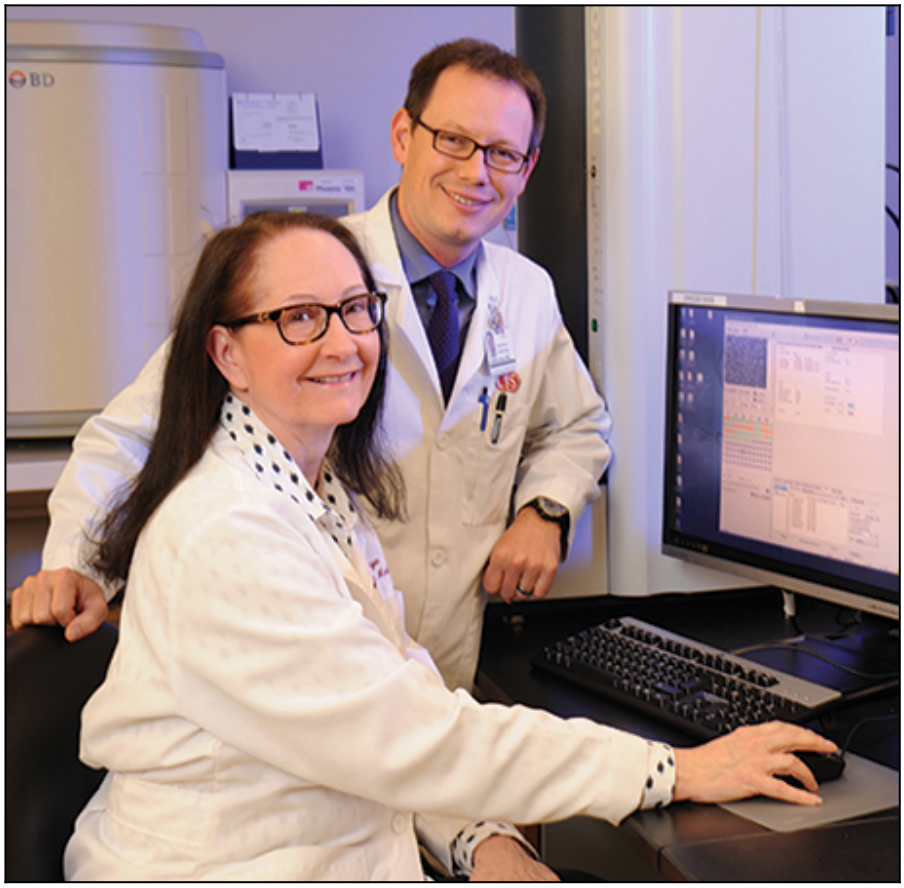
MALDI in microbiology: Set to stun?

Anne Paxton

May 2015—In the business world, the term "disruptive innovation" is hot. In product launches, business plans, and job resumes, it's become a standard part of the pitch. Like the flux capacitor in the fictional DeLorean time machine, disruptive innovations vault a field past traditional barriers and obstacles, outstripping rival technologies.



Dr. Margie Morgan with Jonathan Grein, MD, infectious disease specialist and associate director of hospital epidemiology at Cedars-Sinai. With its MALDI-TOF, the microbiology lab has seen an 18-hour decrease in the time for reporting identification of enteric Gram-negative rods.

But how can you tell if you've got the real thing or just a pretender? Perhaps one giveaway is whether, like *Back to the Future's* "Doc" Brown, you can start tossing into the trash supplies that were once necessities.

That was one of the outcomes a year after Montefiore Medical Center in Bronx, NY, acquired its matrix-assisted laser desorption ionization time-of-flight mass spectrometry (MALDI-TOF) instrument, says Michael H. Levi, ScD, head of Montefiore's microbiology division and associate professor of clinical pathology at Albert Einstein College of Medicine. "Recently I saw my manager throwing out boxes of sugars, stating, 'We're not going to use them anymore!'"

Dr. Levi's microbiology laboratory, which plans to purchase a second MALDI-TOF instrument when it moves to a new facility next year, is not alone in finding the MALDI-TOF transformative. Employed in research for several years, MALDI-TOF mass spec is well established as a rapid, high-throughput method for identifying bacteria, fungi,

and more. Since receiving FDA clearance for U.S. clinical use in 2013, Bruker's Biotyper CA and BioMérieux's Vitek MS have been finding enthusiastic users who, despite the instrument's $200,000-range price tag, can't imagine their microbiology laboratories without it.

Margie Morgan, PhD, believes that MALDI-TOF has the potential to replace most conventional biochemical testing in the microbiology laboratory. Her laboratory at Cedars-Sinai Medical Center in Los Angeles, where she is scientific director of microbiology and associate professor of pathology, was an early adopter in acquiring a MALDI-TOF instrument two years ago. About that same time, the 900-bed institution became one of the largest heart transplant and cardiac centers in the United States. With the increased numbers of immune-suppressed patients and patients with endocarditis, the isolation of unusual organisms became routine.

"Organisms previously seen only rarely in our laboratory, such as the HACEK, *Rothia* spp., *Gemella* spp., and *Abiotrophia* spp., became the norm. There are currently no molecular tests for direct positive blood culture identification of these organisms, and they're not necessarily isolated from just blood cultures—they could be in tissue specimens or various other sample types," she says. "We needed a method to assist in the rapid and reliable identification of these unusual organisms."

From attending meetings and talking to colleagues, she says, "we saw the direction in which labs were moving, particularly larger ones like Cedars-Sinai. They were acquiring MALDI-TOF instruments." Automated and manual biochemical methods, particularly when considering ongoing taxonomic changes, were becoming more problematic.

Cedars-Sinai acquired its Bruker MALDI-TOF before the instrument obtained FDA clearance, which meant conducting a rather extensive validation. Using Bruker's proprietary database of organisms' mass peak profiles, the laboratory validated approximately 500 organisms, a combination of Gram negatives and Gram positives, and including anaerobes.

Dr. Morgan's laboratory has found MALDI mass spec's advantages in rapid results and economy to be dramatic. The laboratory reported an 18-hour decrease in the time for reporting the identification of enteric Gram-negative rods. "If you perform a MALDI-TOF identification, you have your answer in about 15 minutes, while on an automated system it would take five hours—if manual biochemical reactions were needed, three days or more."

Once the upfront investment has been made, the reagents are inexpensive. "An isolate can be identified on MALDI for approximately 50 cents whereas the automated system cards can be as much as $5 to $7 per isolate." The main economic savings to the laboratory is in reagent costs, a factor that Dr. Morgan believes gives MALDI a distinct edge over other existing technologies.

Identifications are improved over biochemical testing in Dr. Morgan's laboratory when the MALDI is used correctly as an identification program. There are nuances, she says, to the use of the MALDI mass spec information that better ensure the accuracy of results. "It's well known that you'll get alerts with the Bruker instrument with a few organism identifications that the MALDI can't discriminate between, such as *Streptococcus pneumoniae* and *Streptococcus mitis*, or *E. coli* and *Shigella*." Alternative methods to confirm identification and analysis of results must be selectively incorporated into the ongoing MALDI program to achieve overall accuracy of identification.

"Also, when unusual organisms are identified, perhaps genera you have not encountered before, you need to investigate further using phenotypic characteristics to assure accuracy and taxonomy placement for guidance in susceptibility testing." Identification is certainly helpful to clinicians in the choice of antibiotic therapy, she says, "but usually they're not going to discharge anyone from the hospital or make any dramatic antimicrobial changes until they have the susceptibility results, and currently susceptibilities using existing instruments are taking the same amount of time" as before MALDI-TOF was implemented. She hopes some type of susceptibility information will be accessible in the future using MALDI.

Dr. Morgan doesn't consider the MALDI a timesaving device. "It saves you time in reporting identifications, but I do not think you would say it's labor saving or that you'd be willing to give up personnel once you acquire one." There

is also a skill set for doing MALDI, she points out. “Everyone is in awe of the MALDI’s performance and willing to learn, but to be a successful operator it is helpful to have a bit of computer expertise, good eye-hand coordination for smearing onto the target plates, and a curiosity to learn about new taxa.”

At Cedars-Sinai, the instrument has been highly reliable. “In two years, I think the longest unscheduled downtime was about six hours, and it was a user issue, not an instrument malfunction. So with our laboratory volume, we’ve not seen a need for a backup instrument.” The instrument requires preventive maintenance about once every six to 12 months depending on usage, and it takes eight to 12 hours, but careful scheduling can help prevent a major disruption in laboratory testing, she says.

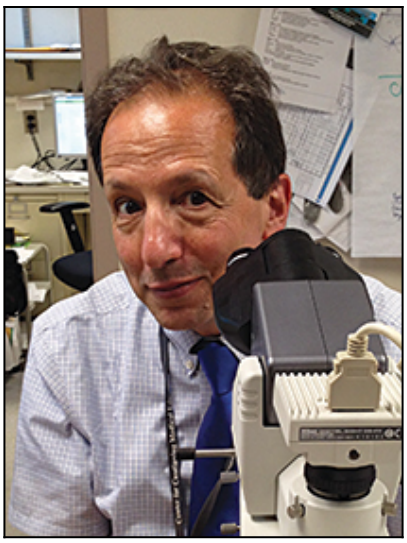
Laboratories vary in how much they rely on their MALDI mass spec instrument for identifications. “Some labs may identify every organism isolated using MALDI, while others may maintain some manual or spot tests—for example, *Staphylococcus* or *Enterococcus* identification. When speciation of an isolate is not required, you could maintain manual tests at the bench level for identification, if you desire,” Dr. Morgan says. Every laboratory needs to make decisions about maintaining select conventional biochemical testing and how it will be used. “You would always need a backup plan in case your MALDI is not functioning for an extended period, or if on occasion you need to confirm an identification of an unusual isolate, or if the MALDI does not identify an organism. But for the most part, you could eliminate the large inventories of biochemical tubes and cards usually present in a microbiology laboratory,” Dr. Morgan says.

For her microbiology laboratory, the main adjustment MALDI implementation required was development of a new workflow. “It’s not just a new piece of equipment. It’s a new program introduced into your laboratory,” she says. “You can make it work for you and speed up the total turnaround time for finalizing cultures or it can disrupt the flow of ID and susceptibility testing and actually make the final result slower.” In her laboratory, once a new, improved workflow was implemented, it led to a smoother laboratory flow and overall shorter turnaround time for finalizing cultures.

European laboratories have helped by leading the way on MALDI, Dr. Morgan notes. “They had MALDI systems five to seven years before most installations started in the U.S., so there was extensive laboratory experience, published literature, and ongoing research to assist us when we acquired our systems.”

Microbiology labs with large test volumes are more likely to be able to acquire a MALDI-TOF. Cedars-Sinai estimates it can pay off its instrument in three to three and a half years, and similar-sized labs have already moved to MALDI mass spec or are considering the move, Dr. Morgan says. While ASTs can be made economically and sized appropriately for smaller laboratories, “it would be difficult to do that with a mass spectrometer. Small labs could certainly benefit, but at this point in time, I don’t see the reality of this technology becoming commonplace in a small microbiology laboratory. But who knows what the future might hold.”

For Montefiore Medical Center, which does about 7,000 blood cultures a month, the benefits of having a MALDI-TOF MS have gone far beyond the ability to eliminate surplus supplies. “It’s really changed our culture and how we do things. We estimate we’re saving about $100,000 a month—minimum,” Dr. Michael Levi says.



Dr. Levi

The lab has made several calculations to show the impact of the MALDI on turnaround time. “Looking at Gram-negative rods, we compared the period from March to April 2013 with the same period in 2014, after we got the MALDI,” Dr. Levi says. “Our median time to identification went from 52 hours to 30. We also looked at our interaction with the antibiotic stewardship team on adjustment of antibiotics for individual patients, and found the median time to streamline a susceptibility regime went from 70 hours to 56 hours. Time to consultation with an infectious disease doctor from 34 to 16 hours.” Similar gains were seen with *Staphylococcus aureus*.

A survey of Montefiore clinicians confirmed they are aware of the difference MALDI is making. Seventy-four percent said they felt that blood culture results were coming sooner, while 70 percent said the MALDI had affected their clinical decision-making or added to patient care.

Dr. Levi finds the MALDI-TOF has rekindled clinicians’ interest in upfront identifications of organisms. “The people who don’t adopt this concept and say, ‘I need susceptibility tests as well to make the report meaningful’ are missing out on providing crucial information for clinicians. Naturally, we’re going to do that as quickly as we can on rapid susceptibility, but there are a lot of bacteria and yeasts where rapid identification will allow clinicians to make better antibiotic choices.” For example, MALDI-TOF recently identified *Haemophilus parainfluenzae* directly from a pediatric blood culture bottle. “This organism causes a very serious form of endocarditis, and the attending clinician decided to increase the dosing of antibiotics to try to avoid complications. Without the direct blood culture identification by MALDI-TOF, the clinician may have only had the Gram stain results to work with for the next 24 to 48 hours. Even more routine identifications like *Escherichia coli* or *Klebsiella pneumoniae* coupled with the patient’s background help the antibiotic steward team make better treatment choices.”

Typically, he says, “We do MALDI on new blood culture plates in the morning and then new positive bottles in the afternoon. Results are entered into the LIS and emailed directly to the antibiotic steward team. So instead of days to get an ID, we’re talking hours, particularly when we do it directly from the blood culture vial.”

Skilled microbiology staff remain essential. With technology like the MALDI, “some people say we’re ‘dumbing down’ microbiology, and it’s going to amount to just another chemistry test, but that’s probably not true in a complex setting,” Dr. Levi says. “One thing we’re learning is that different types of technologists could generally do MALDI-TOF, so some smaller hospitals would say they can cross-train people and don’t need more specialists.”

“But I say that with a caveat: The bigger microbiology gets, the more you need to know about what type of organism it is and what kind of disease it’s causing to make sure the MALDI data makes sense. In a simpler setting where you’re doing basically *Staphylococcus* and *Klebsiella pneumoniae* and *E. coli,* and there are not complicated patients, that’s one thing. For the more complex university hospitals, seeing diseases from all over the world, you really need to know your microbiology.”

The MALDI at Montefiore is being used for anaerobic bacterial identifications, wounds, and enteric pathogens in stools, “but we have not started using MALDI for mycobacteria or yeast. Though the single platform could be used for those kinds of specimens, mycobacteria need to be treated completely differently, and yeast requires an additional extraction step,” says Dr. Levi. “But I think eventually the lab could use MALDI for all different types of organisms.”

The descriptor “multiplexed” doesn’t do justice to the MALDI, in the view of his assistant, Wendy Szymczak, PhD, assistant professor, Department of Pathology. “The way MALDI identification works,” Dr. Szymczak says, “is you’re putting an isolate in the instrument and getting a faster profile for that unknown, then comparing it to the reference database, so it’s more ‘multiplexed’ than something like PCR, where you’re limited by the number of primers in that reaction.” Even highly multiplexed tests are limited to 15 or 20 organisms, though, whereas “with MALDI our database has 2,000 different organisms in it.”

“However, the lab has actually integrated molecular testing with MALDI when it’s known there is a *Staph aureus*, and we can go to a molecular platform to see if it’s positive or negative for resistance to oxacillin,” Dr. Szymczak says, noting that further coordination with molecular is in the works. “We hope in the near future to have a similar type of thing for Gram-negative rods.”

Dr. Levi can point to significant public health benefits that have resulted from the MALDI. “Just as an example, a couple of months ago we got a call from the health department about a patient in the ER, a teacher who they feared had meningitis. We had a culture with only three colonies, but we were able to finalize the identification as *Neisseria meningitidis* within 15 minutes using MALDI. That’s the kind of impact it has.”

The MALDI has also identified many unfamiliar new organisms. “This is another very interesting thing,” Dr. Levi says. “They would have been identified phenotypically as some kind of anaerobe or *Bacteroides* species where you weren’t sure and you’d have to send them to the health department, because we don’t have the right molecular identification methods available to us in-house.” Recently, he says, “We just had a blood culture *Leptotrichia*. We had it confirmed molecularly, and I don’t think we ever saw that before.” These are blood culture isolates that were probably misidentified in the past, Dr. Levi believes.

There have been a few difficulties. Because New York State has its own regulations for non-FDA-approved laboratory tests, “it has been a little confusing figuring out what we can do and what we can’t do. For example, yeast was approved just recently by the FDA for testing via Bruker MALDI-TOF, but before we hadn’t yet gone to New York State with our yeast data. We’re hoping that soon we can start expanding into yeast identification,” Dr. Levi says.

When the laboratory moves to its new facility in 2016, he expects the MALDI-TOF will allow a new paradigm in microbiology. “We’ll have people who can read the plates by looking at photographs of cultures and analyzing them, similar to a radiologist looking at x-ray images. A technologist can decide what colonies need to be identified, send them automatically to someone at the MALDI station for identification, and based on that, set up the appropriate susceptibility testing. So it will change the way we are set up in the laboratory and who does what work.” Microbiology has a brilliant history, Dr. Levi adds, “but with the MALDI-TOF mass spectrometry, we’re really trying to apply new, modern scientific methods.”

“The beauty of MALDI-TOF is that it’s very cheap and very fast,” says Omai Garner, PhD, assistant clinical professor and associate director of clinical microbiology at the University of California-Los Angeles Department of Pathology and Laboratory Medicine. “From a reagent perspective, you only need Matrix, and that’s a chemical component that costs a penny. So MALDI is the No. 1 growth area for bacterial and fungal identification techniques right now.”

Once he saw the technology at work, “We wanted to be on the forefront of having MALDI-TOF,” Dr. Garner says.

UCLA’s health system serves two 400- to 500-bed hospitals and about 200 outpatient clinics. “So our volume, just

in identifications of bacteria and yeast, is relatively high. Our tertiary service with a very high number of transplants means we have a very large, very sick population that is open to infections by opportunistic pathogens."

"We were looking for efficiencies in identification both to meet the high volume and the right level of service." While not automated per se, MALDI-TOF instruments are able to do hundreds of tests at one time inside one instrument. So when MALDI-TOF became available, "we were very interested, because you could not only get the identifications fast once you put the bacterial colony in the machine, but the result also mirrored the specificity of the gold standard, which is 16S rRNA gene sequencing."

UCLA was fortunate to be one of the clinical trial testing sites for the BioMérieux Vitek MS, Dr. Garner says. (The other five sites that tested the instrument before FDA approval were Barnes-Jewish Hospital in St. Louis, Washington University, Cleveland Clinic, NorthShore-LIJ in New York, and Massachusetts General Hospital.) "So we got our hands on the instrument very early on."

Scientifically, the MALDI does not represent a fundamental change, Dr. Garner explains. "You're still analyzing some component of a bacteria and comparing it to a library or standard to make predictable identifications. But you're now able to do it faster and with a much higher specificity." As of yet, MALDI cannot tell a *Staphylococcus aureus* from MRSA, he adds. "It's moving in that direction, and it wouldn't surprise me if in four or five years library components come out that are able to reliably differentiate these two bacteria."

UCLA has many immunocompromised patients in whom organisms considered normal flora are oftentimes pathogenic, he says. "When we put it on the MALDI, it's going to be able not only to identify whether it's a Gram-positive or Gram-negative bacteria, but also to give us a confident species identification on the day of colony growth. Having that immediate species information is critical in allowing us to obtain a susceptibility result that has interpretive criteria. There's also a fair amount of intrinsic resistance among many pathogens, so just by knowing the species, you can predict what antibiotics will work and what will not work."

He cites *Candida krusei* and *Candida glabrata* as organisms that can be intrinsically resistant to fluconazole, one of the typical antibiotic treatments for yeast. "The quicker you can identify the species of these organisms, the better information you can give to the treating clinician so they know which drugs to use or not use. That really has a high patient impact in certain areas of the lab."

Using MALDI doesn't cut any of the time it takes to grow a culture, which is typically 24 hours for aerobic bacteria and 48 hours for anaerobic. "If you're doing an automated platform, it takes a day or two post colony growth to figure out what the organism is. In anaerobic bacteriology, it takes even longer because many of the organisms are either facultative anaerobes requiring an aerotolerance test or are biochemically inert."

Dr. Garner believes acquisition of MALDI-TOF by microbiology labs is surging but that cost remains a potential barrier. "It's initially a very expensive capital equipment cost, and you have to convince your hospital you're going to be able to 'buy back' the instruments in a short period of time." Often, to demonstrate a return on investment, labs have to cite clinical savings like reducing antimicrobial usage or reducing length of stay.

Dr. Garner

For smaller microbiology laboratories, over the near term, he agrees with Dr. Morgan that purchase of a MALDI could be difficult to justify. “But as more and more data and papers come out showing the direct patient care impact of this piece of technology, they’ll have further justification to go to their own hospital administration and say that with MALDI we’re going to cut down days of stay, bed time, antimicrobial usage, and so on.”

Dr. Garner thinks in five years MALDI will be able to provide some susceptibility information. “Just as PCR does, based on the understanding of the proteomic spectrum that’s available, because MALDI is a cheap and efficient way of producing a proteomic spectrum,” he says.

MALDI mass spec is not likely to eliminate conventional biochemical tests, in his view. “MALDI is a very good tool, but no technique is 100 percent. It’s always up to the expertise of clinical scientists on the bench to determine whether or not the MALDI-TOF call is correct, and sometimes it can be questionable. Sometimes you get a ‘no ID’ from the MALDI. So if you don’t have biochemical backup, what are you going to do at that point?”

He is certain that the MALDI technology will get better and better at calling identifications. But it’s important, he says, for clinical laboratory scientists to know and maintain their basic knowledge of biochemistry. “If a submitted urine specimen grows a flat colony that’s a lactose-positive Gram-negative rod on a MacConkey plate and it’s spot indole-positive, that’s going to be *E. coli*. We can’t lose that education. For the patient in the bed on the hospital floor, it doesn’t matter what technique you use to identify the organism. They just need that result as quickly as possible. So I think we need to maintain our entire toolbox.”

MALDI-TOF will continue to improve as there are more and more users, he adds, because the libraries will contain more information. “If there are only nine *Staphylococcus aureus* to compare to your MALDI-TOF result,” he says, “you might not call it correctly. But if there are 9,000 or 90,000, your chances are much better.”

Nevertheless, MALDI presents the same risk associated with any machine: the danger that the human expertise in the lab won’t be there when needed. “As new, young technologists are coming in, you still have to be stringent in how they learn identification schemes, as backup in case the machines go down,” Dr. Garner cautions.

Pay a lot of attention to workflow, he says. “It’s a recognized challenge that once you have a MALDI in your lab, there’s a lot of work to do in the lab to appropriately incorporate that MALDI so it doesn’t become a bottleneck.”

MALDI’s future is secure, Dr. Garner believes. “Right now MALDI-TOF is moving to be the standard for rapid identification of cultured bacteria and yeast, and in the next five or 10 years it will become standard practice for identification. It really can not only dramatically improve turnaround time of identification but also have dramatically positive impacts in the lab.”

Dr. Patel

At Mayo Clinic in Rochester, Minn., the commitment to MALDI-TOF mass spectrometry has been anything but casual. The microbiology laboratory has acquired three of the Bruker MALDI-TOF mass spectrometers since 2010. Says Robin Patel, MD, professor of microbiology, chair of Mayo's Division of Clinical Microbiology, and director of bacteriology: "MALDI-TOF mass spectrometry has completely changed the clinical practice of our culture-based laboratories."

She first encountered the technology in Europe. When the technology was still for research use only in the U.S., her laboratory tested it on Gram-negative bacteria, then Gram-positive bacteria, anaerobic bacteria, yeast, dermatophytes, mycobacteria, etc. "Because it was such a new and different technology, I needed to be convinced, so we tested some of our most challenging and unusual organisms and when that worked, we tried even more uncommon organisms. We've validated each subset of organisms by evaluating performance, building our own mass spectral libraries, and coming up with detailed organism-specific reporting guidelines," Dr. Patel says.

"We found MALDI-TOF mass spectrometry to be accurate and fast. It takes minutes to identify an isolate. For most organisms, the user takes a colony on a plate, places it on a MALDI-TOF mass spectrometry plate, overlays it with reagents, lets the reagents dry on the plate, and places the plate in the instrument." Shortly thereafter, an organism identification is available.

As a result, Mayo Clinic has moved a large percentage of its biochemical-based organism identification to MALDI-TOF mass spectrometry. "We didn't have anything like this before," she says. "Historically, we performed much more biochemical-based identification, and because that didn't always yield a definitive result, and because we identify many unusual organisms, we also performed a lot of sequencing-based identification. We still do some biochemical- and sequencing-based identification, but not nearly as much as we did in the pre-MALDI-TOF mass spectrometry era." Both are costly and take longer than using the MALDI-TOF mass spectrometry approach, she says.

In part, Dr. Patel credits Mayo's reporting scheme with making MALDI-TOF mass spec work so successfully. "We have come up with reporting guidelines for everything we do, so for every organism type we identify, we refer to a table that tells us what is acceptable for reporting." For example: whether it can be reported and, if so, whether it can be reported at the species level, the genus level, the complex level, or whether further testing should be performed, she says. "With this approach, I'd say our accuracy is equivalent to that of sequencing."

But the microbiology laboratory does a lot of testing unrelated to MALDI-TOF mass spectrometry, she says. MALDI-TOF mass spec is a tool for identifying cultured organisms and not a standalone test. "Antimicrobial susceptibility

testing, molecular testing, and serologic testing, among other approaches, are regularly performed in clinical microbiology laboratories and don't benefit from MALDI-TOF mass spectrometry. But for organism identification, MALDI-TOF mass spectrometry has transformed our processes," Dr. Patel says. The ability to put colonies of different organism types onto a single platform is one of its main advantages, she notes.

Mayo Clinic has focused some of its recent research on the clinical value of being able to identify organisms to the species level, which MALDI-TOF mass spec technology facilitates. Prosthetic joint infection has been a particular interest. "Many of the organisms that infect artificial joints are normal skin flora and can be isolated as contaminants or pathogens," Dr. Patel explains. "It can be difficult for physicians to tell whether an organism is a pathogen or a contaminant. We found we can glean some potential clinical significance from the species identification provided by MALDI-TOF mass spectrometry."

Despite the laboratory's having eliminated many of its biochemical tests in favor of MALDI-TOF mass spectrometry, she says, this new technology can't do everything. "For example, *Escherichia coli* is not well differentiated from *Shigella* species by MALDI-TOF mass spectrometry, so we end up preferentially using biochemical testing to distinguish between these organism types." Other organisms are not identified by MALDI-TOF mass spectrometry, for a variety of reasons, she says. Those are identified using sequencing- or biochemical-based identification, or sometimes both. As a large reference laboratory, Dr. Patel notes, Mayo Clinic won't get rid of a biochemical test unless it is unlikely to ever be needed, but in the era of MALDI-TOF mass spec, Mayo Clinic has been able to discontinue some biochemical tests.

MALDI-TOF mass spec has changed traditional workflow. "With MALDI-TOF mass spectrometry, we don't need to perform Gram stains on cultured isolates because if we have a well-isolated colony, we test it by MALDI-TOF mass spectrometry directly." That was a workflow change for microbiology technologists, but the technologists who use MALDI-TOF mass spec enjoy using it. "We are able to identify bacteria and fungi so fast that our technologists get almost immediate feedback as to the identity of colonies they are seeing on plates. And we have lots of interesting findings," Dr. Patel says. "Just yesterday, for example, we had a Gram-negative bacillus sent to us for identification which turned out to be a Brucella species. It came from a patient who hunted wild boars in Florida. We knew what it was right away, compared to in the past when it would have taken us several days to identify it."

Dr. Patel doesn't believe laboratories smaller than hers should rule out acquiring MALDI-TOF mass spec technology just because of its initial cost. "It's within reach for large or medium-sized laboratories. For tiny laboratories, it may not make sense, but exactly where the size cutoff is, we don't know yet."

The microbiology field can take more general lessons from the MALDI-TOF, Dr. Morgan says. "We get kind of stuck sometimes in microbiology with what we're comfortable with. We've been using biochemical and turbidity for ASTs for 50 years. But there are a lot of new technologies coming our way now. They don't come without issues, they're not plug and play, and you have to learn about them and use them correctly. But we need to be open to them."

The possibilities that MALDI-TOF mass spec opens up are exciting, Dr. Patel believes. "We now have two systems in the U.S. that are FDA-cleared. It's a technology that allows us to rapidly, accurately, and less expensively than previously identify bacteria and fungi grown on plates. Now that we have MALDI-TOF mass spectrometry to identify organisms, I would say there will be no going back to the methods we used to use."
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Anne Paxton is a writer in Seattle.