New Technologies in ED
Epidemiology and Infection Control

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Disclosures

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- No commercial interests
You are not you. You are a structural support for bacteria that outnumber your cells 10:1.

97% of your genome is retroviral DNA.

Most of what you think you know about microbiology is wrong, and you may not be prepared for where, and how fast, this is all going.
Some Approaches We’re Finding Useful

- Microbiome-centered, ecological approaches to studying bacteria and viruses in the ED
- Non-culture-based methods in diagnosis and epidemiology
- Integration of ED operational data with the EMR and clinical microbiology laboratory
- Intelligently deployed clinical decision support algorithms
Culture is a poor method for studying organisms that grow on surfaces
- Likely recover only 1:10 to 1:20 organisms present
- Fast growers and usual suspects are favored
- In how many diagnostic arenas would we accept such ambiguity from a clinical test?

In natural ecosystems, you can’t understand the appearance of a dominant species without understanding the competitive and collaborative organisms also present

Thinking about *any* implanted medical device as sterile or infected is hopelessly outdated.
Urinary Catheters as Ecosystems

- 9 previously health adult class I or II trauma patients
- Ag-impregnated urinary catheters placed by RNs during trauma resuscitation
- Catheters were collected at the perineum on the day of removal
  - None were removed for infection
  - Catheters immediately divided into regions
  - DNA stabilization buffer
  - Urine similarly collected
- Material scraped from luminal and abluminal patient-internal and patient-external surfaces and analyzed via T-RFLP
Each peak is an operational taxonomic unit (OTU)
Each peak represents a distinct OTU

Urinary Catheters as Ecosystems

## Sequence Based Analysis of Blood Culture Contaminants

<table>
<thead>
<tr>
<th>Likely Pathogens</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>161</td>
</tr>
<tr>
<td><em>Escherichia coli</em></td>
<td>152</td>
</tr>
<tr>
<td><em>Coagulase negative staphylococci</em></td>
<td>124</td>
</tr>
<tr>
<td><em>Klebsiella pneumoniae</em></td>
<td>96</td>
</tr>
<tr>
<td><em>Pseudomonas aeruginosa</em></td>
<td>33</td>
</tr>
<tr>
<td><em>Streptococcus pneumoniae</em></td>
<td>33</td>
</tr>
<tr>
<td><em>Alpha-hemolytic Streptococcus</em></td>
<td>32</td>
</tr>
<tr>
<td><em>Enterobacter cloacae</em></td>
<td>29</td>
</tr>
<tr>
<td><em>Streptococcus mitis</em></td>
<td>18</td>
</tr>
<tr>
<td><em>Klebsiella oxytoca</em></td>
<td>16</td>
</tr>
<tr>
<td>Other Species (89 total distinct species)</td>
<td>232</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Likely Contaminants</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Coagulase negative staphylococci</em></td>
<td>254</td>
</tr>
<tr>
<td>Isolates not undergoing full identification**</td>
<td>79</td>
</tr>
<tr>
<td><em>Enterococcus faecalis</em></td>
<td>47</td>
</tr>
<tr>
<td>Micrococcus species</td>
<td>31</td>
</tr>
<tr>
<td><em>Bacillus cereus</em></td>
<td>12</td>
</tr>
<tr>
<td>Vancomycin resistant E. faecium</td>
<td>12</td>
</tr>
<tr>
<td><em>Abiotrophia / Granulicatella</em></td>
<td>5</td>
</tr>
<tr>
<td>Nutritionally variant Gram-Positive Coccus</td>
<td>5</td>
</tr>
<tr>
<td><em>Ochrobactrum anthropi</em></td>
<td>4</td>
</tr>
<tr>
<td>Vancomycin resistant E. faecalis</td>
<td>4</td>
</tr>
<tr>
<td><em>Enterococcus durans</em></td>
<td>2</td>
</tr>
<tr>
<td>Lactobacillus species</td>
<td>1</td>
</tr>
<tr>
<td>Lactococcus species</td>
<td>1</td>
</tr>
<tr>
<td>Microbacterium species</td>
<td>1</td>
</tr>
</tbody>
</table>
- S. epidermidis Dendrogram Pending...
Integration of ED operational data with the EMR and clinical microbiology laboratory

- No patient is an island
  - Analyzing individual cases is of limited value in understanding why adverse infectious events occur
  - Operational interdependency across all patients in the ED at some point in time

- At least at our institution, these data couldn’t be any further apart
  - Clinical micro data is essentially dumped onto a tape drive
    - Queries must be submitted to clinical IT and research functionality limited
  - Operational ED data exists in raw form only as patient-centric data elements
    - To know what was going on ED wide at any point in the past, you essentially have to rebuild the time period as a simulation involving all patients moving through the ED at that time
Integration of ED operational data with the EMR and clinical microbiology laboratory
Integration of ED operational data with the EMR and clinical microbiology laboratory

Halverson, et al., Under Review
Use of Clinical Decision Support for Infection Control

Meurer et al., J Am Geriatrics Soc 2008
CDS Applied to an ED Sepsis Bundle at UM

Nelson, Annals Emerg Med 2011
Experts Needed!

- Who on earth is going to work on all of this stuff?
  - If we’re serious as a group, we should be talking about training a workforce
  - Would your department or health system send someone to school for year or two to move this forward?
  - Posters are great, but people make the change
  - Our health system last year lost ~$300K due to contaminated blood cultures in the ED. That’s the scale of investment EDs should be asking for

- Expertise needed immediately:
  - ICHE-relevant Omics
  - Next generation sequencing and mass spectroscopy applications in clinical microbiology
  - Interactions between microbes and engineered surfaces
  - Clinical informatics for integration of disparate data sets