACTORS</th>
<th># CASES*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient did not receive results</td>
<td>133</td>
</tr>
<tr>
<td>Lack of/failure in follow/up system, new finding</td>
<td>113</td>
</tr>
<tr>
<td>Clinician did not receive results</td>
<td>43</td>
</tr>
<tr>
<td>Failure to identify provider coordinating care</td>
<td>33</td>
</tr>
</tbody>
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### Diagnostic Errors – Radiology

**Added Value of Second Opinion by Oncologic Imager**

<table>
<thead>
<tr>
<th>Author</th>
<th>Site</th>
<th>Modalities</th>
<th>n</th>
<th>Disagreement</th>
<th>Change in Management</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lorenzen J, 2012</td>
<td>Breast</td>
<td>Real-time US, mammo</td>
<td>374</td>
<td></td>
<td>26%</td>
<td>Germany</td>
</tr>
<tr>
<td>Lysack JD, 2013</td>
<td>H&amp;N</td>
<td>CT, MRI</td>
<td>94</td>
<td>56%</td>
<td>38%</td>
<td>Canada</td>
</tr>
<tr>
<td>Spivey TL, 2015</td>
<td>Breast</td>
<td>US, mammo</td>
<td>380</td>
<td></td>
<td>53%</td>
<td>Chicago IL</td>
</tr>
<tr>
<td>Hatzoglou V, 2016</td>
<td>Neuro</td>
<td>CT, MRI</td>
<td>283</td>
<td>19%</td>
<td>15%</td>
<td>MSKCC</td>
</tr>
<tr>
<td>Lakhman Y, 2016</td>
<td>GYN</td>
<td>MRI</td>
<td>469</td>
<td></td>
<td>20%</td>
<td>MSKCC</td>
</tr>
<tr>
<td>Coffey K, 2017</td>
<td>Breast</td>
<td>MRI, mammo</td>
<td>200</td>
<td>28%</td>
<td>13%</td>
<td>MSKCC</td>
</tr>
<tr>
<td>Horvat JV, 2017</td>
<td>Breast</td>
<td>Real-time US</td>
<td>209</td>
<td></td>
<td>32%</td>
<td>MSKCC</td>
</tr>
<tr>
<td>Mannelli L, 2018</td>
<td>Pancreas</td>
<td>CT, MRI</td>
<td>65</td>
<td>13%</td>
<td>20%</td>
<td>MSKCC</td>
</tr>
</tbody>
</table>
Misinterpretation of the Diagnostic Imaging studies

Top Contributing Factors

<table>
<thead>
<tr>
<th>FACTOR</th>
<th>% CASES*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical Judgment</td>
<td>67%</td>
</tr>
<tr>
<td>Communication</td>
<td>23%</td>
</tr>
<tr>
<td>Technical</td>
<td>22%</td>
</tr>
<tr>
<td>Administrative</td>
<td>16%</td>
</tr>
<tr>
<td>Clinical Systems</td>
<td>16%</td>
</tr>
</tbody>
</table>

TOP CLINICAL JUDGMENT FACTORS

- Misinterpretation of dx studies 48% (639)

PROCEDURE

<table>
<thead>
<tr>
<th>PROCEDURE</th>
<th>% CASES</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT scan (Abdomen, Head, Chest)</td>
<td>18%</td>
</tr>
<tr>
<td>Diagnostic radiography (CXR / Ortho)</td>
<td>13%</td>
</tr>
<tr>
<td>Mammography</td>
<td>10%</td>
</tr>
<tr>
<td>MRI (Magnetic Resonance Imaging)</td>
<td>10%</td>
</tr>
<tr>
<td>Diagnostic ultrasound</td>
<td>3%</td>
</tr>
</tbody>
</table>

ADDITIONAL CLINICAL JUDGMENT FACTORS INCLUDE:

- Failure to appreciate / reconcile relevant sign/symptom/test result
- Narrow dx focus—failure to establish differential diagnosis
Where Are the Radiologists?

Less populous and more rural counties have fewer radiologists overall and less radiologists subspecialty.
Potential Actions to Improve Patient Access to High-Quality Oncologic Imaging

**Improve Education and Training in Oncologic Imaging**
- Update core and continuing radiology curricula, training, and evaluation to include a greater emphasis on oncologic imaging competencies
- Facilitate and recognize oncology subspecialization in radiology
- Use peer-learning programs to promote quality improvement among radiologists
- Prepare radiologists to incorporate machine learning algorithms into clinical practice
- Emphasize communication and intra- and interdisciplinary collaboration

**Expand Access to Expertise in Oncologic Imaging**
- Form second-opinion networks and cancer imaging consortia
- Develop tools and mechanisms for imaging referrals at cancer centers
- Build community capacity in oncologic imaging through telementoring
- Create oncologic imaging expertise within radiology departments

Adapted with Permission from the National Academies Press, 2018
Increase Integration and Collaboration Among Specialties in Cancer Care

- Engage tumor boards to help integrate specialties for diagnosis and care management
- Provide incentives for interdisciplinary collaboration

Improve and Adopt Use of Clinical Decision Support

- Collaborate with patients and physicians to design decision support tools
- Effectively embed decision support tools into clinical workflow
- Incorporate patient-reported outcome measures (PROMs) within these systems
- Create machine-readable clinical practice guidelines

Adapted with Permission from the National Academies Press, 2018
Potential Actions to Improve Patient Access to High-Quality Oncologic Imaging

Support Innovation in Oncologic Imaging
• Develop machine learning methods to process complex, multi-modality, time-based data
• Use artificial intelligence and interconnectivity to create a more dynamic, proficient, precise, and efficient healthcare workforce
• Ensure appropriate validation and workforce training before disseminating new technologies into clinical practice.

Improve Data Curation, Integration, and Sharing
• Develop systematic approaches for data curation, anonymization, and aggregation
• Standardize data elements and information nomenclature
• Use structured or synoptic reporting to ensure data completeness and quality
• Adhere to the FAIR principles (findable, accessible, interoperable, and reusable)
• Include data from diverse populations

Adapted with Permission from the National Academies Press, 2018
• Issues similar to Radiology are faced by pathology
• Should there be mandatory review of all new cancer diagnoses?
• Use of checklists for pathology sign out?
• Beware of dissemination of new technologies without an adequate evidence base & workforce training.
• Need for standardized display of meaningful data, data integration, timely communication of findings
• Convergence of imaging and pathology on the horizon as pathology goes digital – Integrated Diagnostics
Cancer Diagnostics - Integrated Diagnostics - A Team Effort
Convergence of Life Science, Physical Science, Engineering & Beyond

IMAGING
PATHOLOGY

High-Performance Computing
Big Data
BioPortal
PRECISION MEDICINE
Machine Learning
Clinical Trials
Proteomics
Clinical Bioinformatics
Pattern Discovery
Clonal Heterogeneity

Reference Databases
Biobanking
Precision Oncology: Integrated Diagnostics
Quantitative, Multidimensional, Dynamic Evaluation of Cancer

Measurement Domains - Standardized and Quantitative

- Nucleic Acids
- Proteins
- Small Molecules/Metabolites
- Pathology
- Radiology
- Clinical Informatics

Personalized Treatment
Precision Oncology Medicine, Surgery, Rad Onc and/or Image-guided Intervention

Predictive Modeling
Biomarkers
Prior Outcome data

Integrative Analysis
Computable data
Connected databases
Intuitive visualization
The complexity of cancer diagnosis and treatment requires a multidisciplinary approach - integrated teams of oncologists, surgeons, rad. onc, pathologists, radiologists, APP, nursing & biomedical informaticians.

- **Governance**: Formal interdisciplinary governance structure within an organization is critical to set standards and monitor progress.
- **Measurement**: Measure outcomes frequently, and modify plans accordingly.
- **Essential requirements for quality improvement**:  
  o Culture (constructive not punitive)  
  o Infrastructure (data systems and analysts)  
  o Leadership (clinical and operational)
Thank you!