Relational Coupling by 2-D Barcodes

A Novel Approach to Positive Patient and Specimen Identification in Tissue and Cytology Specimens

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Identification errors 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
Tissue and Cytology Specimens Processing Is Prone to Errors

- Multiple manual procedures
- Transferring and transforming specimens from one state to another during processing
- Results often have a high impact in patient management

**Mislabeling Rate of Specimens, Blocks, and Slides in Surgical Pathology**

136 institutions, 427,255 cases.

- 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

College of American Pathologists QP094, 2009
Using 2D Barcodes in Tissue and Cell Processing

Why use 2D barcodes?
- History of use in industry (including healthcare)
- Low cost methods for printing & reading
- May provide unique, permanent identification
- Reduce errors in data entry or recognition

<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>Up to 1 in 36 Trillion</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</td>
<td>Requires Training and</td>
</tr>
<tr>
<td></td>
<td>High Cost</td>
<td>Workflow Redesign</td>
</tr>
<tr>
<td></td>
<td>High Error Rate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inflexible</td>
<td></td>
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</tbody>
</table>
Imprinting Approach

The conventional linear method employed elsewhere

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 labels are printed on-demand at Cutting station with data directly from LIS

Bar coded slides are scanned by pathologist 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.
Relational Coupling with 2-D Barcodes
A Novel Approach to Designing a Reliable & Cost-effective Identification System
Advantages of **Relational Coupling** over Conventional **Imprinting** Approach

<table>
<thead>
<tr>
<th></th>
<th>Imprinting</th>
<th>Relational-coupling</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specimen Transfer Sequence</td>
<td>Scan – Print – Transfer</td>
<td>Print – <strong>Scan</strong> – 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>Improve cost and efficiency</td>
</tr>
<tr>
<td>Easy Extension to Other Applications</td>
<td>No</td>
<td>Yes</td>
<td>Item tracking, slide and block inventory, tasking, specimen disposal etc</td>
</tr>
</tbody>
</table>
Results

- From May 2010 to Feb 2012, a total of 44,404 laboratory requests were processed at PMH, involving unique 2D barcode identifiers for:
  - 67,705 specimen containers
  - 115,876 tissue cassettes
  - 210,863 histology and cytology slides

- No identification incident had been encountered in the 18-month period.
Potential Errors Prevented by the Introduction of 2D Barcode Relational Coupling Method

Study period: 1 Feb 2012 – 31 March 2012

<table>
<thead>
<tr>
<th>Coupling</th>
<th>Potential Errors</th>
<th>Item Processed</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block Proof Specimen ↔ Block</td>
<td>204</td>
<td>24447</td>
<td>0.83</td>
</tr>
<tr>
<td>Section Pickup Block ↔ Slide</td>
<td>153</td>
<td>22512</td>
<td>0.68</td>
</tr>
<tr>
<td>Slide Release Accession ↔ Slide</td>
<td>81</td>
<td>28875</td>
<td>0.28</td>
</tr>
</tbody>
</table>
Security from Start to Finish

Accessioning
- Barcode printing and labelling
- Block-proof & Smear preparation

Procurement

Processing
- Section Pickup & Slide Release

Reporting
- Task Assembling
- Task Bundling
- Task Finalization

Tasking

Archiving
- Slide-proof

Specimen Disposal
- Slide Inventory Check-in and Check-out

Dispatching
Conclusion

A Novel Approach to Ensure Patient Safety Cost-Efficiently

- Highly Reliable
  - Besides the accuracy of 2D barcodes, the new print-scan-transfer sequence has brought verification and transfer steps closer together to **further minimize the identification risks**

- Better Process Control
  - With **automatic tracking and documentation** throughout the processing steps, valuable information hitherto unavailable by manual means would become accessible for continuous quality improvement

- Flexible and Extensible
  - The highly adaptable system has been **successfully implemented in laboratories with very different workflows**, and its unique ID design enabled extension to application scope beyond correct identification

- More Cost-effective
  - The ability to batch processing has **saved both cost and space**, and more readily fit into current workflow