Learning Objectives

• Review major advances in endoscopic imaging
• Discuss link between imaging and therapy
• Review specific examples of advanced imaging linked to therapy
  • Barrett’s and Squamous cell cancer esophagus
  • Colitis associated dysplasia
  • Inflammatory diseases of the gut (IBD, IBS, Celiac)
• Speculate about future applications
  • Measuring tumor antigens and drug targets
### Technologies
- High Definition
- Chromoendoscopy
- Digital Chromoendoscopy (NBI, FICE, iScan)
- Endomicroscopy
- Molecular Imaging

### Applications
- Polyp detection and classification
  - Polypectomy for only adenomas
  - Resect and and discard
  - Real time guide to Rx (EMR)
- Colitis dysplasia detection
  - Eliminating random biopsy
  - EMR for ALMs
- Barrett’s and squamous dysplasia detection and Rx
- Real time guide to Rx

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#### 2nd Generation NBI (190/290 Series)
**Technical:** 170deg FOV, 13.2 mm OD, 3.7 mm channel

**Dual Focus**

**Improved Vascular Contrast**

**NBI Brighter Image**

180 NBI  
190 WL  
190 NBI
BLI (Blue Laser Imaging: Fujifilm)

New imaging technology using laser light source

Three observation modes

① BLI : Highlighting superficial information with shorter wavelength
② BLI-bright : Brighter for distant view with highlighting superficial information
③ White light : Compatibility with conventional system

Wide Angle Endoscopes and Devices

• Full-Spectrum Endoscopes (FUSE)
  • 3 cameras-3 screens

  Gralnek et al., Lancet Oncology, 2014;15:353-360

• Extra-wide-angle-view-endoscopes (EWAVE)
  • 2 cameras-1 screen

  Uraoka et al. GIE, 2013;77:480-483
Confocal Endomicroscopy

Pentax/Optiscan

Mauna Kea, CellVizio

Volumetric Laser Endomicroscopy (nVLE)/Optical Frequency Domain Imaging (OFDI)
Volume Esophageal Imaging with OFDI

Tethered Capsule OFDI:

Applications and Advancements in the Use of High-resolution Microendoscopy for Detection of Gastrointestinal Neoplasia

Clinical Gastroenterology and Hepatology, Volume 12, Issue 11, 2014, 1789 - 1792

http://dx.doi.org/10.1016/j.cgh.2014.08.004

Low Cost, High Resolution Microendoscopy

Applications to GI Cancers/Precancers
Can Advanced Imaging Replace Random Biopsy in IBD Surveillance?

IBD: DALM vs ALM
New Guidelines for IBD Surveillance: SCENIC

- HD is recommended over Std Definition
- When using Std Def, Chromo is recommended
- When using HD, Chromo is suggested
- No consensus on whether random biopsy is needed above and beyond targeted biopsy*
- Endoscopic removal of all visible dysplasia

*ECCO: Target is preferred over random*

Can Advanced Imaging Increase Adenoma Detection?
NBI Does Not Increase Adenoma Detection: A Meta-Analysis

Dinesen et al. GIE 2012;75:604

Accuracy of in vivo colorectal polyp discrimination by using dual-focus high-definition narrow-band imaging colonoscopy

<table>
<thead>
<tr>
<th>Study ID</th>
<th>RR (95% CI)</th>
<th>Events, Treatment</th>
<th>Events, Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rex et al (2007)</td>
<td>0.97 (0.84, 1.11)</td>
<td>141/217</td>
<td>146/217</td>
</tr>
<tr>
<td>Adler et al (2008)</td>
<td>1.36 (0.91, 2.04)</td>
<td>45/198</td>
<td>33/198</td>
</tr>
<tr>
<td>Inoue et al (2008)</td>
<td>1.23 (0.89, 1.71)</td>
<td>51/122</td>
<td>41/121</td>
</tr>
<tr>
<td>Koltersbach et al (2008)</td>
<td>1.15 (0.89, 1.47)</td>
<td>66/135</td>
<td>62/141</td>
</tr>
<tr>
<td>Adler et al (2009)</td>
<td>1.03 (0.84, 1.27)</td>
<td>140/625</td>
<td>137/631</td>
</tr>
<tr>
<td>Pagli et al (2009)</td>
<td>0.98 (0.78, 1.24)</td>
<td>59/103</td>
<td>63/108</td>
</tr>
<tr>
<td>Overall (I-squared = 0.4%, p = 0.413)</td>
<td>1.06 (0.97, 1.16)</td>
<td>504/1400</td>
<td>482/1416</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Study ID</th>
<th>Accuracy for histology predication (all polyps)</th>
<th>190</th>
<th>180</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy for histology predication (all polyps)</td>
<td>79%</td>
<td>77%</td>
<td>P &gt; 0.2</td>
<td></td>
</tr>
<tr>
<td>Small rectosigmoid (1-5mm) polyps</td>
<td>85%</td>
<td>86%</td>
<td>P &gt; 0.2</td>
<td></td>
</tr>
<tr>
<td>NPV small rectosigmoid (PIVI criteria ≥ 90%)</td>
<td>97%</td>
<td>95%</td>
<td>P &gt; 0.2</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Study ID</th>
<th>ADR</th>
<th>190</th>
<th>180</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADR</td>
<td>50%</td>
<td>52%</td>
<td>P &gt; 0.2</td>
<td></td>
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</table>
High Definition Colonoscopy: A Meta-Analysis

<table>
<thead>
<tr>
<th>Study</th>
<th>N (std def)</th>
<th>N (HD)</th>
<th>ADR (total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>East 2008</td>
<td>72</td>
<td>58</td>
<td>65%</td>
</tr>
<tr>
<td>Pellise 2008</td>
<td>310</td>
<td>310</td>
<td>26%</td>
</tr>
<tr>
<td>Burke 2010</td>
<td>426</td>
<td>426</td>
<td>23%</td>
</tr>
<tr>
<td>Buchner 2010</td>
<td>1226</td>
<td>1204</td>
<td>27%</td>
</tr>
<tr>
<td>Tribonias 2009</td>
<td>197</td>
<td>193</td>
<td>54%</td>
</tr>
</tbody>
</table>

Net effect of HD
3.5% [0.9-6.1] increase in all ADR
-0.1% [-1.7 - 1.6] for advanced ADR

Subramanian et al. Endoscopy 2011;43:499

Endoscopic Caps/Cuffs and Wide Angle Scopes

- Endocuff
- Extra-wide angle view (EWAVE)
Endoscopic Imaging of Early Squamous Cell Cancer of the Esophagus (ESCCE)

ESCCE Screening: NBI vs Lugols


<table>
<thead>
<tr>
<th></th>
<th>Accuracy</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>NBI (non mag)</td>
</tr>
<tr>
<td>Sensitivity (%)</td>
<td>88.3 (72.6–96.7)</td>
</tr>
<tr>
<td>Specificity (%)</td>
<td>75.2 (69.0–80.8)</td>
</tr>
<tr>
<td>PPV (%)</td>
<td>34.3 (25.2–46.4)</td>
</tr>
<tr>
<td>NPV (%)</td>
<td>97.7 (94.1–99.4)</td>
</tr>
<tr>
<td>Accuracy (%)</td>
<td>77.0 (71.3–82.0)</td>
</tr>
</tbody>
</table>
Esophagus Squamous Cell Cancer

Endoscopic Imaging in the Esophagus
Meta Analysis of NBI for HGD

- Sensitivity: 95%
- Specificity: 97%
- Estimated NPV: 99.9%* (assumes prevalence 2%)

PIVI Thresholds
- Per-patient sensitivity ≥ 90% for HGD
- Negative predictive value ≥ 98% for HGD
- Specificity ≥ 80%


Meta-Analysis for Advanced Imaging to Guide Bx in BE

34% increased yield for dysplasia with AI-guided bx

Qumseya CGH 2013;11:1562-1570
**In vivo endomicroscopy improves detection of Barrett's esophagus–neoplasia: a multicenter international randomized controlled trial**

Per Biopsy Yield

<table>
<thead>
<tr>
<th>Method</th>
<th>Sensitivity</th>
<th>Specificity</th>
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</thead>
<tbody>
<tr>
<td>White light</td>
<td>85%</td>
<td>71%</td>
</tr>
<tr>
<td>WL + pCLE</td>
<td>93%</td>
<td>67%</td>
</tr>
</tbody>
</table>

*NBI + pCLE* 100% 56% 4 additional patients detected by pCLE c/w WL

1 additional pt detected c/w NBI

Sharma et al. GIE, 2011;74:465
**Low Cost, High Resolution Microendoscopy**

<table>
<thead>
<tr>
<th>Study</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAC Vila 2014</td>
<td>0.9</td>
<td>0.82</td>
<td>0.72</td>
<td>0.94</td>
<td>0.90</td>
</tr>
<tr>
<td>Lee 2014</td>
<td>1</td>
<td>0.949</td>
<td>0.372</td>
<td>1</td>
<td>0.95</td>
</tr>
<tr>
<td>ESCC Protano 2014</td>
<td>0.90/</td>
<td>0.89</td>
<td>0.55/</td>
<td>0.97</td>
<td>0.90</td>
</tr>
<tr>
<td>Shin (2014)7</td>
<td>0.84–0.93</td>
<td>0.92–0.97</td>
<td>0.67–0.81</td>
<td>0.98–0.99</td>
<td>0.94</td>
</tr>
</tbody>
</table>

**Summary**

- Advanced endoscopic imaging has improved
  - Adenoma detection and classification
    - Potential to replace pathology for small polyps
    - Improved technique more important that technology
  - Dysplasia detection in IBD
    - Allows resection of adenoma like lesions
  - Detection and localization of Barrett’s neoplasia
    - Allows targeted biopsy, EMR, Ablation
- Endomicroscopy is feasible and safe
  - Not yet proven better than NBI/iScan/FICE
  - Newer lower costs systems needed
  - Volumetric laser endomicroscopy (nVLE) promising

*Clinical Gastroenterology and Hepatology, Volume 12, Issue 11, 2014, 1789 - 1792*