Experiences with CLARION™ Stewardship:

Making Sense of Endless Clinical Laboratory Data and Improving Productivity, Cost-Efficacy and Patient Care

How bioMérieux's CLARION™ Stewardship dramatically improved antibiogram creation, timeliness & accuracy; contamination reporting; and facilitated antibiotic stewardship during the COVID-19 Pandemic: First-hand accounts from 5 laboratory managers, pharmacists and clinical laboratory scientists.

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Executive Summary

A hospital antibiogram, which is theoretically the most vital component of an antimicrobial stewardship program, should represent a dynamic aggregation of clinically relevant microbiology data for clinicians to use and quickly determine the best treatment option for their patients at the bedside. An antibiogram should allow clinicians to evaluate antimicrobial resistance patterns among cohorts of specific patient populations. It is a tool that aids in the selection of the right empiric antimicrobial therapy required to treat infections caused by potentially resistant pathogens prevalent in that hospital. It should provide details unique to patient populations, accompanying comorbidities, location-specific data, trends over specified time frames, infection types, and hospital departments.

Unfortunately, this isn't the reality for most hospital antibiograms.

Even for a modest hospital system, this is a colossal amount of data to collect, manage, and effectively utilize. Numerous studies reveal that hospital antibiograms are often inadequate, flawed and frequently outdated by the time they are finally produced and distributed.

A 2012 survey by a large hospital consortium revealed that "the compliance rates to key Clinical Laboratory Standards Institute's (CLSI) recommendations for antibiograms ranged from 64% to 98%."[1]

- Approximately, 60% of the hospitals that responded to the survey reported that their antimicrobial stewardship program had "significant involvement of pharmacists in compiling, reviewing, and reporting antibiograms."

- However, of the 237 hospitals in the network who were sent surveys, only 47 responded.

Another study analyzed 237 cumulative antibiograms compiled by 86 hospitals in Michigan and found that nearly 30 had one or more serious errors.[2]

There is no regulatory pressure to deploy real-time, automated, and highly accurate antimicrobial resistance (AMR) reporting and surveillance systems. The piecemeal implementation of AMR-specific reporting currently in place may actually create additional barriers to the development of a future and automated AMR system because of the high costs of replacing or converting so many non-standard systems.

CLARION is an infectious diseases diagnostics software-as-a-service (SaaS) solution launched in 2018 by bioMérieux. CLARION is a vendor agnostic solution designed for clinical laboratories and hospitals to communicate comprehensive, real-time infectious diseases data and insights to support antimicrobial stewardship programs (ASP) and promote laboratory efficiency. CLARION analytics brings the value of diagnostics in stewardship to life in a dynamic, interactive and intuitive platform. Visualizing clinical data at this scale provides actionable insights for ASPs and affords clinicians the ability to demonstrate best practices and quality improvement in healthcare systems.

Methodology

CLARION customers were interviewed to determine the impact of the tool on the following four areas:

1. The creation, management, and use of antibiograms
2. The management of contamination of blood and urine samples
3. The tracking and management of respiratory infections
4. The management of the data generated by the COVID-19 pandemic

The CLARION sites

Below are details of the four customer sites that adopted CLARION, as well as the laboratory and pharmacy staff who were interviewed for this technology review and assessment.

- Heinz Salazar, Microbiology Lab Manager at Tampa General Hospital system with over 1,000 beds, and 8,000 employees. Salazar has 32 FTE reports, including two supervisors, two lead medical lab technologists, 24 medical lab technicians and two lab assistants.

- Frances Valencia-Shelton, PhD, D(ABMM), SM(ASCP)*, is the Clinical Infectious Diagnostics Director and Ameen Pirasteh, PharmD, is the Antibiotic Stewardship Pharmacist at Baptist Health. Based in Jacksonville, Florida, Baptist Health is a network of five hospitals, affiliated with 45 primary care offices located throughout Northeast Florida and Southeast Georgia. The system includes nearly 1,000 beds.

- Robert Brian, PharmD, is an antibiotic stewardship pharmacist at a hospital located northwest of Memphis Tennessee. This hospital offers acute inpatient care, intensive care, emergency services, diagnostics and radiology, surgery, and IV therapy,. Due to hospital policies, this facility will not be identified specifically in this case study and the CLARION lead at this hospital will be identified with the pseudonym "Robert Brian."

- Barbara Smith is a clinical lab scientist in one of the largest health systems in the Southwest United States, representing over two dozen separate hospitals with approximately 5,000 beds, 20,000 employees and over 5,000 physicians. Due to hospital policies, this large system will not be identified specifically in this case study and the CLARION lead at this hospital will be identified with the pseudonym "Barbara Smith."

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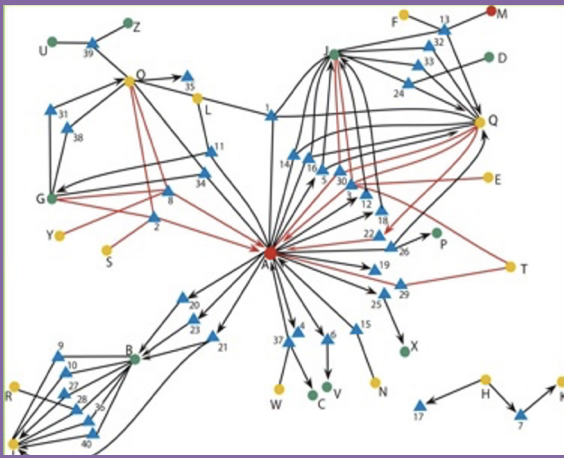
Is your antibiogram outdated as soon as it's completed?

The first and only time Lab Manager Heinze Salazar used the legacy system to create the Tampa General Hospital antibiogram, Salazar said it took six months to complete the process. And by that point, much of it was already outdated.

Resistance patterns within a single hospital can shift significantly in just a few months. Six months is too long to wait for an antibiogram if the tool is expected to provide true guidance for antibiotic use.

The 2011 study "Emergence and rapid regional spread of Klebsiella pneumoniae Carbapenemase-producing Enterobacteriaceae" revealed how a resistant bacteria strain can emerge, spread and become the dominate strain across a 14-hospital network in under 12 months.

Introduction

An antibiogram is a profile of the most common microbial offenders within the hospital and a guideline on how best to treat them. Antibiograms are created by the microbiology laboratory along with the pharmacy, infection prevention staff, and relevant clinicians. Collectively, these clinicians form a hospital's multidisciplinary antimicrobial stewardship program team.

The CLSI guideline titled "Analysis and Presentation of Cumulative Antimicrobial Susceptibility Test Data" recommends that hospitals compile an antibiogram at least once a year.[3]

Antibiograms guide clinicians in the selection of effective antimicrobial therapy based on minimum inhibitory concentrations (MICs) of antibiotics for strains of hundreds of bacterial pathogens, especially the resistant and multi-drug resistant strains.

While these general patterns are often ubiquitous nationwide and, in fact, globally, every hospital has a unique combination of resistance mechanisms and patterns that must be chronicled and consulted in order to make optimal antibiotic treatment decisions.

Antibiograms are unique to the specific patient population from which they are drawn. A bacteria that might be easy to treat with a simple penicillin in one hospital may be predominantly multi-drug resistant in a hospital across town.

> *"Unless you're a lab person, you don't really realize how important it is to segment these data points very precisely," said Lab Manager Barbara Smith. "We needed to segment the data as urine, non-urine cultures for the ED; urine, non-urine for the ICU; and urine, non-urine for the inpatient non-ICU patients. And then we had to layer on top our ESBL, MRSA rate with each of these pieces. It was becoming impossible using our manual system. We needed to automate the process."*

CLSI establishes antimicrobial "breakpoints" or the ideal concentration of an antibiotic to treat a specific bacterial infection, also called a minimum inhibitory concentration (MIC). A bacteria is considered to be susceptible to an antibiotic if the MIC is less than or equal to the susceptibility breakpoint. Since microbes are constantly adapting, CLSI breakpoints are updated on a regular basis, which must be reflected in the antibiogram.

CLSI recommends recording the first isolate per patient in the timeframe defined by the antibiogram, as well as only organisms that were isolated at least 30 times in the defined time frame. Since this document is a snapshot of an ever-evolving situation, CLSI recommends creating them frequently throughout the year, as well as situationally for targeted organisms, patient populations or geographic regions.

The Problem: The antibiogram data flow is growing exponentially while the day remains 24 hours long

Generating the antibiogram is time-consuming with data coming from multiple sources and formats. For this reason, antibiograms are too often an outdated snapshot based on last year's data. In actual practice, data are often pooled and become an average of all patients rather than tailored to specific patient populations. Critical drug choices are made using this method, which is often devoid of any patient-specific factors.

> *"After reviewing the failings of the existing system, we went with the complete CLARION offering, specifically the standard antibiogram susceptibility analysis, blood culture, contamination and micro MDRO reports, and a number of other dashboards," said Heinz Salazar.*

Furthermore, the growth of centralized labs serving multiple hospitals within networks does not obviate the need for antibiograms that are specific to each of those hospitals.

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Without automated surveillance, even the most basic annual antibiogram is becoming an overwhelming and time-consuming task for many clinical labs. The need for more specific antibiograms for patient populations, different locations, and specific infections makes manual tracking virtually impossible without dedicated staff and unlimited time.

And time is one commodity that hospital staff simply do not have. In 2017, the American Hospital Association (AHA) conducted a comprehensive review of federal law, regulations, and guidelines in an attempt to quantify the time, budget and resources required by U.S. hospitals and post-acute care (PAC) providers to comply with these mandates.[4]

Health systems, hospitals and PAC providers must comply with 629 discrete regulatory requirements across nine domains. These include 341 hospital-related requirements and 288 PAC-related requirements:

- Hospitals and PACs spend nearly $39 billion a year to comply with these regulatory requirements.

- A modest community hospital with fewer than 200 beds must allocate nearly $7.6 million annually on administrative activities to support regulatory compliance.

- A typical hospital dedicates 59 full-time equivalents (FTE) to regulatory compliance, many of whom are clinicians who must divert time from patient care to meet these obligations.

- According to the AHA: "On a more granular basis, this translates to $47K per hospital bed," with staff salaries accounting for over 80 percent of these costs.

The CLARION Advantage

What if you could harness the power of an advanced analytic platform to drill down to an antibiogram that is more suited to specific populations? What if physicians could decide to prioritize therapies according to toxicity, convenience to the patient, or a number of other patient-specific factors?

Utilization of the intuitive CLARION platform provides the capability to track changes in antimicrobial susceptibility and improve metrics that can impact patient care and outcomes.

> *"The syndromic antibiogram is one of the most important features of CLARION," said Robert Brian PharmD.*
> *"Historically, the antibiogram would track, for example, all UTIs with all available antibiotics and maybe segregate these further for pediatric and adult patients. The CLARION syndromic antibiogram gives you the best possible pathway by diagnosis based on treatment trends for this diagnosis within your hospital."*

According to Dr. Brian, CLARION's antibiogram can functionally determine what percentage of the time a certain antibiotic has worked as a single therapy to treat this specific pathogen and what percentage of those infections required combination therapy.

"CLARION also breaks this down even further by gender and age and other factors you can pre-select—hospital location, where they were admitted, special unit or ED and many other parameters—in order to precisely profile patients to determine the best possible single, double or triple therapy that will give this specific patient the best possible outcome and the fastest resolution." said Brian.

When, for example, a facility physician chooses fluoroquinolone therapy for a patient, CLARION can report all phenotypic resistance mechanisms to fluoroquinolone antibiotics seen in the hospital over a selected time interval.

"The dashboard will show any resistance mechanisms found including wild type mutations," said Dr. Brian. "For instance, depending on the antimicrobial class(s) selected, you can see penicillinases, cephalosporinase, mecA, mecB, porin mutations and others. Additionally you can trend these over time and compare the changes by year to visualize resistance trends."

"I can also see how these resistance patterns have changed over time and what is trending by specific populations," said Dr. Brian. "This kind of information is incredibly valuable to clinicians. It allows for informed decision-making, drug restrictions and breakdowns by many others filters and customizable parameters."

Many hospitals that rely on a lab information system (LIS) or clinical decision support systems (CDSS) for creating an antibiogram struggle not only with duplicate isolates but also determining overall hospital infection rates versus ICU rates since patients are often relocated throughout the hospital in a single stay.

"With a system as large as ours and with so many different hospitals, we needed a way to streamline our antibiogram," said Barbara Smith, a clinical lab scientist at a 5,000-bed network. "Prior to Clarion, we used our LIS middleware software to create antibiograms, but it only allowed us to track patients once admitted to the floor. Cultures developed from samples taken in the ED or ICU were difficult to link to patients once on a floor, which skewed our data. Often, these cultures were counted twice, which also created a serious misrepresentation of the pathogens in our hospitals."

For many hospitals, solving these problems is a manual process that takes an enormous amount of time and resources. In one antibiogram study of a single organism at a large university hospital going back 6 years, it took between 6-10 hours for each year analyzed, in total between 36-60 hours for a single bacterial species.[5] Imagine the time required for hundreds of organisms.

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For Barbara Smith, the annual process of assembling the antibiogram started by exporting data from her lab's LIS middleware into Excel spreadsheets. She then would begin the process of manually cleaning, organizing and categorizing thousands of lines of data. Smith had to import multiple LIS datasets from each facility within the hospital network, as well as separate datasets collected from ED, ICU and admitted patients within each hospital.

Another major problem Smith had with the legacy antibiogram process was that it could not separate Staphylococcus aureus cultures into methicillin-resistant S. aureus (MRSA) and methicillin-susceptible S. aureus (MSSA) cultures, forcing Smith to manually separate them in a spreadsheet. While MRSA and MSSA have similar rates of virulence, MRSA is the most common cause of hospital acquired blood infections or bacteremia.[6]

Inaccurate reporting of MRSA vs. MSSA infections leads to flawed antibiograms and substandard clinical decision making. This is why the CLSI antibiogram guidance places a high priority on the rapid and accurate differentiation of MRSA from MSSA infections.[7]

> *"The level of analytics provided by CLARION far surpasses our hospital information system, LIS, EMR and anything I've ever seen," said Heinz Salazar. "Being able to customize critical reports through the dashboards is—to me—the greatest benefit of CLARION. Creating different filters and customized reports that are accurate is just such a huge benefit."*

In his first year as the microbiology lab manager at Tampa General Hospital, Heinz Salazar realized he had to improve the process of creating the network's antibiogram. Salazar inherited a process of incomplete data collection. For example, it simply overlooked certain organisms, including Burkholderia cepacia (B. cepacia), which was particularly confusing to Salazar because Tampa General has a large population of Cystic Fibrosis (CF) patients.

"Tampa General has a dedicated CF clinic, so we see a lot of these organisms," Salazar said. "We needed a system that included Burkholderia cepacia and didn't randomly skip important organisms that we need to track and surveil."

Having a thorough and accurate antibiogram dedicated for the CF patient population is particularly important because these patients often suffer from "chronic focal infections" of the lungs caused by multi-drug resistant bacterial strains.

CF isolates demonstrate unique colony morphology, drug susceptibility patterns, and genomic hypermutability. Multi-drug resistant *B. cepacia* is common in the lungs of CF patients and is highly associated with failed lung-transplantation.[8]

"So, obviously, an antibiogram that ignores *B. cepacia* in a patient population with a significant number of CF patients is unacceptable," said Salazar.

"The legacy system had many other shortcomings," said Salazar. "For example, it was only pulling 5-day VITEK reports and only showed us the MICs, but we were not getting E tests, Kirby Bauer results, and other vital reports. We were also missing data from the Accelerate PhenoTest® BC kit pathogen identification and AST data, as well."

The Tampa General legacy system could only broadly divide cultures into urines versus non-urines.

"Everything was bundled together into these two groups, which is not really reflective of our patient community," Salazar added. "So now with CLARION we can pull in-house inpatients and outpatients and urines and non-urines."

Deep Smarts: Protecting Mission-Critical Institutional Knowledge

Being the only lab personnel who created her hospital system's annual antibiogram, Lab Manager Barbara Smith felt tremendous pressure as the sole keeper of this institutional knowledge. She repeatedly tried to train new supervisors to perform this laborious and intricate process, but simply could not find the time.

To properly train another senior lab staff member on the antibiogram process would effectively take two lab senior leaders off-line for two weeks, or a complete months' worth of time for a single senior full-time equivalent (FTE).

Vital institutional knowledge and experience that employees accumulate over time is what Harvard Business Review calls "Deep Smarts." This mission-critical knowledge can simply disappear when someone retires or takes another job. And once gone, it's very difficult, in not impossible, to replace. (Ref: https://hbr.org/2014/12/whats-lost-when-eperts-retire).

In the case of antibiograms, that knowledge can make the difference between life or death. But with automation, CLARION becomes the keeper of a hospital's resistance surveillance "Deep Smarts," so critical staff departures don't have to be catastrophic. And the training required to expand the circle of those who can perform this vital task can be done in a day, not weeks.

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How did you rollout CLARION for culture contamination management?

"Just like with our antibiogram, the legacy system for contaminations was a very manual process, even counting how many cultures we were getting in a day," said Heinz Salazar of Tampa General Hospital. "We had to count and review every single possible contaminant, but we were not getting a full picture of every contaminant we saw in the department. "

To determine how accurate the legacy system for culture contaminants actually was, Salazar ran both systems in parallel—CLARION and the legacy system—to measure the discrepancies.

"We found that there were typically about a 200-culture difference between the two," said Salazar. "In fact, there was a lot of information we were losing in the manual process."

Prior to CLARION, Tampa General's contamination rate was about 2 percent. After implementing CLARION, the accuracy rate moved much closer to the national average of about 3 percent.

"The main reason for this is that we were missing 20 to 30 contaminants every month," said Salazar. "With CLARION, I can actually review and pool every single contaminant. And in a couple hours, I can review and make sure that they're true contaminants before we report it."

By accurately pinpointing contaminants, CLARION has helped Tampa General identify trends, like the blood collection locations with frequent contaminants. The lab shares this with information with nurses and phlebotomists so that they can resolve problem sites with training.

> *"Overall for blood culture contamination, CLARION has saved us approximately 5 days of work per month," said Salazar. "We actually had a full-time tech dedicated to this but now can use this time for other critical functions."*

The facility southwest of Memphis uses the bioMérieux ADVANCED EXPERT SYSTEM (AES) for automated antimicrobial susceptibility testing (AST). This system ensures quality susceptibility test results and decreases the chance for human error through rapid, automatic and systematic validation of every susceptibility test result. Every MIC result is checked against a database of more than 3,500 phenotypes and 30,000 MIC distributions to determine consistency with previously defined wild or resistant phenotypes. CLARION can be used to create multiple dashboards to organize and optimize AES data for clinical decision making.

"With CLARION, you can tell when a bug is a contaminant and which is not," said Robert Brian, PharmD and "Contaminants typically show up as one isolate while true infections are two or more."

> *"As a stewardship pharmacists, I would say the biggest benefit of CLARION is time." Said Ameen Pirasteh, PharmD, the Antibiotic Stewardship Pharmacist at Baptist Medical Center in Jacksonville, FL. "It helps save a great deal of time. It has significantly improved data management and ease of use. For example, accessing data to analyze a specific trend or concern, that used to take hours of time. Now we can quickly pull the specific data and rapidly determine if we have a problem or not."*

Instead of wasting time and resources doing susceptibility testing of contaminants, CLARION freed the lab at the facility southwest of Memphis to focus on cultures with true infections. It also eliminated the antibiogram inaccuracy created by contaminants.

Describe the benefits CLARION provided your hospital during the COVID-19 Pandemic.

By 2017, the effort to reduce antibiotic overuse within hospitals and to judiciously guide the use of these vital drugs via hospital-wide stewardship programs was having a undeniable positive impact. However, the Covid-19 pandemic appears to have erased much of that progress.

The 2017 study "Interventions to improve antibiotic prescribing practices for hospital inpatients" demonstrated the profoundly positive impact antibiotic stewardship efforts were having on patient care and outcomes.

All four of the CLARION customers interviewed said the tool "Exceeded" their expectations and that they would definitely recommend it to colleagues!

But a 2021 study by the Antibiotic Resistance Project of the Pew Charitable Trust revealed that antibiotic stewardship efforts failed to prevent misuse and overuse in U.S. hospitals for patients admitted due to Covid-19.[9]

The Pew research team concluded:

- 52 percent of COVID-19 admissions received at least one antibiotic

- 36 percent received multiple antibiotics during hospitalization

- Only 20 percent of these COVID-19 patients were diagnosed with suspected or confirmed bacterial pneumonia

- Over 80 percent of COVID-19 patients were given antibiotics upon admission with no possibility that confirmatory lab test results were used in these treatment decisions

"Somewhere between 4-7 percent of COVID-19 patients need antibiotics due to opportunistic bacterial co-infections," said Robert Brian, PharmD. "Originally, the CDC believed as many as 15 percent would need antibiotics, but with the help of the CLARION dashboards, we quickly learned that this wasn't true for our patient population."

"Early into the Pandemic, we began to run Procalcitonin (PCT) tests on our COVID-19 patients," said Brian. PCT is normally less than 0.05 ng/ml in healthy adults. When PCT reaches 0.5 ng/ml, that's a good indication of a systemic bacterial infection. PCT is usually only elevated during bacterial infections. Viral infections have no impact on PCT production.[10]

"CLARION will give you the most common causative pathogens by diagnosis, listed by likelihood among your specific patient populations," said Robert Brian, PharmD. "It also gives you a list of the antibiotics — for each pathogen — that can be used to treat it, in order of efficacy for each unique patient population. That's harnessing your hospital's information to make highly informed treatment decisions."

By using CLARION, Brian could compare the PCT results with the COVID-19 patients who had received antibiotics to see if there were any improvement in the outcomes of these patients. According to Brian : "This revealed that we were overusing antibiotics in our COVID-19 patients with no added benefit to these patients."

The Impact: How CLARION Improves Productivity, Patient Care and Reduces Costs

"Today, I can complete the antibiogram in a single day: from two entire weeks down to one day," said Barbara Smith. "We're able to standardize reporting for physicians and there's a lot of benefits that come from this for us. Surveillance was just taking up so much of my time spent and CLARION made life so much easier."

"Combo therapies for pseudomonas is the best illustration of the benefits of CLARION," Smith added. "This is a very important function to be able to look at drug combinations and resistance patterns. Labs need the flexibility to be able to pick any group or set of drugs and see what those drug activities have done against pseudomonas over a specific period of time," she added. "This is information clinical teams need to know. They want to know, based on accurate and recent resistance patterns, if their therapeutic choice is the right decision, and they turn to us for guidance, which we can now provide through CLARION."

"With antibiograms, there's often something that seems odd or kind of different," said Frances Valencia-Shelton, PhD, Clinical Infectious Diagnostics Director at Baptist Medical Center in Jacksonville, FL. "CLARION will allow us to go and pull that data set up very quickly. If something seemed to rise or maybe you just seem to have a spike in ESBLs, for example, you can go back and look at it and determine if something is different or if some change may have contributed to this trend."

"Physicians have come to expect this kind of real-time information from the lab and CLARION makes it easy for us to provide it: current trends, real-time analysis of ongoing lab and clinical data in order to optimize patient outcomes with data-driven action," said Robert Brian, PharmD. "With CLARION, comprehensive data collection is covered, period!" said Heinz Salazar of Tampa General. "We have much more complete data because it's pulling data straight from the LIS and it captures everything. Anything that gets reported on the LIS will make it to the CLARION database, which is basically everything that we report. Additionally, CLARION lets us filter all of this by ED, by clinics, by inpatient, etc."

$6,426 Annual Savings

The average lab director in central Texas is paid $6,426 every two weeks, including salary and benefits. This is just one of the many hidden financial costs of an inefficient antibiogram program, not to mention the clinical costs of inaccurate reporting.

"Previously, this mostly manual process would take at least two weeks of my time," said Lab Director Barbara Smith. "That's probably a conservative estimate, but honestly if I sat down and did nothing but the antibiogram, it would take me at least two solid weeks, and that's if I was doing none of my other responsibilities. I would not be attending meetings or processing samples. I honestly wouldn't even be answering emails. It would just be sitting and doing the antibiogram and nothing else."

https://www.salary.com/tools/salary-calculator/clinical-lab-services-director-benefits/el-paso-tx

CLARION also allows Salazar to quickly provide very targeted antibiograms upon request. "I received a request the other day about the pediatric ICU, which the filtering ability of the CLARION dashboards allowed us to provide. We can now go in and filter down into much greater detail. And all it takes is a couple minutes to get the data I ask for."

"The CLARION dashboards present data in such a way that you can rapidly identify trends that might otherwise take months to emerge," said Robert Brian, PharmD. "By using the dashboard for our COVID-19 population, we quickly learned that the CDC recommendations about bacterial co-infection was inaccurate for our patient population. This allowed us to safely cut our antibiotic use in these patients by half."

Antibiogram Improvement: Before v After CLARION
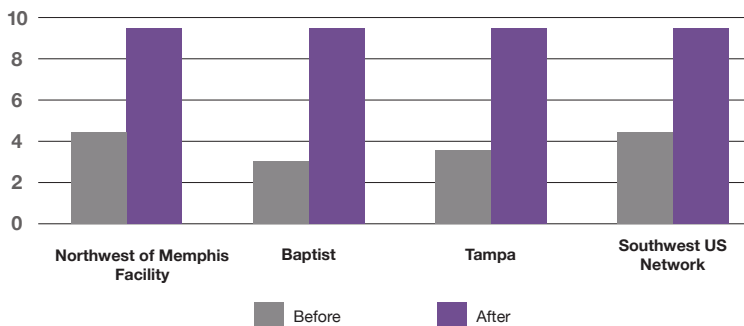
All four CLARION customer sites were asked to rank their experience in creating their hospital's antibiogram with and without using CLARION, on a scale from 1 to 10.

Before █ After

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Conclusion

CLARION assisted the clinical lab scientists and pharmacists at these hospitals to make sense of a colossal and growing body of clinical lab data. It brought organization to a near boundless amount of information, customizable rules required to organize it, and the imaging and presentation tools needed to act on it.

CLARION saved these facilities weeks of work and frustration. It empowered these professionals to provide answers to highly specific questions in real time that were nearly impossible to answer accurately before CLARION.

CLARION eliminated the onerous chore of antibiogram creation that is standard in far too many hospitals today, along with the inevitable errors and flaws that come with manual processes. Antibiograms that were often outdated by the time they were released became true reflections of the bug-drug interactions that exist in the hospital in real time, allowing for the improved empiric treatment selection. of patients on an individualized basis.

For these healthcare professionals, CLARION brought order to the chaos of data overload, saved precious time and resources, and empowered clinicians to make decisions that reduced antibiotic overuse and improved clinical outcomes.

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* Dr. Valencia-Shelton is on the speakers bureau for bioMerieux, Inc at the time of writing of this White Paper.

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