Potential Impact of Rapid Diagnostics in Management of Suspected Pneumonia

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INTRODUCTION

- To treat suspected or confirmed but unidentified bacterial infections, physicians often begin treatment with empiric antibiotics.[1]
- If the patient does not truly have an infection, has a viral infection, or the bacteria is resistant to the empiric antibiotic choice, patients may not improve or may worsen.[2]
- Increased rapidity of pathogen identification and rapid results from samples would allow physicians to narrow antibiotic treatment for the specific pathogen identified earlier in the course of treatment.[3]
- The Unyvero Platform is a rapid molecular diagnostics system which recently completed a Phase 3 clinical trial of its Lower Respiratory Tract Infection (LRT) Application Cartridge for patients with suspected pneumonia and has been submitted to the FDA for approval.
- Beaumont Health was the highest enrolling site for this clinical trial.
- We hypothesized that rapid diagnostics tests have sufficient throughput and would improve outcomes, reduce costs, and decrease length of stays for patients at Beaumont Health System with bacterial pneumonia infections.

METHODOLOGY

- A retrospective chart review was performed for Beaumont Health System inpatients age 18 or older with culture data available from endotracheal aspirates (EA) and bronchoalveolar lavages (BAL) from January to December 2013.
- Clinical and demographic data was collected and analyzed during the peak pneumonia season of January to March 2013 for appropriateness of antibiotic treatments based on the culture results to predict the potential benefits of the Unyvero System.
- Appropriateness of antibiotic treatment at culture time was evaluated by a board certified infectious diseases physician, as overtreatment, undertreatment, appropriate with treatment, or appropriate without treatment.
- Data on number of cultures received per shift was reviewed to determine the size of the system needed to adequately cover the requirements of a clinical microbiology lab serving a three-hospital system with 1840 total beds.

RESULTS

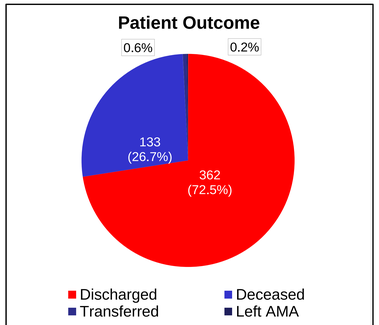

Figure 1: Outcome for patients from January-March 2013 at Beaumont Health System. Outcomes categories were discharged, deceased, transferred, or left against medical advice.

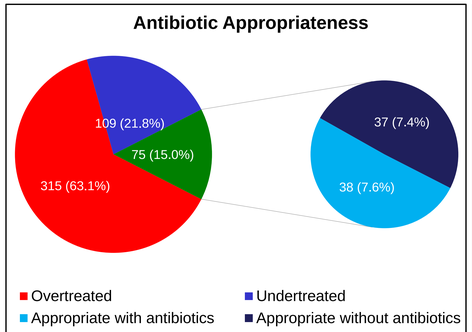

Figure 2: Antibiotic appropriateness for study patients from January-March 2013 at Beaumont Health. Categories were overtreated, undertreated, appropriate with antibiotics, and appropriate without antibiotics based on the culture results.

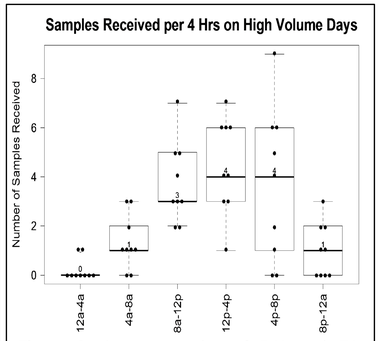

Figure 3: Average number of BAL and EA samples received per four-hour blocks at Beaumont microbiology labs during the highest volume days of 2013 (≥16 samples/day).

	4 samples	8 samples	12 samples	16 samples	20 samples
1 lysator 2 analyzers	4.5 hrs	8.5 hrs	12.5 hrs	16.5 hrs	20.5 hrs
1 lysator 4 analyzers	4.5 hrs	5 hrs	8.5 hrs	9 hrs	12.5 hrs
1 lysator 8 analyzers	4.5 hrs	5 hrs	5.5 hrs	6 hrs	8.5 hrs
2 lysators 4 analyzers	4.5 hrs	4.5 hrs	8.5 hrs	8.5 hrs	12.5 hrs
2 lysators 8 analyzers	4.5 hrs	4.5 hrs	5 hrs	5 hrs	8.5 hrs

Table 1: Unyvero throughput - each lysator can prepare 4 samples in 30 minutes and each analyzer can test 2 samples in 4 hours. For the highest volume blocks of 12 concurrent samples, additional lysators or analyzers can be added to reduce a maximum of 12.5 hrs to 5 hrs.

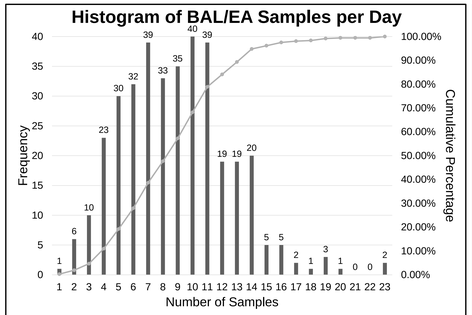

Figure 3: Number of BAL/EA samples per day received at Beaumont microbiology labs. Axes describe frequency and cumulative percentage of days with samples ranging from 1 to maximum 23. Median of number of samples based on this chart is 9, with 96% of days receiving ≤15 samples for analysis.

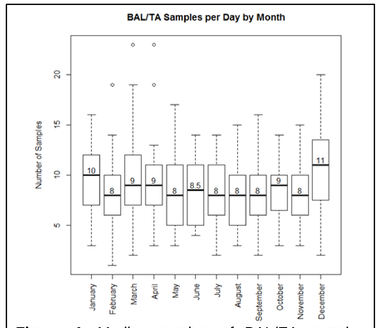

Figure 4: Median number of BAL/EA samples received per day by month in 2013 at Beaumont microbiology. December-March saw the highest number of samples per day, corresponding to the peak pneumonia season.

- Of the 499 total samples examined, 375 were endotracheal aspirate and 124 were bronchoalveolar lavage.
- The average time from sample collection to final sample result for bacterial culture was 2.7 days, with an average length of stay for patients of 28.2 days.
- The average cost per day during an admission with a sample collected was $2,538.
- Only 15% of patients were being appropriately treated based on their culture results.
- Of the 109 undertreated samples, 83 were modifiable based on identifying the organism. Two additional were potentially modifiable if full culture was available. 24 required phenotypic information to modify.
- Of the 18 patients who died, were not in hospice care, and were undertreated, 15 had modifiable courses of antibiotics based solely on the organism identification. One additional patient was potentially modifiable but full culture data is not available. Two were not modifiable based solely on the organism identification.
- Of the 15 modifiable patients, 7 could have had the final clinical outcome modified by having the Unyvero data available.
- Beaumont microbiology labs received an average of 8.9 samples per day in 2013, with a median of 9 and maximum of 19, and 96% of days receiving ≤15 samples per day.

CONCLUSIONS

- We can conclude that with more rapid results of the Unyvero LRT Application Cartridge, patients might have improved outcomes with appropriate antibiotics being utilized earlier.
- We can conclude that in large microbiology labs, this rapid diagnostics system has the throughput to run all of this sample type concurrently with minimal equipment.

DISCUSSION

- Standard culture technique took an average of 2.7 days for final results, during which the patients being undertreated may not have improved or could have worsened.
- The 22% of patients being undertreated would be the targeted usage for quicker targeted antibiotic therapy.
- The patients who were identified as undertreated and deceased without hospice care are where the Unyvero Platform and the LRT Application Cartridge has the most potential to make an impact on clinical outcomes.
- By narrowing coverage for the 63% of samples that were overtreated, potentially harmful antibiotic side effects could be avoided, the cost of treatment from the average cost per day of $2,538 could be decreased.
- Also important is the potential for decreased development of antibiotic resistance in pathogens with quicker target therapy, which would have lasting effects in the healthcare industry overall.
- If the Unyvero is utilized in microbiology labs, it would still be necessary to concurrently run conventional cultures and antibiotic sensitivity testing from acquired samples, as the Unyvero assay runs a finite panel that covers only 90% of pathogens causing pneumonia and only gives genotypic not phenotypic resistance data.
- From analyzing the quantity of samples received at Beaumont, with a conservative estimate of receiving up to 8 samples per four hour block compared to the peak average of 4.4 samples seen on high volume days, one lysator with four analyzers should be sufficient.

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