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MEDICAL LABORATORY TECHNOLOGY TRAINING STANDARDS IN PAKISTANI INSTITUTIONS: A DESK STUDY

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ABSTRACT

Background: Medical Laboratory Technology (MLT) is a important allied health profession responsible for performing diagnostic tests on biological specimens to support clinical diagnosis, monitor patient health, and guide treatment decisions. Accurate laboratory investigations are pivotal, particularly in life-threatening situations, necessitating the presence of well-equipped teaching laboratories affiliated with hospitals to train competent medical laboratory professionals.

Objective: This study aims to evaluate the existing training standards of MLT programs across Pakistani institutions, identifying professional criteria fulfillment and highlighting prevalent shortcomings in educational and clinical training frameworks.

Methods: A comprehensive desk review was conducted using data extracted from 185 Pakistani institutions offering MLT courses. The

study analyzed curricula, clinical training affiliations, and certification provisions from institutional websites and official publications. Institutions were categorized into four grades (A to D) based on their compliance with core professional and educational requirements.

Results: Only 18 institutions (9.72%) met the criteria for Grade A, providing comprehensive training including clinical attachments, standardized curricula, and certification support. Seventeen institutions (9.18%) achieved Grade B, while the majority, 84 institutions (45.40%) were graded C, and 66 institutions (36.67%) were Grade D, reflecting significant gaps in clinical training, curriculum standardization, and professional certification.

Conclusion: The findings underscore the critical need for standardization and improvement in MLT education in Pakistan. Many institutions lack essential job training facilities within teaching hospitals and proper clinical affiliations, compromising the quality of graduate competencies. Establishing rigorous accreditation standards and enforcing curriculum uniformity are imperative to produce skilled medical laboratory professionals capable of supporting effective healthcare delivery.

INTRODUCTION

Medical Laboratory Technology forms the backbone of modern healthcare diagnostics. Professionals in this field conduct vital laboratory analyses on biological samples including blood, urine, and tissue facilitating accurate disease diagnosis, treatment monitoring, and epidemiological surveillance [1, 2]. With evolving medical complexities and emerging infectious diseases, the demand for highly competent medical laboratory technologists is rising globally.

In Pakistan, MLT is an allied health profession that holds significant importance in patient care. However, the standards of education and training vary widely among institutions, raising concerns about the competence of graduates entering the healthcare system [3, 4]. The quality of laboratory diagnostics directly influences patient outcomes, as erroneous or delayed results can

lead to misdiagnosis or mistreatment, which, in extreme cases, can be fatal [5, 6]. Therefore, it is essential that MLT educational programs maintain rigorous training standards, incorporating both theoretical knowledge and extensive practical exposure in clinically affiliated laboratories.

This study presents a comprehensive overview of MLT training standards in Pakistani institutions. It aims to delineate the essential professional criteria for MLT education, assess the current status of training programs, and identify systemic gaps impeding the development of qualified medical laboratory professionals.

Role and Importance of MLT in Healthcare

Medical laboratory technologists are indispensable in clinical workflows, providing diagnostic data that informs nearly 70% of medical decisions [7]. Their responsibilities span specimen collection, preparation, analysis, quality control, and result interpretation. Consequently, MLT education must ensure students acquire competencies in diverse pathology disciplines hematology, microbiology, chemical pathology, histopathology/cytopathology, and molecular diagnostics [8, 9].

Global Training Standards

Internationally, medical laboratory education emphasizes integrated theoretical and practical training, with mandatory clinical rotations in hospital laboratories to ensure hands-on experience [10, 11]. Regulatory bodies such as the American Society for Clinical Pathology (ASCP), Clinical Laboratory Improvement Amendments (CLIA), and National Accrediting Agency for Clinical Laboratory Sciences (NAACLS) prescribe standards encompassing curriculum content, faculty qualifications, infrastructure, and clinical training Table 1 [12, 13].

Teaching pathology lab for MLT training requires comprehensive coverage of all major pathology sections, including histopathology, hematology, clinical pathology, microbiology, chemical pathology, immunology, and molecular diagnostics. The criteria for effective pathology lab teaching include a well-structured curriculum aligned with national and international standards, availability of modern laboratory equipment, access to a variety of clinical specimens, trained faculty with subject expertise, and strict adherence to biosafety protocols. Hands-on training in sample collection, processing, staining, microscopy, and diagnostic interpretation is crucial. Each pathology section must be integrated with theoretical understanding and practical application to develop core technical competencies [14, 15, 16]. The importance of this training lies in its direct relevance to accurate disease diagnosis, monitoring, and public health

surveillance. Well-trained MLT professionals serve as the backbone of diagnostic services in healthcare, ensuring reliability and precision in laboratory results. A thorough understanding of all pathology sections equip students with the skills to work in diverse clinical settings and fosters critical thinking, problem-solving, and decision-making abilities [17, 18]. Furthermore, it enhances research capabilities and promotes continuous professional development, making pathology lab teaching a cornerstone of MLT education that ensures the production of competent and confident laboratory technologists Table 2.

Table 1. Standard overview of MLT curriculum and outline of training rotations for students.

Discipline	Sub-disciplines	Training rotations
Clinical Chemistry	Chemical Pathology	One month
	Toxicology	One month
	Endocrinology	One month
Hematology	Transfusion medicine (Immunohematology and Blood Banking)	Two months
	Clinical Hematology	Two months
Clinical Pathology	Macroscopic, Microscopic and chemical-based identifications of body fluids	Two months
	Bacteriology	One month
	Medical Mycology	One month
Medical Microbiology	Medical Virology	One month
	Medical Parasitology	One month
	Immunology & Serology	One month
Medical Pathology	Histopathology	Two months
	Cytopathology	One month
Molecular	Molecular Pathology	Two months

Biology		
	Cytogenetic	One month
Basic Medical Sciences	Anatomy	Demonstrations
	Physiology	Demonstrations
	Biochemistry	Demonstrations

Table 2. Criteria of a teaching pathology lab

Established Laboratory Department	HOD	Expert: Technologist/Technician
Hematology Molecular Pathology & Cytogenetics, Hemopathology, Blood banking & Immunohematology	Hematologist	Hematology & transfusion medicine
Histopathology Cytopathology, Histopathology, Immunohistochemistry	Histopathologist	Histopathology
Microbiology Clinical Bacteriology, Clinical Mycology, Clinical Virology Clinical Parasitology, Serology & Immunology.	Microbiologist	Microbiology
Chemical Pathology Toxicology, Clinical Chemistry, Endocrinology.	Chemical Pathologist	Chemical pathology

Challenges in Pakistan's MLT Education

Previous studies highlight several challenges confronting MLT education in Pakistan, including inadequate clinical training attachments, inconsistent curricula, lack of standardized certification, and insufficient qualified MLT faculty especially at doctorate level and departmental heads [19, 20, 21, 22]. Mostly institutions hire non-MLT faculty. Hiring non-MLT faculty to teach MLT students weakens practical training, limits clinical relevance, and hinders professional skill development. These instructors often lack hands-on lab expertise and current diagnostic knowledge, leading to gaps in competency, reduced student confidence, and poor alignment with

professional standards and real-world medical laboratory practices. While the Higher Education Commission (HEC), Pakistan Medical and Dental Council (PMDC) and recently Allied Health Professional Council (AHPC) have introduced some regulations, implementation remains inconsistent across public and private sectors.

METHODS

Data Collection

A desk study methodology was employed to evaluate MLT programs across Pakistan. Data were collated from official institutional websites, published curricula, training manuals, and accreditation documents of 185 institutions offering MLT degrees or diplomas.

Criteria for Evaluation

Institutions were assessed based on four core professional and educational parameters essential for quality MLT training:

a) *Teaching Laboratory Facilities*

Presence of well-equipped clinical pathology labs attached to accredited teaching hospitals.

b) *Job Training (Clinical Attachment)*

Availability of practical rotations in clinical lab settings for real-time hands-on experience.

c) *Professional Certification*

Support for national or international certification and registration of graduates.

d) *Standardized Curriculum*

Alignment of academic content with recognized international MLT curricula.

Grading System

Based on compliance with these criteria, institutions were classified as follows:

I. **Grade A:** Fulfilled all four criteria.
II. **Grade B:** Fulfilled teaching lab, job training, and standardized curriculum; certification optional.
III. **Grade C:** Fulfilled standardized curriculum and certification only; lacked clinical lab attachment and job training.
IV. **Grade D:** Lacked clinical training, teaching labs, certification, and/or curriculum standards Table 3.

Table 3. Institutional Grading Criteria

Requirement	Grade A	Grade B	Grade C	Grade D

Teaching Hospital Lab	✓	✗	✗	✗
Clinical Job Training	✓	✓	✗	✗
Professional Certification Path	✓	✓	✓	✗
Standard Curriculum	✓	✓	✓	✓

RESULTS

Out of 185 institutions, only 18 (9.72%) met all essential criteria for MLT training and were graded as A. Another 17 (9.18%) fulfilled most but lacked teaching hospital affiliations (Grade B). A majority, 84 (45.40%), failed to provide any job training or clinical affiliation (Grade C), and 66 (36.67%) were poorly structured with minimal educational standards (Grade D) Fig 1.

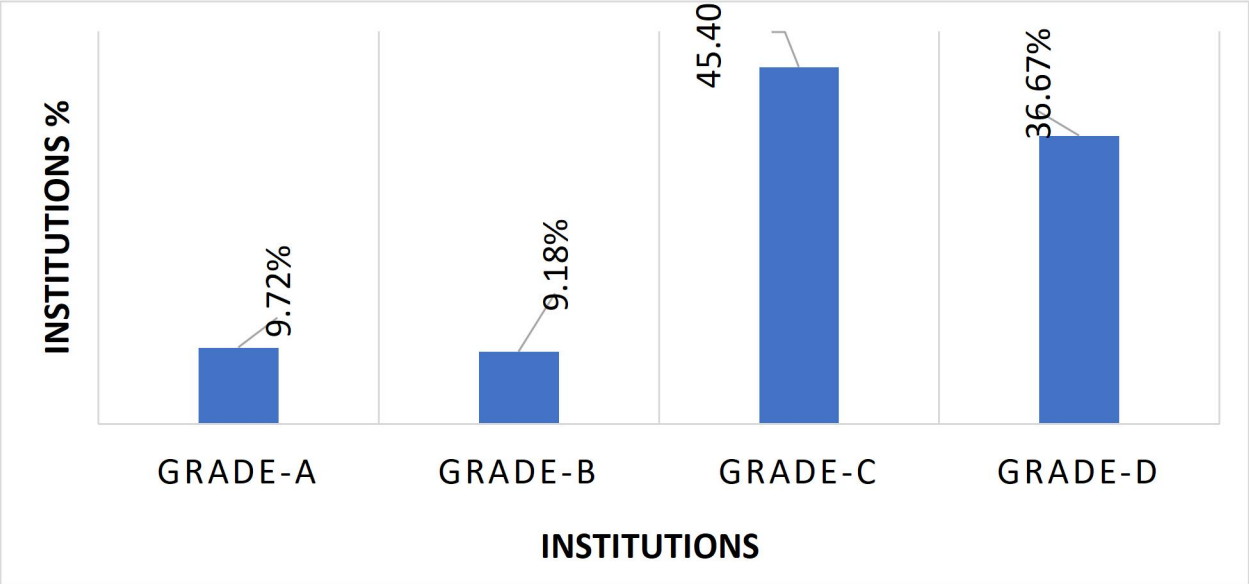

Figure 1. Percentage of MLT offering institutions according to their grades in Pakistan.

Availability of Clinical Training Facilities

Only 20 institutions (Grades A and B) had direct affiliations with teaching hospitals possessing dedicated clinical pathology labs (hematology, microbiology, clinical chemistry, molecular pathology). The majority, especially those in Grades C and D, lacked any formal clinical attachments, offering only limited laboratory demonstrations disconnected from real clinical workflows.

Curriculum Standardization

Most institutions incorporated core theoretical courses covering medical microbiology, hematology, clinical chemistry, immunology, and pathology. However, discrepancies were noted

in the depth and scope of practical components and integration of emerging diagnostic technologies such as molecular methods.

Certification Support

Professional certification was inconsistently promoted. While Grade A and B institutions encouraged students to pursue recognized certifications from approve teaching where they performed job training and professional accreditation from AHCP at national level, many lower-grade institutions lacked awareness or resources to guide students in certification processes.

DISCUSSION AND CONCLUSION

MLT training necessitates a balanced combination of didactic instruction and rigorous clinical practice. Theoretical knowledge alone is insufficient for producing competent professionals capable of functioning in complex clinical environments [23]. Teaching laboratories affiliated with hospitals provide vital exposure to specimen handling, diagnostic instrumentation, quality assurance, and patient safety protocols [24]. The predominance of Grade C and D institutions reveals systemic weaknesses: absence of hands-on clinical training, lack of teaching hospital collaborations, and insufficient faculty expertise. Many institutions rely heavily on classroom-based demonstrations with outdated or inadequate laboratory setups, depriving students of the opportunity to interact with real patient samples and laboratory staff. Graduates from under-equipped programs may lack critical competencies, resulting in diagnostic errors, delays, and compromised patient care. Inaccurate laboratory results can lead to inappropriate treatments or missed diagnoses, impacting morbidity and mortality rates. Ensuring uniform high standards in MLT education is thus essential for strengthening Pakistan's healthcare system. Countries with advanced MLT training systems mandate minimum clinical training hours, standardized curricula, and certification before licensure. Pakistan could benefit from adopting similar frameworks, enforced by national regulatory bodies with periodic institutional audits. An accreditation council can play a pivotal role in enhancing the quality assurance of Medical Laboratory Technology education and training in Pakistan by establishing and strictly implementing standardized benchmarks for curriculum design, clinical training, faculty qualifications, and institutional infrastructure. Given the significant disparities identified in this study where over 80% of MLT institutions fall below Grade A or B levels the council's regulatory mechanisms are essential for ensuring consistency, credibility, and competence in MLT graduates. By conducting periodic institutional audits, verifying clinical affiliations with

teaching hospitals, and mandating compliance with a unified national curriculum, the council can enforce essential training standards. Furthermore, the council can introduce compulsory faculty development programs, ensure the availability of well-equipped laboratories, and require institutions to demonstrate measurable student outcomes and graduate competencies. Incorporating transparent, digitalized accreditation systems with public reporting can promote accountability and drive improvements. Through these quality assurance mechanisms, the Accreditation Council can help align MLT education with international standards, ensure the production of professionally competent technologists, and ultimately strengthen the diagnostic capacity of the country's healthcare system.

CONCLUSIONS

This desk study highlights significant gaps in the quality and uniformity of Medical Laboratory Technology training across Pakistani institutions, revealing that while a small proportion offer comprehensive programs with clinical attachments, the majority lack critical components such as hands-on practical training, standardized curricula, and professional certification support. To elevate the profession and ensure patient safety, it is imperative to mandate clinical attachments within accredited teaching hospital laboratories, standardize and regularly update curricula in line with international best practices, and actively promote professional certification and continuous education. Implementing these measures will not only enhance the competence of Pakistani medical laboratory professionals but also ensure their meaningful contribution to accurate diagnostics, effective patient management, and the broader goals of public health improvement.

Declarations

Author contributions

All authors provided equal participation in collection and verification of the data, analyzed the results, and prepared the manuscript.

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Conflict of interest

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