Using LEAN and Automation to Create the 24-Hour Hospital Microbiology Lab

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Objectives

At the conclusion of this lecture, participants will be able to:

- Explain how LEAN principles apply to the clinical microbiology lab.
- Using the Children's National Medical Center "pre-LEAN" Clinical Microbiology Lab as an example, describe the current state of many such labs today.
- Identify opportunities for improving the efficiency of clinical microbiology labs.
- Assess the impact of LEAN measures on the Clinical Microbiology Lab’s efficiency and consider how your laboratory might be similarly impacted.
Healthcare and LEAN

• **LEAN** principles may be applied to processes that can be mapped as a series of discrete steps

• Healthcare in general, and laboratory testing in particular, are especially amenable to LEAN improvement
  - Some of the estimated $850 billion per year of waste in the U.S. healthcare system can be attributed to hospital laboratories
  - A **LEAN** overhaul of the hospital laboratory involves carefully analyzing each step in its processes, eliminating wasteful activity and inactivity, and developing revised processes in which each step adds value

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Laboratory Testing and LEAN

• The main objective of a **LEAN** laboratory reorganization is to deliver the highest quality test results possible, at the lowest cost, within the shortest time, while improving physician, patient, and employee satisfaction

• The deliverables of a successful **LEAN** laboratory reorganization include:
  - Improved operational performance
  - More standardized processes
  - Fewer errors
  - Lower test costs
  - Better employee morale
  - Enhanced patient management
Five LEAN Concepts that Apply to Laboratory Testing

- **Value**: Seek to increase the clinical value of testing from the physician and patient perspectives
- **Value Stream**: Analyze the steps of each testing process and eliminate wasteful activity and inactivity
- **Flow**: Make each testing process proceed as evenly as possible
- **Pull**: Maintain a “just-in-time” inventory of supplies
- **Continuous Improvement**: Strive for perfection by constantly reviewing the steps of each testing process

The LEAN Process in the Microbiology Lab at Children’s National Medical Center

- Microbiology Lab workload and staffing data were submitted to Guidon Performance Solutions (Mesa, AZ) prior to their on-site visit
- A 3.5 day lab evaluation was conducted by experts from Guidon and bioMerieux
- The focus was on the blood and urine culture value streams, our two busiest streams
- Limiting parameters
  - No new laboratory space was available
  - No additional staffing was available
  - Costs of lab layout changes had to be minimal
Excerpts from the Guidon Report

Day 0-2 Current Specimen Flow

“Spaghetti Diagram”
15 minutes of laboratory activity
Pre-LEAN

Excerpts from the Guidon Report

Current Value Stream (Urine)  Pre-LEAN

20-25% of Positive Urine has TAT of 3 days or More
~40% of Positive Urine is Re-incubated – contributing to Delay
Excerpts from the Guidon Report

Hourly Volume and Specimen Processing Staff Capacity Distribution

Pre-LEAN

- Processing Capacity
- Volume by Hour

Volume distribution is based on Sept 15-23
Volume distribution assumes 5 hour delay from order to views available
- Staff distribution is based on work schedules

Excerpts from the Guidon Report

Positive Culture Turn Around Time

Pre-LEAN

Positive TAT (Days)

<table>
<thead>
<tr>
<th></th>
<th>2</th>
<th>3</th>
<th>4+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood</td>
<td>8%</td>
<td>47%</td>
<td>45%</td>
</tr>
<tr>
<td>Urine</td>
<td>72%</td>
<td>22%</td>
<td>6%</td>
</tr>
<tr>
<td>Misc</td>
<td>43%</td>
<td>34%</td>
<td>23%</td>
</tr>
<tr>
<td>Resp</td>
<td>15%</td>
<td>26%</td>
<td>57%</td>
</tr>
</tbody>
</table>

GUIDON
Major LEAN Recommendation

- Move staff from the Day to the Evening and Night shifts to enable 24-hour specimen processing and culture reading
  - ~25% of our specimens were waiting 1-10 hours for processing
  - Cultures that became positive during the late day, evening or night shifts were waiting 1-20 hours for the initiation of workups
  - The Joint Commission required round-the-clock specimen and positive blood culture processing capability during our 2011 survey

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Microbiology Laboratory Staffing

<table>
<thead>
<tr>
<th>Pre-LEAN</th>
<th>Post-LEAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC Incoming Day shift</td>
<td>MC Incoming Day shift</td>
</tr>
<tr>
<td>MC Incoming Evening shift</td>
<td>MC Incoming Evening shift</td>
</tr>
<tr>
<td>Blood Culture Bench</td>
<td>MC Incoming Night shift</td>
</tr>
<tr>
<td>Urine/Stool Culture Bench</td>
<td>New Cultures Bench Day shift</td>
</tr>
<tr>
<td>Respiratory Culture Bench</td>
<td>New/Old Cultures Bench Evening shift</td>
</tr>
<tr>
<td>Miscellaneous Culture Bench</td>
<td>New/Old Cultures Bench Day shift</td>
</tr>
<tr>
<td>Mycology/Parasitology Bench</td>
<td>Old Cultures Bench Day shift</td>
</tr>
<tr>
<td>Virology Bench 1</td>
<td>Mycology/Parasitology/QC Bench</td>
</tr>
<tr>
<td>Virology Bench 2</td>
<td>Serology + &quot;Water Spider&quot;</td>
</tr>
<tr>
<td>Serology + Help for Busy Bench</td>
<td>Coverage for Day-Off Techs</td>
</tr>
<tr>
<td>Coverage for Day-Off Techs</td>
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</tr>
</tbody>
</table>
# Microbiology Testing – Pre-LEAN Approach

<table>
<thead>
<tr>
<th>Time</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Day Zero</strong></td>
<td>0000 – 1600 New specimens are examined microscopically and inoculated to culture media</td>
</tr>
<tr>
<td></td>
<td>1600 – 2400 New specimens are examined microscopically and inoculated to culture media</td>
</tr>
<tr>
<td><strong>Day One</strong></td>
<td>0800 – 1600 Culture media are examined for growth and identification/antimicrobial susceptibility tests are set up</td>
</tr>
<tr>
<td></td>
<td>0800 – 1600 Culture media are reincubated to allow more time for organisms to grow</td>
</tr>
<tr>
<td><strong>Day Two</strong></td>
<td>0800 – 1600 Identification/antimicrobial susceptibility test results are reviewed and released to the physician</td>
</tr>
<tr>
<td></td>
<td>0800 – 1600 Culture media are examined for growth and identification/antimicrobial susceptibility tests are set up</td>
</tr>
<tr>
<td><strong>Day Three</strong></td>
<td>0800 – 1600 Identification/antimicrobial susceptibility test results are reviewed and released to the physician</td>
</tr>
</tbody>
</table>

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# New Culture Reading Schedule

<table>
<thead>
<tr>
<th>Culture Inoculation Time</th>
<th>Culture Reading Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>0001-0200</td>
<td>1601-1800</td>
</tr>
<tr>
<td>0201-0400</td>
<td>1801-2000</td>
</tr>
<tr>
<td>0401-0600</td>
<td>2001-2200</td>
</tr>
<tr>
<td>0601-0800</td>
<td>2201-2400</td>
</tr>
<tr>
<td>0801-1000</td>
<td>0001-0200</td>
</tr>
<tr>
<td>1001-1200</td>
<td>0201-0400</td>
</tr>
<tr>
<td>1201-1400</td>
<td>0401-0600</td>
</tr>
<tr>
<td>1401-1600</td>
<td>0601-0800</td>
</tr>
<tr>
<td>1601-1800</td>
<td>0801-1000</td>
</tr>
<tr>
<td>1801-2000</td>
<td>1001-1200</td>
</tr>
<tr>
<td>2001-2200</td>
<td>1201-1400</td>
</tr>
<tr>
<td>2201-2400</td>
<td>1401-1600</td>
</tr>
</tbody>
</table>
# Microbiology Testing – Post-LEAN Approach

<table>
<thead>
<tr>
<th>Time</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Day Zero</strong></td>
<td>0000 – 2400</td>
</tr>
<tr>
<td></td>
<td>New specimens are examined microscopically and inoculated to culture media</td>
</tr>
<tr>
<td><strong>16 Hours Later</strong></td>
<td>0000 – 2400</td>
</tr>
<tr>
<td></td>
<td>Culture media are examined for growth and identification/antimicrobial susceptibility tests are set up</td>
</tr>
<tr>
<td><strong>18-24 Hours Later</strong></td>
<td>0000 – 2400</td>
</tr>
<tr>
<td></td>
<td>Identification/antimicrobial susceptibility test results are reviewed and released to the physician</td>
</tr>
</tbody>
</table>

## Pre-LEAN versus Post-LEAN Microbiology Testing

- In the pre-LEAN scenario, positive culture workups began when the lab staff was ready – organisms waited for the next day shift to arrive
- In the post-LEAN scenario, positive culture workups begin when the organisms are ready – staff are always available
- In the pre-LEAN scenario, final results of uncomplicated positive cultures were released in 40-64 hours
- In the post-LEAN scenario, final results of uncomplicated positive cultures are released in 34-40 hours
Impact of LEAN on Turnaround Time
Six Month Period Post-LEAN versus the Same Six Month Period Pre-LEAN
Impact of LEAN on Turnaround Time
Six Month Period Post-LEAN versus the Same Six Month Period Pre-LEAN

Impact of LEAN on Turnaround Time
Six Month Period Post-LEAN versus the Same Six Month Period Pre-LEAN

Specimen Collection Day of the Week
Impact of LEAN on Turnaround Time

Six Month Period Post-LEAN versus the Same Six Month Period Pre-LEAN

Specimen Collection Work Shift

Impact of LEAN on Turnaround Time

Six Month Period Post-LEAN versus the Same Six Month Period Pre-LEAN

Intensive Care Units and the Emergency Department
Impact of LEAN on Turnaround Time
Six Month Period Post-LEAN versus the Same Six Month Period Pre-LEAN

Antimicrobial Susceptibility Results

Further Recommendations

• Reorganize the floor plan, including creation of a Microbiology Incoming cell to reduce the amount of “spaghetti” and increase the available technologist time

• Add the “Water Spider” concept to the Microbiology Lab
  – Transport specimens from the pneumatic tube to the Incoming bench
  – Supply media and reagents to the Incoming and Plate Reading benches
  – Complete “start-up” tasks (e.g. temperature monitoring, preventive maintenance, general QC)
  – Transport cultures to and from the incubators
  – Answer telephone calls (wireless ASCOM phone)
Other LEAN Microbiology Recommendations

• Creation of “work cells” to minimize unnecessary movement and motion
• Add additional automation to the Microbiology Laboratory
  – Plate streaking
  – Gram staining
  – ID/AST
  – Data management
• More frequent deliveries of culture media and reagents to lessen storage space requirements and deterioration of labile materials
• Use of information technology to standardize culture workups, reducing inefficiency and mistakes

Automated Culture Plate Inoculation

• The goal of microbiology cultures is to furnish well-isolated colonies for additional testing
• The urine culture photos above illustrate how much better a job the automated culture plate inoculator does than a human
• In this example, identification and antimicrobial susceptibility results would be available at least 18 hours sooner from the culture plates inoculated with the automated instrument
Summary (1)

• We need to creatively reevaluate our practice of clinical microbiology.
• Because of new technology and a shrinking workforce, labs must implement operational changes that promote more efficient work practices.
• We need to leverage automation to standardize testing, reduce turnaround times, eliminate errors, and lower costs.
• Relatively few labs have gone down this road so far – it’s time for all of us to get moving!

Summary (2)

• The LEAN-based reorganization of our Microbiology Lab eliminated a great deal of wasted activity and inactivity.
• The changes were made without increasing lab space or lab staff.
• The clinical utility of test results was improved because they are now less prone to human error and are now available on a more timely basis.
• The morale of the staff is higher than ever, as evidenced by the following question asked at a recent lab meeting: “Why didn’t we do this a long time ago?”