Automating Microbiology in a Stepwise Fashion

Our Multi-Year Journey to Reduce Time to Answer, Improve Productivity, Increase Quality and Contribute to Better Patient Care

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Executive War College
ON LAB AND PATHOLOGY MANAGEMENT

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Disclosures*

• Partial Travel Reimbursement (related to an invited talk at ECCMID 2018)
  – Copan

*relevant to this topic, within the past 12 months
1. Describe the paradigm shift that is moving microbiology to a 24/7 laboratory discipline with rapid test results and efficiency.

2. List opportunities for integrating automation and artificial intelligence in microbiology.

3. Recognize the challenges of the concomitant culture shift required when introducing a new technology that has broad applications in a laboratory discipline.
Serve four academic tertiary-quaternary acute care centres
- includes 5 ICUs, 2 NICUs, the largest adult transplant centre in North America, complex cardiovascular and orthopedic surgical centres, high-risk obstetrics, three infectious disease services

Also serve five rehabilitation centres, long-term care/palliative/mental health centres, tissues banks
UHN/SHS
Microbiology Layout
~ 2000 tests/day
Specimens Leftover

100-200 specimens leftover/day

Figure 8: Daily Specimen Input vs. Processed vs. Specimen Left Over
UHN/SHS Micro

- Total Tests
  - Trend (Total Tests)

- #UP FTE
  - Trend (# UP FTE)

- Tests/UP FTE
  - Trend (Tst/UP FTE)
UHN/SHS Micro

Total Tests
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Tests/UP FTE
--- Trend (Tst/UP FTE)
UHN/SHS Micro

1. MALDI
2. WASP/LBM
3. Virtuo
4. 4800/6800
5. UBC
6. WASPLab
7. Aries
8. 24/7

Total Tests
Trend (Total Tests)

#UP FTE
Trend (# UP FTE)

Tests/UP FTE
Trend (Tst/UP FTE)
**MALDI (Vitek MS, bioMérieux)**

- Easy business case with ROI 3 yrs based on supply cost, TAT, workflow
  - Saved one MLT (enteric)
  - Used for all bacteria, yeast and moving to molds
  - Facilitates rapid ID on BC short incubation cultures
- Risk: black box & no backup
- Mitigate risk: education/images & purchased two
WASP/LBM (Copan)

- Business case helped by consultants recommendation
  - Saved 2 MLA
  - Reduce workload by pooling ARO swabs due to increased Sn of LBM/ESwabs
  - Customized to unique orders (1 swab 3 tests; 1 test 3 plates) thanks to SCC/Copan
- Risk: no backup
- Mitigate risk: purchased two
Virtuo (bioMérieux)

- Easy business case as no competition; timing worked with availability in Canada at contract end
- bioMérieux worked directly with hospital administration
- Lab worked with bioMérieux to obtain Health Canada validation data
- Auto-load and auto-unload; all negatives auto-discarded
  - Saved 2.5 MLT; added 1 MLA
- Risks: none identified
Cobas 4800/6800 (Roche)

- Moved MPX test for HIV, HBV, HCV donor screening onto Cobas 6800 & CMV antigenemia to CMV PCR on Cobas 6800 facilitating efficiency for both
- Moved GC/CT and added HPV genotyping to Cobas 4800
  - Saved 2 MLT
- Risks: none identified
Universal Bar Code (SCC)

• Key to efficiency with WASP (Copan) and Virtuo (bioMérieux) was transition to universal bar code recognition

• Specimens arrive and are placed directly onto WASP (Copan) and Virtuo (bioMérieux) and are received (and plated) automatically

➢ Net savings reported for WASP and Virtuo take universal bar code recognition into account
**WASPLab (Copan)**

- Original plan was to expand WASP to WASPLab all along; on capital requests annually
- Business case based on FTE savings through attrition (hands-on-time) and improved TAT (shorter incubation, 24/7), quality
- Timing worked out with government innovation fund and peak of impending retirements
  - Saved 2 FTE to date (expect 3 more)
WASPLab (Copan)

- Use WASP for agars, smears, broths
- High volumes initially prioritized:
  - ARO screens, urines, GBS swabs, miscellaneous swabs
- Then added:
  - Blood cultures*, stools, respiratory (2019)
- Tissues, sterile fluids manually planted
- Bench workflow changed, breaking work down into simple tasks
  - Screener/reader and picker benches
  - Old work benches
Maximize benefit by using smart incubation in which no growth/no significant growth plates are segregated using **segregation software**.

Further maximize benefit by using **artificial intelligence (Phenomatrix)** to detect do the same and also detecting significant growth.
Using artificial intelligence to interpret urine culture plates

7/11/2017-12/29/2017
2032 urine images used for training

4/19/2018-5/9/2018
2972 consecutive urine images used to verify the system
Oxoid Brilliance UTI Clarity

PhenoMATRIX

Urine Optimization

No Growth
No Significant Growth
BP for AST
ID/AST
Urine Optimization

No Growth
No Significant Growth
BP for AST
ID/AST

29%
62% (n=105/d)
read by PhenoMATRIX
(38% (n=65/d)
to be manually reviewed)
No Growth
No Significant Growth
BP for AST
ID/AST

29%
27%
3%
2%

59% (n=100/d) auto-reported with the push of one button
PhenoMATRIX™ Urine Optimization

No Growth
No Significant Growth
BP for AST
ID/AST

29%
27%
3%
2%

56% (n=95/d) no hands-on plate time

Urine Optimization
Urine Optimization

No Growth
No Significant Growth
BP for AST
ID/AST

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*All “ID/AST” but lactobacilli on MALDI-TOF so NSG
Automated NAAT (Aries, Luminex)

- Rationale for Aries (Luminex) and GeneXpert (Cepheid) rapid testing = savings on isolation
- Easy business case for Aries (Luminex) due to reduced pricing
  - Moved all influenza, C. difficile, VRE, CPO NAAT testing set up to MLAs, adding 1 MLA and saving 0.5 MLT
- Risks: potential for contamination
- Mitigate: training
UHN/SHS Micro

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8. 24/7
• No business case required as did not include adding FTE
• Ultimately adopting automation with more rapid TAT facilitated moving to 24/7
  – WASP Lab streamlined workflow with optimized shorter exact incubation times
  – Shorter time to answer by having 24/7 planting, testing, and resulting
End Result: Improved Productivity
End Result: Improved Productivity

UHN/SHS Micro
End Result: Faster Time to Answer

- All specimens are set up as they are received (no “leftovers”)
- All results are resulted as they are available
- Universal barcode reduced time to “received”
- Shorter incubation times with smart incubation
- Shorter time to results with short incubation blood cultures combined with smart incubation and MALDI (e.g. 4h growth)
- Shorter time to results with segregation/PhenoMATRIX and auto-reporting for urine and ARO screening benches
End Result: Improved Quality

- More accurate identification with MALDI
- Consistency in streaking agars, smear preparation
- Consistency in labelling without errors
- Consistency in following SOP
- Consistency in incubation times
- Images facilitate training
- Images facilitate review (staff and seniors and turnaround-time quality indicator reviews)
Lessons Learned – What Worked

- Engage external consultants
  - Provided LEAN consultation, provided push towards automation
  - Facilitated change in lab culture, engaged lab by completing time studies and spaghetti diagrams

- Keep automation on annual budget requests
  - Kept big picture of what we wanted on annual capital budget requests so not forgotten, low hanging fruit when innovation monies became available

- Have a clear project lead for each project
  - Involved the lab but the project lead made the final call
Lessons Learned – What Worked

– Interfacing with LIS
  • Crucial for each step on our journey to automation
  • Universal bar code reader key to maximizing efficiency with WASP and Virtuo

– Industry support – take advantage of it
  • Coordinated ward training regarding transition to LBM
  • Worked with central purchasing to coordinate changeover to LBM

– Take advantage of retirements
  • Prevented emotional toll and severance related to dismissals
Lessons Learned – What Could Have Been Done Better

-Culture shift

• Automation on single instruments – easy; staff jumped at using them even before officially implemented given intuitive improved workflow and turn-around-times
• But change to WASPLab a significant change in workflow:
  ➢ Recommend visiting a laboratory with established full laboratory automation for a significant period of time to truly understand the workflow; not just a meet and greet visit
  ➢ Recommend changing your workflow ahead of adopting automation (e.g. consolidate ID/AST benches)
Lessons Learned – What Could Have Been Done Better

– Culture shift

• Recognize that microbiology has traditionally been a hands-on field and that being hands-on is what drove many of our more experienced technologists into the field

• Moving to image analysis is like learning to ride a bike again but virtually

  ➢ Set expectations accordingly and expect dissent by some
  ➢ Take baby-steps one at a time
  ➢ Do not pair moving to 24/7 with moving to full automation; wait for full automation to be implemented first
Lessons Learned – What Could Have Been Done Better

– Culture shift
  • Implementing full automation especially with segregation software/incorporated AI takes time
  ➢ Set expectations of senior management and laboratory technicians and technologists
  ➢ Expected FTE savings will only be achieved once implementation has occurred and workflow has been optimized
UHN/SHS Micro

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Acknowledgements

UHN SHS Microbiology Core Management Team:

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