

A REPORT FROM THE AMERICAN COLLEGE OF MICROBIOLOGY

# Clinical Microbiology in the 21st Century

KEEPING THE PACE



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MICROBIOLOGY

# Clinical Microbiology in the 21st Century

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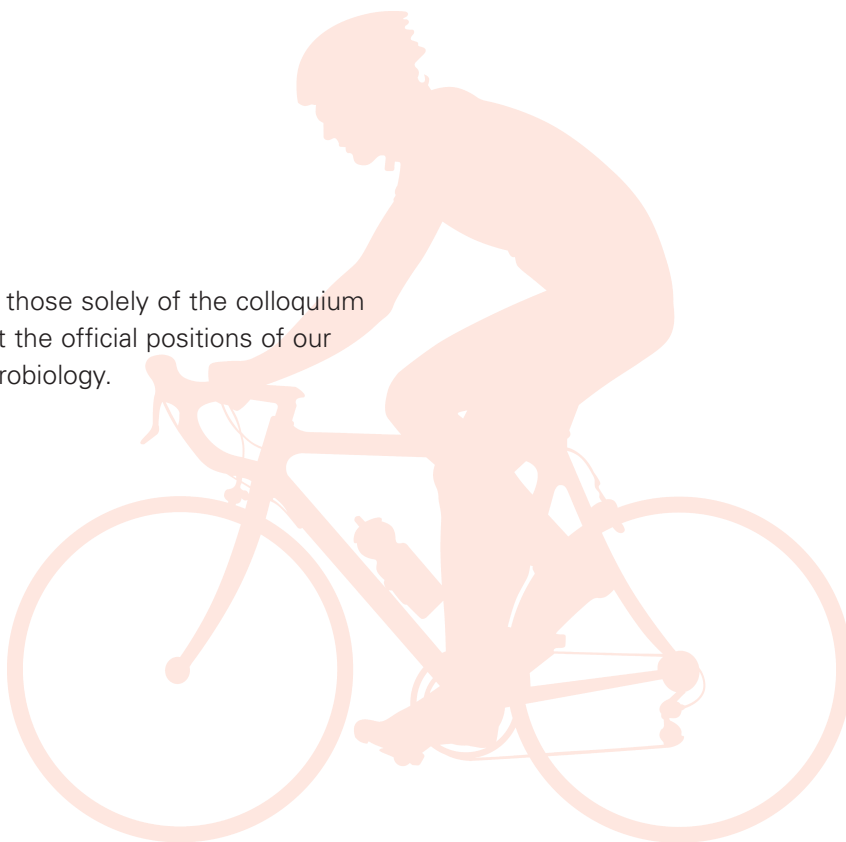
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# EXECUTIVE SUMMARY

What is a clinical microbiology laboratory? When a specimen is collected in a hospital, public health, or other medical setting, it goes to a laboratory for analysis, and specimens that are bacterial, viral, parasitological, or mycological (fungi) are sent to the clinical microbiology laboratory. Clinical microbiology laboratories provide services that are critical to the well-being of our population—analyzing specimens collected from sick patients and gathering data that enable the correct diagnosis to be made for victims of infectious diseases. They are the sentinels for bioterrorism events and natural outbreaks of infection which threaten the public health of the communities they serve. These laboratories provide crucial information that guides the selection of the right antimicrobial therapy for patients with treatable infections. They are the first to recognize the emergence of resistance to frequently used antimicrobial agents. Individuals who work in clinical microbiology laboratories are highly trained professionals who make countless decisions each day that save lives and benefit the sick and at-risk members of our society.

Despite the pivotal role of clinical microbiology laboratories in our healthcare system, these laboratories are victims of difficult times. The American College of Microbiology convened a colloquium of experts in clinical laboratories to deliberate the problems facing clinical microbiology laboratories today and ones they likely will confront in the future. The issues discussed included an array of scientific issues, healthcare administration issues, and personnel obstacles in recruiting and retaining qualified workers. A group of thought leaders with expertise in clinical microbiology, infectious diseases, pathology, diagnostic test development, basic microbiological research, and healthcare administration were assembled to discuss the current status of clinical microbiology, the directions in which it is headed, and solutions for the problems of today and those likely to be encountered in the years to come.

Chief among the scientific issues facing clinical microbiology laboratories is the difficulty in translating promising research achievements into tangible improvements in the diagnosis and management of infectious diseases. The reasons are complex and multifaceted, including:

- There are a limited number of laboratories with expertise at the leadership and bench levels to perform increasingly complicated laboratory tests—this is particularly true in the area of molecular diagnostics.
- There is a lack of personnel resources and test specimens to verify that new diagnostic tests perform as expected.
- Costly regulatory barriers exist that laboratory vendors in the commercial sector must overcome before they can sell new products that are licensed by the U.S. Food and Drug Administration (FDA).

- The challenge of obtaining laboratory reimbursement from government-affiliated and private health insurance companies is daunting, especially with new cutting-edge technologies.

The end result is that technological advances in clinical microbiology laboratories often lag far behind novel approaches developed in microbiology research laboratories. When innovations do become available to clinical microbiology laboratories, they frequently are bewildering and confusing to laboratories that are ill-prepared to adopt them.

Several other scientific challenges were identified. The pharmacokinetics and pharmacodynamics of antimicrobial agents and the pharmacogenetics of patients are decisive factors impacting the success or failure of antimicrobial therapy. Yet, antimicrobial susceptibility testing methods currently used by clinical microbiology laboratories do not take these into account when predicting the efficacy of a particular course of therapy. Point-of-care testing has undergone tremendous growth in the healthcare arena and will continue to do so in the future. However, the relatively few infectious disease diagnostic tests that can be used in this setting cause concern among clinical microbiologists because of their disappointing sensitivity, specificity, and overall lack of accuracy.

Other scientific issues include the pressure to obtain more rapid identification of pathogens, to better differentiate between pathogens that harbor and do not harbor key virulence factors and antimicrobial resistances. This is especially difficult because there is increasing pressure for clinical microbiology laboratories to detect emerging infectious diseases as soon as they are recognized.

In addition to the scientific challenges above, clinical microbiology laboratories currently are confronted with administrative problems related to communication and staffing. Both sets of problems are likely to worsen in the years ahead.

Communication of information among clinical microbiology laboratories and local, state, and national public health entities is ineffective, and that reality places the population at unnecessary risk. Communication among clinical microbiology laboratories and public health agencies is critical, since they must act in a coordinated fashion to recognize and control bioterrorism events and outbreaks of infection. Development of a standardized approach to inter-laboratory communication would go a long way toward rectifying this problem.

The current shortage of qualified clinical microbiology laboratory workers will worsen in the coming years due to the aging of the present workforce and the alarming shortfall of replacement workers enrolled in college training programs and technical schools. Incentives for young people to choose laboratory professions as a career path are largely absent. Salary scales have fallen behind those for opportunities in other healthcare-related specialties and those in the business and legal professions. Laboratory workers do not receive the recognition and credit they

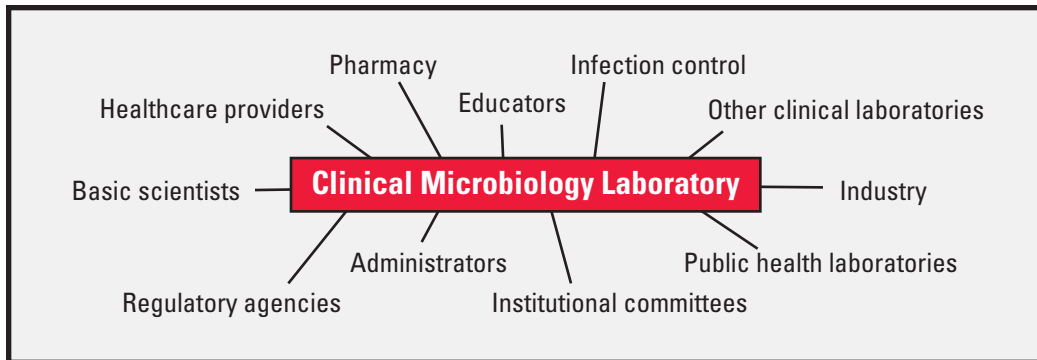
deserve as key members of the healthcare team. The challenge and excitement of clinical microbiology must be better marketed so that a career in this field becomes the first choice of students instead of a consolation prize for those unsuccessful in entering other fields of endeavor.

Recommendations for addressing each of these scientific and non-scientific issues are laid out in this report.



# WHAT IS CLINICAL MICROBIOLOGY?

Clinical microbiology plays a crucial role in the health of individual persons and the communities in which they reside. Most microbes that live on or within the body are beneficial and help keep individuals healthy. Distinguishing between microorganisms that are beneficial and those that are disease-producing is a critical function of the clinical microbiologist. Clinical microbiology also impacts the health of the public by helping to manage infectious disease outbreaks by identifying pathogens that could potentially infect dozens, hundreds, or even thousands of people and coordinating with the public health laboratories in the community.



A clinical microbiology laboratory accepts specimens collected from a wide variety of body sites and through the use of various tools (e.g., microscopy, detection of microbial DNA and/or RNA, detection of microbial antigens, detection of antibodies, and/or growth of microorganisms in culture) can determine what microorganisms are present and which may be causing infection. The same laboratory takes painstaking care in detecting antimicrobial resistance mechanisms in the microorganisms recognized to aid physicians in selecting the most appropriate antimicrobial therapy.

The individuals doing this work are thoroughly trained, highly skilled medical technologists and medical laboratory technicians who draw upon their education and experience to make informed decisions as to how to proceed with their diagnostic work. They are led by laboratory supervisors and directors who oversee their work, who vigilantly monitor test results for anomalies, and who are responsible for selecting the methods used in the laboratory. Other critical activities include ensuring that quality systems are in place to guarantee that accurate, clinically relevant test results are being produced, assessing the competencies of laboratory workers on a regular basis, and maintaining a safe and secure workplace environment.

The health of individuals and communities hinges on the services provided by clinical microbiology laboratories and the expertise of the professionals who provide these services. If hospitals, administrators, physicians, policy makers, and clinical microbiologists do not accept the responsibility and do not take the appropriate actions to address the problems outlined in this document, it is likely there will be a negative impact upon patient care and the health care system.

## CASE HISTORY

Some of the problems encountered by clinical microbiologists today are illustrated in the following case study. The scenario is a fictional outbreak of methicillin-resistant *Staphylococcus aureus* infection (MRSA), a real problem faced every day.

Brandi is a healthy, vigorous, 18-month-old girl who lives with her parents and four-year-old brother in the far-out suburbs of a large U.S. city. Both parents are employed in the city, necessitating the use of Monday-Friday daycare for both children. The time of year is August during a particularly hot and humid summer season. One Monday, while changing a diaper before dropping off her children at daycare, Brandi's mother notices a small pimple-like lesion on Brandi's buttock. To her it resembles an insect bite, and she makes a mental note to do a better job of protecting her children against exposure to mosquitoes, ticks, and spiders. She applies a dab of zinc oxide ointment, just in case it is the beginning of a diaper rash, and then takes the children to daycare.

Brandi's daycare location is part of a for-profit company that operates several facilities in and around the city. The company is licensed by the state and during the last on-site survey at Brandi's location they received high marks for their attentiveness to the children and the safety of their facilities. As the day wore on, Brandi becomes increasingly fussy and appears to be experiencing pain in her buttock area. The daycare center attendant assigned to Brandi this day has kept an eye on the lesion her mother had pointed out and thinks that it is getting redder and looking more and more like a pus-filled pimple as time goes by. In the middle of the afternoon, the pimple bursts during a diaper change, and the attendant uses a diaper wipe to remove the pus from Brandi's skin and from the plastic pad on the changing table. Later in the afternoon, when Brandi's mother picks her up, she seems warm to the touch and unusually irritable. The mother decides to take her to a neighborhood after-hours pediatric clinic once her husband arrives home from work so that he can take care of Brandi's brother.

At the after-hours clinic, Brandi is seen by a nurse practitioner who notes a low-grade fever and an erythematous draining pustule on her buttock. She thinks it resembles a spider bite that might have become infected. She asks the pediatrician on-duty to examine it. He prescribes oral amoxicillin-clavulanic acid and recommends over-the-counter ibuprofen for the pain and fever. The pediatrician advises Brandi's mother to take her to the community hospital emergency room if her child does not show improvement within 24 hours.

Overnight, Brandi's fever abates, but her buttock lesion appears to be getting worse. Her mother stays home with her the next day and feels

that Brandi is not improving, despite the short-term subsidence of her temperature. She decides to take Brandi to the hospital ER for evaluation when her temperature begins to rise in the afternoon, despite administration of ibuprofen. Brandi is examined by a physician's assistant who finds her moderately febrile with an angry-looking, very tender, oozing lesion on her buttock. Blood is collected for a complete blood count and a blood culture. A swab of the draining wound is sent to the laboratory for Gram stain and culture. Thirty minutes later the white blood cell count comes back elevated and the differential cell count indicates a bacterial infection. The Gram stain of the pus revealed many inflammatory cells along with gram positive cocci in clusters. Brandi is admitted to the pediatrics ward of the hospital and is started on intravenous oxacillin therapy for a presumed staphylococcal infection.

The above scenario has been replayed with slight variations in every community in the U.S. countless times during the past 10 years. It is an example of the importance of clinical microbiology and its practitioners to the patient care team. But favorable patient outcomes do not come automatically. Physicians caring for patients like Brandi depend on the clinical microbiology laboratory for test results that point to the correct etiologic diagnosis of infection and for the antimicrobial susceptibility results that aid them in choosing the antimicrobial agents that will eradicate the infection.

Patients who suffer from infections very different from Brandi's also benefit significantly from the work of clinical microbiologists. The list of infections is extremely long, but a few notable examples include a variety of life-threatening pneumonias, bacterial/fungal/viral meningitis and encephalitis, food-borne infections like those caused by *Escherichia coli* O157:H7 and *Salmonella*, urinary tract infections, facial sinus infections, ear infections, respiratory virus infections, HIV infections, tuberculosis, malaria, and infestations caused by many intestinal parasites. Almost all of this work occurs "behind the scenes" from the patient's point of view and is performed by faceless individuals who toil in parts of the hospital rarely visited by outsiders.

**After less than 24 hours, the clinical microbiology laboratory reported that both Brandi's blood culture and wound culture did in fact yield growth of *Staphylococcus aureus*. The next task for the laboratory was to determine the antimicrobial agents that would likely be effective in treating Brandi's infection.**

Some consider detection of antimicrobial resistance to be the most critical of several important responsibilities of the clinical microbiology laboratory. It is at this point in the management of seriously ill patients that the initial choice of antimicrobial therapy either is validated or found to need revision according to the antimicrobial susceptibility results. Laboratories perform this testing while adhering to the standards promulgated by the Clinical Laboratory and Standards

Institute (CLSI), a non-profit organization dedicated to promoting laboratory testing that offers reliable, reproducible, and clinically-useful results. Antimicrobial testing, in particular, is affected by methodological variables that if not controlled can yield falsely susceptible or falsely resistant results.

The testing of Brandi's pathogen is a good example of the complex tasks facing clinical microbiologists. Detection of resistance in *S. aureus* to three key classes of antimicrobial agents (the semisynthetic penicillinase resistant penicillins [methicillin, oxacillin, nafcillin], the glycopeptides [vancomycin, teicoplanin], and the lincosamides [clindamycin]) is much more problematic than it might seem at first blush. Clinically important phenomena known as heteroresistance and inducible resistance require clinical microbiologists to deviate from standard test methods when testing staphylococci. Knowing when to deviate, how to deviate, and how to interpret the results from these modified tests call for up-to-date knowledge of ever-changing susceptibility test procedures.

**The clinical microbiology laboratory determines that both of Brandi's *S. aureus* isolates are MRSA. Additionally, the isolates are inducibly resistant to clindamycin, but are found to be vancomycin-susceptible. Brandi's hospitalization continues, and her antimicrobial therapy is switched to intravenous vancomycin.**

Management of suppurative infections like Brandi's entails the drainage of accumulated pus along with appropriate antimicrobial therapy. The antimicrobial susceptibility testing performed by clinical microbiology laboratories is extremely helpful to physicians in most circumstances, but sometimes conventional results are misleading because they fail to consider the pharmacokinetic and pharmacodynamic parameters of the antimicrobial agents given to patients. Development of a stronger working relationship among clinical microbiologists, clinical pharmacologists, and physicians during the selection of antimicrobial therapy would be of great advantage to patient care. The emerging field of pharmacogenomics, in which genetically-based variations in how patients respond to antimicrobial therapy from the perspectives of efficacy and toxicity, for the most part is not yet a factor in physician decision-making. There remains much room for improvement in how *in vitro* susceptibility data are interpreted in the context of individual patient care.

Correct identification of MRSA and other antimicrobial resistant microorganisms is a challenge that competent clinical microbiology laboratories meet without difficulty. However, researchers have gained much more knowledge of pathogenic microorganisms like MRSA than we are able to discover in the clinical laboratory. A major hurdle in clinical microbiology is the significant lag time before techniques that generate medically-useful information about pathogens can be translated from the research laboratory to the clinical laboratory. Issues of cost, equipment, test standardization, and reimbursement for testing are the major impediments. Currently, laboratories are heavily dependent upon the commercial sector to take on the risks and costs of developing new technology, obtaining licensure from

the Food and Drug Administration (FDA), and gaining approval for new Current Procedural Terminology (CPT) reimbursement codes before they can take advantage of progress made by the research sector. This dependence, along with the overwhelming workload of the FDA and the American Medical Association CPT Committee, contribute to delays in implementing new technology.

**The physician caring for Brandi, remembering that MRSA infections are reportable to the state public health system where Brandi resides, completes the information requested on the official reporting form and drops it in the mail later that day.**

Communication of the occurrence of infections of public health importance to appropriate authorities is mandated by law in many jurisdictions. And yet the frequency with which this actually is done is disappointingly low. Transmission of paper records via conventional mailing systems is highly inefficient and prone to errors. At a time when financial transactions between banks, between businesses and banks, between individuals and banks, and between individuals and businesses are routinely and flawlessly handled electronically, it is difficult to understand why the same effort has not been made to facilitate the electronic reporting of reportable diseases. Establishment of a healthcare system infrastructure to make this happen is costly, and the settling upon a standard by which mandatory information could be sent from disparate information systems to a single repository would require a difficult-to-achieve consensus. But the return on that investment in terms of improved public health would be gigantic by comparison.

**On Friday, while reviewing that week's activity records, the Director of Brandi's daycare center notices an unusual cluster of children with diaper-associated lesions. Upon questioning the involved employees, she learns that most of the five children had developed pustular lesions on or near the buttocks 2-3 days after Brandi had been admitted to the hospital. Parents of three of the children had also sought medical attention for their child. The daycare center Director notifies the county health department who launches an investigation. Specimens are collected from each of the affected children and cultured. Several daycare center sites, including the pad on the diaper changing table are also cultured. All five children and the pad yield growth of MRSA.**

Were the isolates from Brandi, the five other children, and the pad on the diaper changing table the same strain of MRSA? The county public health laboratory referred the isolates to the state public health laboratory for further characterization.

Similar apparent outbreaks of infection are commonplace today in hospital settings. Very few hospital clinical microbiology laboratories, however, are equipped to perform the testing necessary to determine whether an outbreak caused by a single strain is in progress or the isolates in the cluster are unrelated to each other. Those laboratories that can perform the analysis receive no reimbursement for the

expense of testing—despite the fact that early recognition and termination of an outbreak of infection saves the laboratory, the pharmacy, the hospital, and ultimately the healthcare system many more dollars than the expense of the testing.

Too often financially-based decisions are made in a very short-sighted manner, particularly when expensive, new technology is involved. A question frequently asked by decision-makers is: will the laboratory be reimbursed for the cost of the testing? In many instances the answer is no, or at least not completely reimbursed. But when a far-sighted analysis is performed that takes into account all of the cost savings that derive from the testing, the correct decision is obvious.

**Brandi is discharged from the hospital in good health. New cases of MRSA buttocks infection stop occurring at the daycare center after staff education is initiated and effective disinfection measures for diaper changing areas implemented.**



## **WHY DOES CLINICAL MICROBIOLOGY MATTER?**

Clinical microbiology is different from other sections of the laboratory because it deals with live microorganisms that multiply rapidly, are vulnerable to inappropriate handling between the patient and the laboratory, are able to evolve resistance to therapeutic regimens, may or may not be causes of infections, and can disrupt the public health through devastating local, regional, national, and worldwide outbreaks.

Clinical microbiology laboratories help manage outbreaks of infectious disease by identifying and curbing pathogens that could potentially infect dozens, hundreds, or even thousands of people. By communicating and coordinating with public health laboratories, clinical microbiologists recognize, track, and control outbreaks at the community level. Should there be a bioterrorism event, clinical microbiologists would be the first line of protection by detecting the presence of a given disease in the community.



# WHAT ARE THE PROBLEMS FACING CLINICAL MICROBIOLOGY LABORATORIES TODAY?

Clinical microbiology is at the horns of a crisis that threatens the lives of individual patients and the public as a whole. Failing to resolve the challenges confronting clinical microbiology could overwhelm the ability of hospitals to manage infections and undermine the collective public health. Scientific and non-scientific difficulties are threatening the ability of clinical microbiologists to manage their responsibilities to individual and community health. Clinical microbiologists must find ways to cope with these difficulties—ranging from slow technology transfer to problems communicating with public health departments—in order to improve patient care and prevent outbreaks of infectious disease. A number of issues related to staffing, recruitment, and training have also reached crisis levels and must be addressed.

## **PROBLEM: IMPLEMENTING THE RESULTS OF RESEARCH IN THE LABORATORY**

A primary scientific challenge facing clinical microbiology today is the rapid translation of research results into practice. Researchers are constantly making novel discoveries in diagnostics and analytics, but clinical laboratories have been slow to adopt new methods that put these discoveries to work for patient care. In many cases, the cost of implementing the new technology is prohibitive or not cost-effective for smaller facilities. In others, the sensitivity and specificity parameters of the new product only marginally meet the expectations of clinicians and require laboratories to conduct backup testing to ensure accuracy of results. Clinical laboratories must keep pace with discoveries in basic science and make needed changes in diagnostic procedures in order to improve patient outcomes, but this need must be accommodated by manufacturers that provide products that are affordable and serve all patient populations. Discontinuation of irrelevant, outdated testing platforms must be part of this effort. More rapid implementation of research findings is an achievable goal for clinical microbiology; many other areas of medicine enjoy continual input from basic science.

The use of molecular diagnostics is an example of a technical gap that exists in clinical microbiology laboratories. For example, the polymerase chain reaction (PCR) is an extremely useful tool and has been widely used in research for over 20 years, yet many laboratories at smaller community hospitals have yet to offer any PCR-based tests. Gene microarrays, first developed in the 1990s, could be used to screen specimens for hundreds of microorganism-specific genetic sequences simultaneously—essentially a molecular analogue of culture. They are another example of valuable technology that has not yet become available in clinical microbiology laboratories.

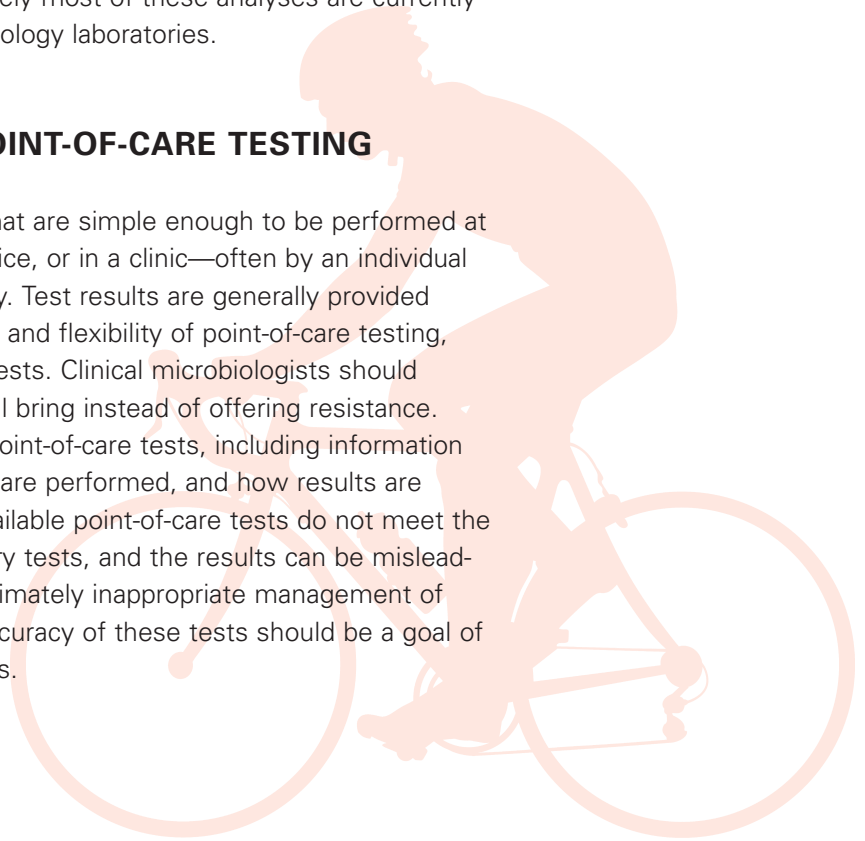
Translating research achievements into clinical microbiology laboratory practice is critically important and must be accomplished in a more timely fashion. To get this done, clinical microbiologists need to partner with professionals from the basic science, business, and government communities. Translational studies, in which advances in basic research are tested in a clinical setting, are a prime opportunity to form such partnerships. Forging relationships with industry colleagues in order to provide meaningful feedback to manufacturers and to convey the needs of diagnostic labs will hasten the process. Obtaining clearance from the Food and Drug Administration (FDA) to use transitional technologies in clinical microbiology laboratories needs to be streamlined and made less burdensome for manufacturers.

### **PROBLEM: UNDERSTANDING AND REPORTING THE VIRULENCE CHARACTERISTICS OF PATHOGENS**

Investigating the virulence of pathogens and understanding the manner in which virulence factors affect the human host is a major challenge for clinical microbiology laboratories. Many organisms isolated in the laboratory are clinically unimportant under some circumstances and clinically significant in others. Skilled clinical microbiologists help make those determinations, the results of which often direct therapeutic decision-making. It would be advantageous to rapidly characterize both phenotypic and molecular traits of microorganisms to improve the care provided to patients. Unfortunately most of these analyses are currently beyond the capabilities of clinical microbiology laboratories.

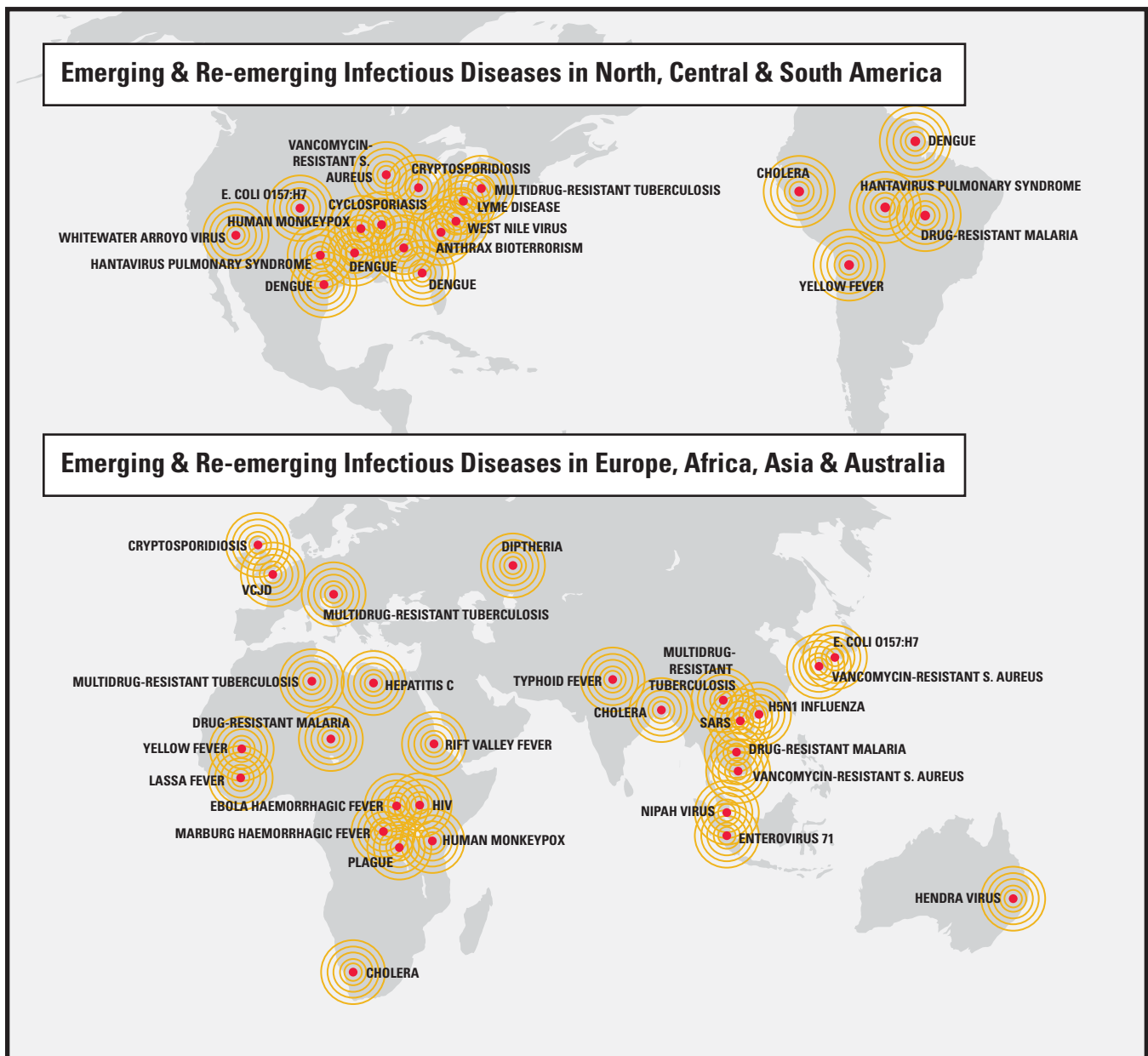
### **PROBLEM: THE IMPACT OF POINT-OF-CARE TESTING**

Point-of-care testing includes assays that are simple enough to be performed at the patient's bedside, in a physician's office, or in a clinic—often by an individual who does not work in a clinical laboratory. Test results are generally provided within minutes, and because of the ease and flexibility of point-of-care testing, there is an increasing demand for such tests. Clinical microbiologists should embrace the changes this movement will bring instead of offering resistance. Training personnel on the limitations of point-of-care tests, including information on when tests are necessary, how tests are performed, and how results are interpreted, is critical. Many currently available point-of-care tests do not meet the accuracy standards expected of laboratory tests, and the results can be misleading, lead to erroneous diagnoses, and ultimately inappropriate management of patient care. Improving the diagnostic accuracy of these tests should be a goal of manufacturers and clinical microbiologists.



## PROBLEM: THE ONSET OF EMERGING AND RE-EMERGING INFECTIOUS DISEASES

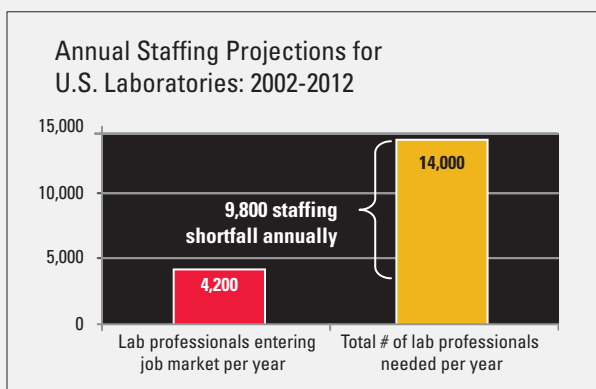
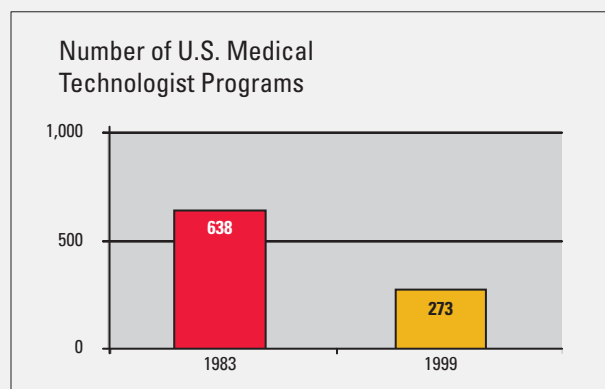
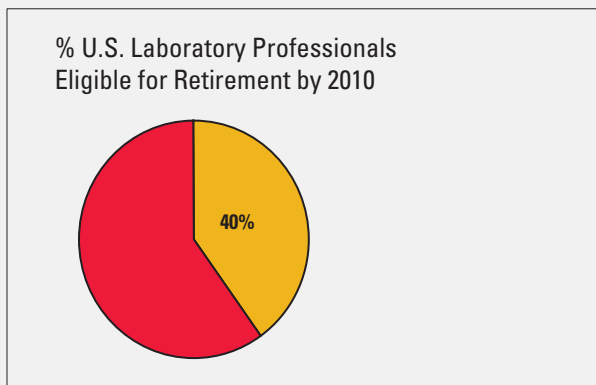
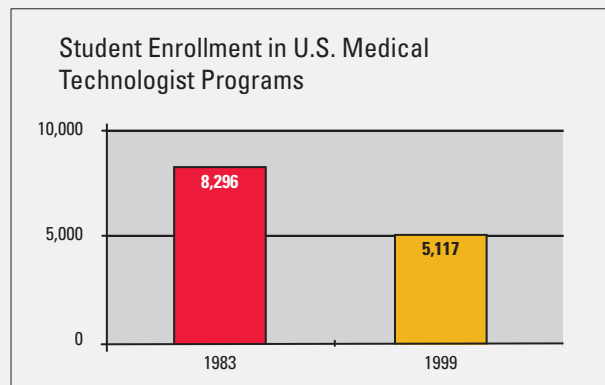
Clinical microbiology labs are often ill-equipped to cope with diagnosing new or forgotten infectious diseases, especially when pathogen detection requires phenotypic or genotypic tests that are not widely available. Clinical microbiologists could play a role in developing diagnostic capabilities, but in many instances there is little incentive offered by their employers to conduct the necessary research. Where opportunities do exist, progress may be stymied by the bureaucratic requirements of institutional review boards (IRBs) and the Health Insurance Portability and Accountability Act (HIPAA).



## PROBLEM: THE SHRINKING CLINICAL MICROBIOLOGY LABORATORY WORKFORCE

One of the most important problems facing clinical microbiology centers on the laboratory workforce. Thoroughly trained, highly skilled workers are a vanishing breed. A number of studies have shown that there are more laboratory workers today leaving the workplace than are entering the workplace. The reason is that the average age of laboratory workers has increased to almost 50 years and when they retire, there are not enough newly educated replacements just finishing school to take their places. The situation is reaching a crisis point similar to that experienced in the nursing profession a decade ago. One solution is to make the laboratory profession more visible to students and a more attractive choice from a salary and fringe benefit standpoint. Another solution is to publicize the exciting nature of clinical microbiology in identifying outbreaks of infection, in working on the front lines to recognize bioterrorism events, and in learning to use the latest technologies while performing molecular diagnostics. The implication of some popular television shows that physicians are the individuals performing definitive laboratory testing must be dispelled.

### Staffing Shortage



Anonymous. 2000. Lab. Ind. Rep. 9(5):4 Ward-Cook, K. and S. Tannar. 2001. Lab. Med. 32:124-138

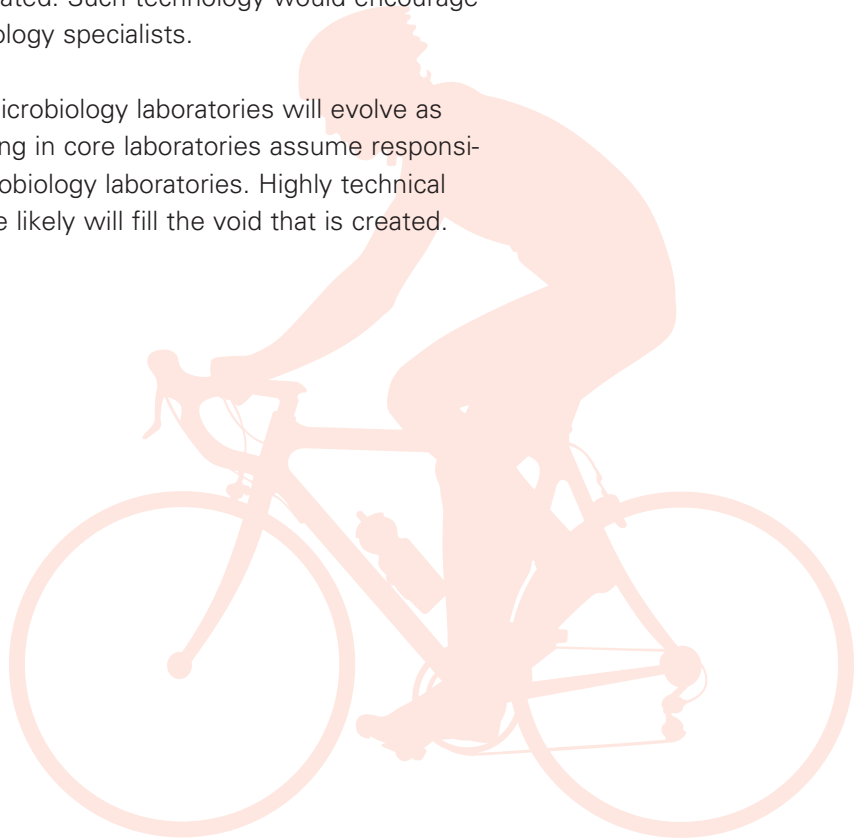
# THE FUTURE OF CLINICAL MICROBIOLOGY

Traditional boundaries now in place that separate clinical microbiology from other laboratory disciplines are disappearing. In order to develop more effective diagnostic assays and to manage outbreaks of infectious disease in a more timely and efficient manner, clinical microbiology professionals must engage in partnerships with professionals from other disciplines.

New tests should be developed in cooperation with colleagues from the basic science and industrial arenas. Professional networking, joint participation in meetings, and other modes of communication will be required to foster these kinds of collaborations.

Clinical microbiologists must also partner in a more productive way with public health laboratorians. These two groups need to maintain open channels of communication on a daily basis, not just in times of crisis. Working together, clinical microbiologists and public health laboratorians can provide training, diagnostic support, facilitate test development, and help one another understand the emergence of new pathogens and new forms of antimicrobial resistance. Tele-microbiology, in which experts use video and other imaging technologies to analyze and interpret the results of tests performed at a distant site, will be a useful tool for linking laboratories that are geographically separated. Such technology would encourage more frequent consultation with microbiology specialists.

In the future, the activities of clinical microbiology laboratories will evolve as point-of-care testing and automated testing in core laboratories assume responsibilities formerly belonging to clinical microbiology laboratories. Highly technical testing requiring microbiological expertise likely will fill the void that is created.



# RECOMMENDATIONS

1. Translating innovative research developments into actual use by the clinical microbiology laboratory is of fundamental importance, and it must be accomplished in a timely fashion. New diagnostic tools for clinical microbiology laboratories should be created through partnerships between clinical microbiology professionals and researchers in basic science and industry. Professional networking, participation in seminars, and other modes of communication are required to foster these kinds of collaborations.
2. Competent medical technologists and medical laboratory technicians are in very short supply. This shortage directly impacts the ability of clinical microbiology labs to diagnose and help manage infectious diseases. Laboratories and hospitals must provide meaningful incentives to retain clinical microbiology professionals and the years of valuable experience and skill these individuals have accrued on the job. Recruitment strategies must recognize the need to attract new leadership to the field of clinical microbiology. It may be advisable to convene symposia, with personal invitations to students and faculty of middle schools, high schools, and colleges that describe leadership careers in clinical microbiology at regional and national microbiology meetings.
3. Point-of-care testing, especially those analyses that are conducted at the patient's bedside, in a physician's office, or in a clinic, is a growing trend in health care, and clinical microbiology professionals should prepare for this future reality. Clinical microbiologists must ensure that the individuals who perform point-of-care testing understand how to interpret the results. Clinical microbiologists should be called upon to help select the assay targets, advise on test formats, and participate in clinical trials.
4. Laboratory information systems should support dynamic bi-directional communication between laboratories (including local, state, and national public health laboratories) and generate reports regarding test positivity rates and antibiotic resistance trends.
5. Hospital administrators, regulatory agencies, and the legislative arena must be made aware that clinical microbiology laboratories are the centerpiece of infectious disease diagnosis, as well as the cornerstone of infection control. They must be made to realize that such laboratories require knowledgeable specialists, not generalists, to optimize both service and cost savings for the health care system.