Effectiveness of Barcode Tracking

In Documenting Errors & Preventing Patient Specimen Identification Incidents in Anatomical Pathology Laboratory

Dr K.C. Lee
COS(Pathology)

Department of Pathology
Princess Margaret Hospital

15 May 2013
“Identification error is the single most important cause of patient safety incidents in pathology.”

Lord Carter’s review of NHS Pathology Services submission of the Royal College of Pathologists, 2006
Laboratory Processing Quality is Among the Best

Source: modified from C. Buck, GE
Laboratory Errors – When and Where

• One study of 129 incidents*
  – 71% pre-analytical, 18% analytical, 11% post-analytical
  – 30% involved cognitive error (incorrect choices caused by insufficient knowledge)
  – 73% involved non-cognitive error (lapses in expected automatic behavior)

• 95% potential adverse events
• 73% preventable – including patient specimen identification errors

* Classifying laboratory incident reports to identify problems that jeopardize patient safety.
Histology laboratory workflow has not changed in decades

Yet

- Increasing volume
- Expanding scope and complexity
- Processing remain largely manual
Anatomical pathology laboratory results often have a high impact in patient management.
Full of Mislabeled Opportunities

- Case accessioned
- Pathologist dictates gross description *(Gross Room)*
- Stickers with labels applied *(Histology)*
- Pathologist requests additional blocks *(Gross Room)*
- Pathologist calls up case to enters diagnosis *(Offices)*
- Slides pre-labeled by hand *(Histology)*
- Cassettes preprinted and placed with specimen *(Gross Room)*

= Opportunity for transcription error
Tissue and Cytology Specimens Processing Is Prone to Errors

• Large study of 136 institutions, 427,255 cases*
• Errors occur in the procurement, accessioning, and processing of surgical pathology specimens
• Overall mislabeled rates of 1.1 per 1,000 cases:
  – 1.0 per 1,000 specimens
  – 1.7 per 1,000 blocks
  – 1.1 per 1,000 slides
• Wide range of reported error rates

*Mislabeling Rate of Specimens, Blocks, and Slides in Surgical Pathology
College of American Pathologists QP094, 2009
Difficulties in Estimation of Identification Errors

• Lack of effective and timely information collection mechanism
• Variation in reporting practices
• Differences in defining errors
• Stigma of disclosing errors
Objectives

• To develop a tracking system capable of process-specific error capturing and documentation in every step of manual steps of specimen transfer

• To implement an automatic mismatch error reporting mechanism in order to assess the effectiveness of the system in preventing potential specimen identification incidents, and for implementing targeted quality improvement measures
# Achievable Error Rates

<table>
<thead>
<tr>
<th>Error rates</th>
<th>Error Prevention Methods</th>
<th>Real world Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/100</td>
<td>Clear process</td>
<td>Errors filling out lab requisition</td>
</tr>
<tr>
<td></td>
<td>Reliance on education/vigilance</td>
<td>Failure to give results to patients</td>
</tr>
<tr>
<td>1/1,000</td>
<td>Systems for error identification and mitigation</td>
<td>Mislabeled specimens</td>
</tr>
<tr>
<td>1/10,000</td>
<td>Advanced design + Automation</td>
<td>Specimen loss</td>
</tr>
<tr>
<td>1/100,000</td>
<td>Error ID/ mitigation</td>
<td>Computer interface errors</td>
</tr>
</tbody>
</table>

To go from 1/1,000 → 1/10,000 requires automation.

Resar RK. Making noncatastrophic health care processes more reliable... Health Serv Res. 2006; 41:1677-1689.
Towards Error-free Specimen Identification through Automation

<table>
<thead>
<tr>
<th>Laboratory Testing</th>
<th>Front-end Automation</th>
<th>Workflow Automation</th>
<th>Instrument Automation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Hematology</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Blood Bank</td>
<td>No</td>
<td>No</td>
<td>Available</td>
</tr>
<tr>
<td>Microbiology</td>
<td>No</td>
<td>Evolving</td>
<td>Limited</td>
</tr>
<tr>
<td>Anatomical Pathology</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
Using 2D Barcodes in Laboratory

Why use 2D barcodes?
- Low cost methods for printing & reading
- May provide unique, permanent identification
- Small footprint – required for printing onto slides and blocks

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Manual Matching</th>
<th>Bar Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed (12 Digits)</td>
<td>6 Sec</td>
<td>0.3 to 2 Sec</td>
</tr>
<tr>
<td>Error Rate</td>
<td>1 in 300</td>
<td>1 in 10.5 million to 1 in 612.9 million</td>
</tr>
<tr>
<td>Advantages</td>
<td>Human readable</td>
<td>Low Error Rate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low Cost</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High Speed</td>
</tr>
<tr>
<td>Disadvantages</td>
<td>Human High Cost</td>
<td>Requires Training</td>
</tr>
<tr>
<td></td>
<td>High Error Rate</td>
<td>and Workflow Re-design</td>
</tr>
<tr>
<td></td>
<td>Inflexible</td>
<td></td>
</tr>
</tbody>
</table>

Block Proof

Section Pickup

Slide Release

Slide Inventory
Conventional (Imprinting) Approach

*Changing workflow to fit into the system*

Gross Specimen is Accessioned

Gross Specimen and Paperwork are Bar Coded

Gross Specimen Bar Code is Scanned to Imprint Cassettes

Bar Coded Cassettes are Printed Using Data Directly from LIS

Bar Coded Cassettes are Scanned at the Cutting Station

Bar Coded StainerShield Labels are Printed On-Demand at Cutting Station With Data Directly from LIS

Bar Coded Slides are Scanned By Pathologist and Transcriber for Entry of Results

*Without the ability to batch processing* the simple linear approach requires barcode printing at the spot of transfer, and thus costly and inefficient, and therefore is not widely used.
Limitations of Conventional Systems

- Commercially available systems are all conventional designs and mostly are simple with limited capability
- More comprehensive systems are expensive and requiring substantial change in workflow
  - Slide pre-print not possible or not practicable – affecting efficiency
  - May require more manpower as batch processing not possible
- Most cannot make use of existing barcode-printable slide and cassette printers
- Options for expansion of scope to support other automation needs are limited
An Novel (Relational Coupling) Design

The new design for better efficiency and cost-effectiveness

Referencing to relational map

Creation of relational map

Start

Print parent item barcode (e.g. Specimen ID)

Relational Coupling

Print child items (e.g. Block ID)

Correction

Successful

Transfer specimen to next processing step

Failure

An Novel (Relational Coupling) Design

The new design for better efficiency and cost-effectiveness

Referencing to relational map

Creation of relational map

Start

Print parent item barcode (e.g. Specimen ID)

Relational Coupling

Print child items (e.g. Block ID)

Correction

Successful

Transfer specimen to next processing step

Failure

An Novel (Relational Coupling) Design

The new design for better efficiency and cost-effectiveness

Referencing to relational map

Creation of relational map

Start

Print parent item barcode (e.g. Specimen ID)

Relational Coupling

Print child items (e.g. Block ID)

Correction

Successful

Transfer specimen to next processing step

Failure

An Novel (Relational Coupling) Design

The new design for better efficiency and cost-effectiveness

Referencing to relational map

Creation of relational map

Start

Print parent item barcode (e.g. Specimen ID)

Relational Coupling

Print child items (e.g. Block ID)

Correction

Successful

Transfer specimen to next processing step

Failure
Conventional Approach
vs
Novel Design

Imprinting

Relational-coupling
Comparison of Conventional (Imprinting) and Novel (Relational Coupling) Approaches

<table>
<thead>
<tr>
<th>Specimen Transfer Sequence</th>
<th>Imprinting</th>
<th>Relational-coupling</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Scan – Print – Transfer</td>
<td>Print – Scan – Transfer</td>
<td>Juxtapose scanning and transfer for greater security</td>
</tr>
<tr>
<td>Batch &amp; Parallel Processing</td>
<td>No</td>
<td>Yes</td>
<td>Reduce cost and improve efficiency</td>
</tr>
<tr>
<td>Slide Pre-printing</td>
<td>No</td>
<td>Yes</td>
<td>More adaptable to different workflow</td>
</tr>
<tr>
<td>Easy Extension to Other Applications</td>
<td>No</td>
<td>Yes</td>
<td>Readily extensible to item tracking, slide and block inventory, specimen disposal etc.</td>
</tr>
</tbody>
</table>
System Development & Implementation

- A web-based Relational Coupling system implemented in PMH since 1st May 2010
- Successfully implemented in the Anatomical Pathology laboratories of 5 hospitals: PMH, YCH, PYNEH, TMH and POH
Barcode Tracking & Error Prevention

1. Preparation

2. Scanning

3. Coupling

4. Logging
Results (1)

- Over 500,000 specimens, tissue cassettes, and slides with unique 2D barcodes printed
- At PMH, in 12-month period from Feb 2012 to Jan 2013, a total of 35,934 laboratory requests were processed
- Efficient and readily adapted to different workflow
Results (2)

No identification incident had been encountered

All mismatch errors were correctly signaled to the operating technician for immediate correction

Feb 2012 – March 2013 (PMH)
Results (3)

Potential errors **Prevented** by the tracking system

<table>
<thead>
<tr>
<th>Coupling</th>
<th>Mismatches</th>
<th>Item Processed</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specimen Sampling</td>
<td>117</td>
<td>46,386</td>
<td>0.38</td>
</tr>
<tr>
<td>Section Pickup</td>
<td>442</td>
<td>66,605</td>
<td>0.66</td>
</tr>
<tr>
<td>Slide Release</td>
<td>310</td>
<td>134,305</td>
<td>0.38</td>
</tr>
<tr>
<td>Task Finalizing</td>
<td>265</td>
<td>25,973</td>
<td>1.02</td>
</tr>
</tbody>
</table>

Feb 2012 – March 2013 (PMH)
Conclusion

- A novel design barcode tracking system has been successfully developed and implemented to fit into the complex workflow of Anatomical Pathology laboratory.
- The system, with automatic error capturing, is highly effective in ensuring correct patient specimen identification.
- The automatic process-specific error reporting, with information hitherto unavailable by manual means, would be very useful for implementing further targeted measures for continuous quality improvement.