Review article

A Modified Approach to Medical Laboratory Science Clinical Experiences in a Health System in the United States

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One of the most significant challenges contributing to the increased vacancy rates and workforce shortages of Medical Laboratory Scientists (MLS) in the United States is the inability of students to procure a clinical site or clinical programs for training and practical experience. This is due to shortages of practicing MLS professionals required to maintain internship programs and provide training. Baby boomer retirements, laboratory program hiatus, and, more recently, COVID-19 have escalated employee demands and intensified resignations, career changes, and premature retirements within the clinical environment. Elevating vacancy rates within organizations has sparked an evaluation of barriers and pathways to support modification of existing MLS training programs. As a result, this paper provides strategies to incorporate additional laboratories and use best practices in laboratory simulation and online learning to increase student opportunities for clinical training within a hospital or health care organization. Synchronizing didactic lectures and clinical instruction, using online Problem-Based Learning (PBL) and weekly Team-Based Learning (TBL) can eliminate the need for rigorous one-on-one clinical rotations. Health care organizations and clinical laboratories must collectively address current and future needs in the MLS workforce. Pedagogical changes are needed to increase the number of student opportunities for training within clinical laboratories and strong support to establish a framework to modify approach to MLS clinical site training.

Key words: MLS, Student, Vacancy rates, Clinical Laboratory, Clinical Experiences.

Introduction

Medical laboratory scientists (MLS) have an immeasurable role in providing vital information for managing patient diagnosis and treatment by conducting diagnostic laboratory testing. Medical laboratory professionals deliver a staggering 13 billion diagnostic tests annually in the United States to physicians who will make consequential patient care decisions with the information.[1] As one of the highest volume medical activities influencing nearly 2/3rd of the decisions made by physicians, clinical laboratory testing can save future costs, time, and even patients' lives when used for early detection and disease prevention.[2] Without medical laboratory professionals, physicians would be blindly treating the patient.

MLS are considered healthcare detectives, yet despite the importance of the work, they are also considered a "hidden profession."

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The COVID-19 pandemic brought the Clinical Laboratory Scientist (CLS) profession to the public eye, but it also exacerbated well-known concerns, including understaffing, increased workload, and work-life balance issues.[3] Clinical laboratorians had to pivot quickly, validate new analyzers, and adapt to unexpected conditions, including lack of personal protective equipment shortages (PPE), social distance requirements, and unprecedented numbers of COVID-19 testing while maintaining the regular workflow.[4]

The nation faces a growing and critical shortage of qualified medical laboratory staff in clinical laboratories. The U.S Department of Labor, Bureau of Labor Statistics projects an increase in demand for MLS of 11 percent from 2020 to 2030, faster than the average for all occupations.[5] The number of physicians and other healthcare providers requiring specimen analysis for overall health and diagnostics creates a demand requiring skill and competence. Unfortunately, there are not enough qualified medical laboratory professionals practicing in the United States to sustain the testing necessary for 330 million Americans. The scarcity of certified MLS impedes the ability of clinical laboratories to meet the growing demands of patient testing and could present difficulties for patient care and well-being. On average, about 25,900 openings for MLS and medical laboratory technicians (MLTs) are projected each year, resulting from a departure in the labor force due to retirements and, more recently, resignations and increased absences experienced during the COVID-19 pandemic.[5]

In addition to the increased demand for medical laboratory professionals, there are insufficient prospects for the onsite clinical practical experience required to prepare MLS trainees. Clinical experience is an integral part of any medical laboratory science training program. In fact, California defines clinical training as "Practical experience means hands-on, direct work experience in clinical laboratory science techniques on real patients in a clinical laboratory certified by the Clinical Laboratory Improvement Amendments of 1988 (CLIA)."[6] MLS students receive instruction under direct and constant observation and evaluation by practicing MLS. However, increased vacancies in clinical laboratories prevent organizations from offering the practical clinical experiences required for proper training and education of MLS students nationwide.

In addition to increased vacancies within clinical laboratories, NAACLS-accredited MLS programs have minimally increased in the last ten years, from 226 in 2011 to 239 in 2021, leaving laboratory leaders wondering if MLS programs can sustain the projected growth rate for medical laboratory science professionals.[7,8,9] Concerned stakeholders, including universities, clinical affiliates, employers, and professional organizations, are encouraged to take action through collaboration and strategizing to satisfy qualified medical laboratory professional demands in the years to come.

All clinical laboratory organizations, whether they are large health systems or smaller clinics need to consider adding training rotations to compliment existing laboratory sites to share in the training of new laboratory professionals. Laboratories could add additional students to the MLS training programs and increase the potential candidates available for hire each year. Creating a modified approach to MLS clinical site training coupled with changes in pedagogical delivery of didactic content, has the potential to expand to include the smaller facilities, and using best practices in laboratory simulation would eliminate the need for rigorous one-on-one clinical rotations and alleviate the additional burden on current laboratory professionals in training roles.

Background

Aging workforce

As baby boomers retire, the clinical laboratory loses many experienced and well-developed

professionals. According to the American Society for Clinical Pathology (ASCP) vacancy surveys, retirement rates for those retiring in the next five years are at their highest levels across multiple clinical laboratory departments. The blood bank anticipates a staff member reduction of 13.0% and 24.3% for supervisors, core laboratory retirements for staff are highest among the departments surveyed at 15.1% and 32.1% for supervisors, and the microbiology staff retirement rate is 12.8% and 30.9% supervisors (Table 1).[10,11]

Many baby boomer laboratorians joined the profession before training program closures began in the late 1990s. These experienced individuals have worked in the field extensively and serve as technical experts. Long-time laboratorians easily recall performing manual techniques to determine analyte values or identify bacteria. High-throughput laboratories often use closed system automation for testing analysis, but the principles behind the testing are based on manual methodology. This practical experience gained through hands-on experience is rarely practiced in the laboratory today. The loss of medical laboratory professionals retiring from clinical laboratories not only diminishes the number of employees in the laboratories but also removes an abundance of knowledge and experience. The demand for laboratory testing will also increase as the population increases and ages.

Vacancy Rates

Long before the Covid-19 pandemic, laboratories nationwide were experiencing staffing challenges. In a 2015 article by Kimberly Scott for the American Association of Clinical Chemistry (AACC), she stated, "The shortage of qualified laboratory professionals is not a new story; it is also one that won't go away." This statement continues to ring true today.[12] A 2012 survey conducted by ASCP identified vacancy rates for clinical laboratory personnel across the nation at 6.0%, with 9.0% of the employees expected to retire within 24 months.[10] Responders to the 2012 survey indicated "aging labor force, improvement in science and technology, and laboratory program closure" as the causative factors in the laboratory labor force status. As growing demands for medical care increase with an aging population and medical care advances, laboratory test volumes grow. Inexperienced medical laboratory professionals new to the job and substandard financial earnings compared to other health care professionals contributed to the shortage of well-trained, competent personnel in 2012. Similarly, today, limited program availability and the retiring workforce create staffing shortages that are difficult to fill.

Medical laboratory science vacancies have intensified due to disruption in the workforce caused by the COVID-19 pandemic and expected retirements. Declining numbers of students entering accredited education programs increased demands on employees, competitive salaries and sign-on bonuses at various laboratories, and staff burnout have exacerbated resignations, career changes, and premature retirements on top of the baby boomer generation retirements.[3]

Although COVID-19 increased medical laboratory professionals' visibility, it has negatively impacted MLS education primarily

Table 1: Percentage of Staff (nonsupervisory) and Supervisory Retirements rates, 2020 and 2012.

	Retirement Rate, %					
	Staff (nonsupervisory)			Supervisory		
Department	2020	2012	Δ	2020	2012	Δ
Blood bank	13.0	7.0	6.0 ↑	24.3	8.0	16.3 ↑
Core lab	15.1	6.0	9.1 ↑	32.1	24.0	8.1 ↑
Microbiology	12.8	9.0	3.8 ↑	30.9	10.0	20.9 ↑

by halting or delaying clinical rotations. Students were limited in laboratory rotations, sent home for safety precautions and social distancing, and sites stopped taking students during the pandemic.[13] Students could not get the "practical experience" required to qualify for state licensing where required, worsening the increasing staff vacancies in areas such as California. It appears the pandemic has already accelerated future shortages in the CLS field. Laboratory professionals must prioritize actions to define solutions and the next steps to strengthen the medical laboratory professional workforce.[3]

Cost of Education

Competition for medical laboratory personnel has intensified over the last several years, and staff resignation rates are beginning to be an increasing problem. To fill vacancies nationwide, some laboratories are hiring noncertified staff. This is not an option for regulated Clinical Laboratory Improvement Amendments (CLIA) laboratories. CLIA is responsible for regulating diagnostic testing before use on human blood samples and requires clinical laboratories to be certified by the Center for Medicare and Medicaid Services (CMS).[14] Hiring noncertified laboratory personnel is not a legal option in some licensure states such as California, nor is it an option that some laboratories wish to consider. An Oklahoma City laboratory conducted a study and found there were increased errors and lengthier training times required for employees lacking certification compared to those with certification. Additionally, these employees failed to recognize critical results "because they don't know the clinical difference in a test." These problems required additional time allocation and financial resources.[15]

Similarly, training additional students in a laboratory setting raises concerns that these actions may negatively affect productivity. But investing time in educating students within any organization can assist with a significant return on investment. The cost to recruit a new employee not trained internally requires factoring in evaluation and authorization to replace the vacancies, interview time and lost productivity for supervision, time to process newly hired applicants, and orientation and training time.[16] Students educated within a clinical laboratory organization are future pretrained employees who will require less instruction during the probationary period; this is where the organization can save money in the long run.[12]

Training programs

In 1983 approximately 9000 individuals graduated from accredited MLS programs; in 1992, the numbers decreased to 5760.[17] The percentage of graduating laboratory professsionals in 2019 diminished to 3663, 36 percent compared to almost 30 years ago, but the population in the United States increased by more than 20 percent.[3] Over the last 19 years, MLS training programs have decreased by 50%. According to the NAACLS, MLS programs have gone from 468 in 2002 to 239 in 2021.[8,9]

The decreased number of MLS training programs has prevented qualified individuals from being accepted into accredited training programs. Prospective students often must wait a whole year to reapply. Limited training spots create a highly stressful environment for students and clinical affiliates. Developing strategies to address these concerns must be at the forefront of conversations in the field and requires a collective effort by interested parties at all levels within the clinical laboratory organizations. Many college graduates in biology and science are still unfamiliar with the profession and the pathways leading to laboratory careers. Current literature states that enhancing the MLS profession's visibility through outreach to primary schools, high schools, professional networks, and college campuses can encourage recruitment into the field.[3] But where will these students train? The shortages of clinical training opportunities continue to limit the recruitment route and the future success of individuals in the profession.[3]

The current laboratory personnel shortages continue to negatively impact staff work-life balance, morale, and retention. A satisfaction study by the ASCP in 2020

identified participants had high job fulfillment but only a fair work-life balance. The main reasons for dissatisfaction were elevated job-related stress, burnout, additional responsebilities, loss of work schedule flexibility, and understaffing.[17] More than half (59.1%) of the survey respondents reported feeling inadequately compensated for their work. The objective of developing a modified MLS training program is to address the current vacancy increase and expected growth rate in MLS shortages over the next decade.

Curriculum design

Regulatory Requirements

NAACLS recognizes and accredits hospital affiliated university programs across the country to meet the established standards in clinical laboratory sciences. NAACLS standards serve to develop, maintain, and promote quality, provide recognition, and assist in developing and evaluating medical laboratory science programs.[19] Clinical site responsebilities include having at least one medical laboratory professional liaison per site responsible for coordinating clinical instruction and maintaining communication with the university program director. If a program is a stand alone hospital-based NAACLS accredited program, no clinical liaison is needed.

NAACLS standards require a clinical curriculum to include clinical chemistry, hematology/hemostasis, immunology, transfusion medicine, microbiology, urine, body fluid analysis, molecular diagnostics and laboratory operations.[19] The curriculum at each clinical site must address pre-analytical, analytical, and post-analytic components. Additional topics include safety, regulations and standards, and good communication to serve the needs of the service and enable students to achieve entry-level competencies in each discipline. Although NAACLS standards require a wide variety of curriculum topics for instruction, there is no documentation of specific timelines or rotational obligations. Clinical laboratories or university program must also meet several minimum requirements to train MLS students. These requirements include adequate space and equipment, and minimum instructor to student ratios as determined by the clinical laboratory or university based program administration.

Current Training Programs

Many hospital-based and some university programs continue to adhere to outdated pedagogical training schedules. One such laboratory, Los Angeles County Department of Health Service (LAC-DHS) laboratories is required to strictly adhere to California state requirements, and each student receives 52 weeks of individualized training at the three hospitals. Student training mimics the training program required for a newly hired MLS professional, except students are not allowed to perform patient work.[20] Students are paired with an MLS for 5-6 hours a day for four days a week. Trainers prepare them to think critically, navigate the laboratory information system (LIS), and practice manual methods used in clinical patient care. Students observe licensed MLS professionals verify patient results, and as time permits, they are provided with step-by-step instructions to resolve test result abnormalities and inconsistencies that require investigation. Students do not train together as they rotate throughout the clinical rotations. They each work independently with a seasoned MLS professional. It has always been this way, and it worked. For years LAC-DHS, like many other laboratory science organizations took pride in the ability to train students one-on-one and devote dedicated time to them. The ability to do a quality job with the increase in vacancies makes this approach challenging and unsustainable, and it affects the value of the practical experience required to prepare MLS trainees to meet professional requirements.

Hospital or clinically based NAACLS accredited programs may provide online or face-to-face didactic lectures one day per week or half-days every day, based on the program design. Each program is unique depending on clinical rotation, classroom and

instructor availability. The lectures do not always coincide with the clinical rotations for every student, and this asynchrony creates difficulties for students unable to connect technical information with practical experience. Synchronizing didactic lectures and clinical instruction may increase student engagement with didactic material and alleviate the repetition of technical explanations from clinical instructors, allowing them to focus on workflow tasks. This would likely require programs to utilize on-line learning management systems to provide lectures simultaneously for all students independent of their individualized clinical rotations. Upon completing the clinical training and didactic lectures, students are qualified to take the Board of Certification (BOC) of the ASCP national certification examination.[22]

In addition to implementing online instruction many clinical laboratories rely on a single large laboratory to train the MLS students in all the major disciplines required by NAACLS. Training students independently in a single medical center's core laboratory, composed of chemistry, hematology, urinalysis, and coagulation, occupies a major part of the student clinical training. This leaves little time for the core laboratory staff to onboard and instruct new hires, perform instrument validations and computer upgrades, prepare for inspections, and implement new projects without feeling overwhelmed and anxious. Utilizing additional smaller affiliated laboratories that perform high complexity testing within the core disciplines, would provide an opportunity to expand clinical experience training. Each laboratory generally has the technical infrastructure to cover the three phases of laboratory testing in biochemistry, hematology, coagulation and urinalysis to support MLS students. Implementing training on a broad scale across multiple laboratories must be tested and designed properly to determine whether this structure can provide quality MLS training to more students in each health system. No one size fits all.

Additional pedagogical innovations

MLS programs aim to train students to master theory, gain professional knowledge, and develop skills in clinical laboratory science.[23] Didactic material establishes a foundation for the clinical laboratory experience to build on. Clinical rotations teach what one can only learn in the clinical setting, such as onsite workflow managing numerous specimens, multitasking, instrument functionality, maintenance and automation, regulatory compliance, and documentation of consistent, official records.[21]

Moreover, clinical laboratory affiliates are focused on hiring new graduates and have invested time in training. Clinical laboratories can overcome laboratory shortages by modifying current MLS training programs and increasing the number of students accepted within each organization annually. Doing so will provide a larger pool of qualified candidates to fill vacancies.

Innovative Solutions

A recent study in a clinical pathology course explored the impact of blended learning, the combination of an online classroom and in-person learning, and its acceptance as a form of education in the discipline. It determined that there was astronomical acceptance by students and faculty alike and above-average achievement compared to conventional educational methods alone.[24] The pandemic altered educational platforms. In-person learning quickly transitioned to online audiences and has become widely adopted as a preferred method across college and university campuses. Why should this be any different for all MLS programs including hospital -based?[25] With technological advancements, online learning, and engagement through a computer has become more prevalent. As demands increase for educational programs and clinical sites to educate more MLS students with scarcer resources, online

education becomes a more appealing environment for educating future professionals. Synchronous and asynchronous virtual learning can be an effective educational method for delivering clinical lessons and, if constructed clearly and with detail, can provide lasting and consistent instruction.[26]

In fact, some universities have already changed clinical rotation timelines and are focusing on "getting students comfortable working in the hospital laboratory setting."[27] The University of Minnesota's MLS program reduced the time MLS students spend on clinical rotations from 22 to 12 weeks. The MLS accelerated program taught at South Dakota State University uses a combination of online, on-campus, and clinical courses in a 16-month program. This allows students to complete coursework faster than in traditional on-campus programs. Class sizes are as large as 24 students, and ASCP Board examination pass rates between 2018 and 2021 were 95%, respectively.[28]

These programs' success and ability to increase seats at clinical sites rely on exposure to testing methods or mock patient samples at the university using tabletop instrumentation similarly to those found in clinical laboratories. Students experience hands-on opportunities with laboratory information systems, digital microscopy, and specimen results that mimic real-life scenarios in simulation laboratories with detailed rubrics that grade students on turnaround time, accuracy, and reporting of critical values.[21] Simulation laboratories are not meant to replace in-person clinical training but may be used to help meet clinical hour requirements in these scenarios.[29]

Technology Based Learning Strategies

Clinical diagnostic laboratories must work together to address the challenge of significant MLS vacancies. To increase the number of MLS students trained annually, laboratory leadership should evaluate the current curriculum and determine how to best prepare students to master skills and perform clinical tasks skillfully with existing resources. By focusing on the purpose of clinical rotations and creating new models of education using online resources and affiliations with sister facilities, the organizations can successfully train more students annually.

Programs can easily create online tutorials as well as other educational materials using technological advancements in the online learning environment. Online tutorials may consist of recorded experimental or practical work supporting and enhancing learning and teaching. Implementing effective online learning that includes problem-based learning (PBL), self-study modules, and digital resources allows students to visualize clinical concepts in action, creating favorable outcomes. Online learning provides students with "manageable and effective access to a wider variety and greater quantity of information. These platforms accommodate students with various learning needs, promote interest in instruction by using multiple methodologies and nurture knowledge of clinical laboratory science by seeing processes completed correctly by the instructor that can be re-watched multiple times.[27] Researchers have identified no significant difference in MLS trainees' test scores and the ASCP Board of Registry certification scores for online learning students compared to traditional learning.[25]

Decreasing clinical rotations and focusing on the student "getting comfortable in a clinical laboratory" is a desirable option to train an increased number of students annually. However, it must be noted that some licensure states are still severely limited to address the shortage based on state regulations. Presently, California requires a bachelor's degree, with specific course requirements and a year of internship, to become eligible to take the ASCP MLS board exam to become both California licensed and nationally certified. The 52-week practical training requirements limit programs from altering the number of weeks a trainee must dedicate to the required subject by receiving hands-on direct work experience with actual patient samples. However, there is no clear hourly

requirement per week documented. The California Code of Regulations, last updated over half a century ago, needs modernizing. If not taken seriously, organized strategies to address the MLS workforce shortages will not be enough to reverse California's systemic problem based on limited clinical training capacity.[30]

The idea of the one-on-one teaching program historically offered through many clinical laboratory training programs is attractive to many MLS trainee candidates. Applying clinical skills in a laboratory environment can be challenging for students, and individualized instruction tailored to their learning style provides a platform where they can succeed. For the MLS instructor, this design is also appealing. Instructing one student at a time is less overwhelming and allows for a relationship to build with a potential future employee. Students have varying clinical skills when entering any MLS program, so with only one student to consider, the trainer can closely observe the students' strengths and weaknesses and has the freedom to modify the pace of instruction, accordingly, making this platform productive and meaningful.

Historically each student is generally paired with a practicing MLS professional for practical experience during the week and varies from four to six hours per day. Instructors review theory, and standard operating procedures, demonstrate laboratory skills and then observe the students performing similar actions on mock patient samples. Students observe the verification of patient samples and wait for unusual specimens to surface for more detailed instruction. More recently, one on one instruction has become nearly impossible to accomplish. With the shortage of laboratory professionals, students no longer get the sought-after individualized attention from the MLS trainer, who must multitask and cover multiple laboratory workbenches. Students spend more time reviewing standard operating procedures independently and observing the MLS perform patient care. There are fewer opportunities for MLS instructors to delve into abnormal patient sample workups and explanations.

With the inability to manage one on one training in the clinical laboratory, how can more students be added to the training program as the generation of baby boomers retire and with the persistent shortage of MLS and supervisors in the laboratory. An approach that, in recent years, has gained popularity in medical education is team-based learning (TBL).[31] TBL is an active collaborative approach to small group teachings and has been successfully used across numerous STEM fields (Science, Technology, Engineering, and Mathematics).[32] TBL is already used among laboratory professionals with colleagues and through interprofessional learning during communication with nurses, physicians, and pharmacists. This platform enhances critical thinking, communication skills, and active learning and would benefit students by involving them in scenarios encountered regularly in the laboratory.[33] Clinical sites may already be using a similar platform. Introducing a method for standardized clinical teaching and collaboratively education through the use of a team-based approach will eliminate many of the redundancies in processes and workforce utilization during the clinical experience.

A study on TBL in medical schools held sessions once per week for two hours, where before class, students were given required reading and pre-recorded lectures. Individual readiness was assessed using a multiple-choice quiz at the beginning of the session, followed by team-based clinical problem-solving using open-ended responses. Immediate feedback sessions, promoting discussions, and opportunities to challenge answers were facilitated by instructors, who then concluded the session by summarizing the assignment and providing key take-home messages. The TBL structure was more conducive to learning, remained student-centered, and generated positive outcomes.[31]

TBL does require facilitation from an educator. With the current clinical training structure performed in many hospitals and other health care based programs, educators may spend 20 or more hours per week with each student, collectively, and potentially adding up to over 100 hours per week discussing the same purpose of testing, analytic platforms, problem-solving, and operating procedures with individual students. One review session, face-to-face session of two hours per week with a single instructor using TBL across the student cohort can save hundreds of hours of manpower and alleviate redundancies. In turn, this would lessen the burden on laboratory staffing, as they work with each student for several hours waiting for unusual patient samples to provide opportunities for clinical problem-solving. MLS professionals could instead spend fewer hours with students providing focused, practical experiences.

The use of TBL across a student cohort would also support the addition of other smaller laboratory participation in the hands-on, direct clinical experiences. The education of analyte testing, analytic platforms, problem-solving, and operating procedures would be identical for each student. Time spent in the clinical rotations would focus on content and processes not included in the TBL sessions and didactic lectures, such as laboratory workflow, handling of specimens and multitasking, use of automation, adherence to regulatory compliance, and lab safety and record keeping.[21]

Clinical rotations are expected to provide work experience and evaluate competency in the students' ability to understand and perform laboratory tasks. Students are prohibited from verifying patient results, and training sites should not expect them to be fully proficient in these actions. Technological advancements have decreased the time required to achieve skill levels expected of MLS students by streamlining the preanalytic phase of specimen handling and eliminating labor-intensive and time-consuming manual testing. Standardization of instrumentation, operating procedures, and processes at clinical laboratory training sites would allow the additional laboratories to participate in rotational training and create room for additional students. Reaching proficiency in laboratory tasks for the students at each individual laboratory as a new employee will require site specific in-depth training in each department.

Conclusion and implications

Laboratory shortages are a reality at medical centers nationwide. Many qualified candidates are eligible to enter MLS training programs across the country. Procuring a clinical site for practical experience is one of the biggest challenges not only for hospital or health care based programs but also university programs, mainly due to shortages of practicing MLS professionals needed to maintain internship programs and provide training. This clearly affects the pipeline to provide future laboratory professionals.[34] Current program enrollments cannot keep up with the increasing demand for vacancy rates as they approach critical levels. Clinical laboratories must address and assess the ability to accept and train additional students into the existing MLS training programs.

Clinical laboratories could easily double the number of students in MLS programs by modifying current practices that include synchronizing didactic lectures with clinical instruction, using PBL online platforms and weekly TBL, and utilizing all high-complexity core laboratories to provide the clinical experience required for student training. Transitioning from what used to be to what needs to be will not be without challenges as laboratorians face increasing time constraints and demands. Additional studies and assessments are required to understand best practices with online learning, PBL, and TBL and how the modified training will align with each required task. The use of additional laboratories will need guidance and preparation in

coordinating clinical instruction and maintaining communication with the MLS program director per NAACLS guidelines.

Discussing the future of clinical training with various laboratory managers, identified a desire to increase the number of trainees and support to establish changes to program practices. One lab manager even suggested "starting early to form the framework."[35] Laboratory leaders must develop new ways of providing a personalized, self-directed learning experience if clinical diagnostic laboratories wish to maintain the success achieved through one-on-one training. Collaboratively, clinical organizations can develop best practices in MLS training across affiliated laboratories, eliminate the need for rigorous one-on-one clinical rotations, and alleviate the burden on staff in training roles. Providing an opportunity for more students to secure a spot in a clinical site for practical experience and resolving the biggest problem facing the training of future MLS professionals. Clinical diagnostic laboratories will also need to improve recruitment of well-qualified, knowledgeable MLS candidates for the future of the profession. Success also relies on leadership support, a willingness to modify current practices, and the ability to reflect expectations of the profession and prepare students for successful entry into the clinical laboratory environment.

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