



Exploring the Role and Importance of Medical Laboratories in Healthcare

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Abstract

1. Introduction

Clinical laboratory services are an essential part of health systems and are critical for patient care. Informed decisions at every level of the health system, from the primary care provider to the specialist, to researchers and health care policymakers, derive from the answers provided by the laboratory. Laboratory services have undergone radical transitions over the past three decades. This has produced an impressive arsenal of new and powerful diagnostic tests that are increasingly at the core of diagnostic and therapeutic decisions at all levels of the health system. In addition, the need to manage epidemics, improve surveillance, and monitor the outcomes of therapeutic and preventive interventions has further accentuated the importance of the laboratory, especially in support of primary health care.

As the field of laboratory medicine has gained complexity, sophisticated testing has drifted away from the patient's side and under more specialized professional control into what has become known as centralized clinical laboratory services. In recent years, laboratory specialists have increasingly been called on to become active partners in patient care, adding value in test ordering, specimen collection, and interpretation and translation of laboratory results into diagnostic and therapeutic actions. Efforts are now being initiated to build the capacity of the medical laboratory service delivery system and to integrate this essential service into a broader strategy of strengthening health systems capable of delivering quality health care to all.

Methods

The field of medical laboratory science (MLS), also known as clinical laboratory science or medical technology, is the diagnostic branch of medicine. It is reserved for use by qualified individuals who are highly educated and formally regulated by an appropriate professional



body. MLS professionals work as key members of the healthcare team and are responsible for generating confirmatory test results for about 70% of all objective decision-making initiated by physicians, nurses, and other members of the healthcare team. MLS has been described as being at the core of every step of modern patient care. It holds such a foundational role because of the importance of laboratory data for various inpatient and outpatient case management, including diagnostic, therapeutic, and monitoring purposes. The reliability of these testing results is crucial for quick clinical decisions by healthcare professionals. Such accuracy is ensured by scientifically backing laboratory personnel through their technical skills and dedication to optimizing various aspects of test performance in tandem with the well-defined rigors of established regulations.

Conclusion

This article has been a small celebration of the medical laboratory and its activities. We have described some of the many diverse activities of the laboratory and explained why the laboratory cannot afford to be ignored by healthcare professional colleagues, managers, and those in government, whatever country they live in. The future will see many changes in laboratories as they embrace the courageous new world of information technology and as healthcare becomes increasingly determined by patient choice. However, for patients, the basic function of providing information to doctors to help with the investigation, management, and prevention of human disease remains constant and will, for some time to come, be the most important role we play. We have not been able to describe in detail how we might provide the definitive evidence of value that will be essential for our survival in the brave new world. The precise collection of simply defined and meaningful outcome data on large numbers of patients will, however, be central to models of service evaluation, which will be briefly examined in a subsequent discussion.

2. Historical Evolution of Medical Laboratories

The dawn of laboratory medicine has often been attributed generally to 400BCE and Hippocrates and in total confusion to anywhere from the Greeks to the Babylonians and Egyptians. Confounding matters near the beginning of medical testing's written record, New Testament writings refer to the first laboratory; 'Samuel II, Chapter VI' discuss "bowls of gold" and "bowls of silver" used for Asa's testing. Additionally, the Bible's Old Testament lists numerous potential tests for leprosy and other ailments. Finally, Islamic texts from the ninth century highly recommend "the testing of water, food, and drugs." Of course, laboratory diagnosis was not the sole property of the Greeks, Jews, Arabs, or other races, people, or religions. Every culture practiced some form of it before the 'Dark Ages'. Unfortunately, the library at Alexandria got into pharmaceuticals, and the papers burned hot and long (Strain & H. Ravalico, 2021). As an aside, interestingly things have not improved



much and fires are still a pervasive problem in Africa and Asia – even at the CDC, where the sprinklers did not put out the fire until many tests had been destroyed.

Once the routine medical laboratory started operations in the late 1800s, it required packaging tests, test materials, and a ‘clean’ laboratory for each test to be drawn – much the same protocols still used today. Even so, the ‘cork,’ ‘bleeder,’ complete with ‘slip-sap’ drawers resembled a Gothic torture chamber far more than the clinical facilities of the modern imagination. One early laboratory utilizes the Mason City Chamber of Commerce and even advertises in the 1940s: “GUARANTEED TECHNICIANS Sterile equipment used at all times!” – clearly demonstrating the extremely experimental state of medical laboratories until recently.

3. Key Functions and Services Provided by Medical Laboratories

Millions of clinical specimens are collected and processed each day within thousands of laboratory facilities in health facilities around the world. Many are collected in remote communities where minimal facilities are available and transported to district hospitals or central laboratories before being analyzed, often with poor quality control mechanisms in place (Toni Maria Tadeu & Geelhoed, 2016). The results are subsequently returned using the same transport system and are used for patient management, outbreak investigations, community health surveillance and safety monitoring. Laboratory results are necessary for the monitoring and treatment of patients. Medical laboratories provide a hands-on environment where samples provided by patients are tested. This type of laboratory testing functions to support a condition or sort of assessment for medical purposes. These tests are performed by trained professionals, and results can be utilized by medical practitioners to analyze and devise treatment plans for patients according to their needs.

The services generally offered by medical laboratories include: (i) collection of pathology specimens for analysis, (ii) diagnostic testing (urinalysis, hematology, chemistry, microbiology), (iii) medical oversight, (iv) courier services, and (v) assisting in forensic and post-mortem testing (Strain & H. Ravalico, 2021). With the development and innovations of various competitive private health providers, the expansion of health services has gradually progressed. Along with this, medical laboratories have also been established for the conduct of various diagnostic examinations. When a patient suffers from an unknown ailment, he or she seeks medical help at the hospital or private clinic and the referring doctor advises him or her to take various pathology exams. After consulting with a physician, when a patient plans to take some tests, he or she needs to have a medical laboratory where the tests are performed.



4. Technological Advancements in Medical Laboratory Science

Medical laboratory science plays a critical role in healthcare. Without laboratory results advance, reactions to medications are unknown; there wouldn't be the ability to monitor diabetic patients. Medical laboratory results are included in 70% of a patient's medical record. Medical laboratories play a key role in diagnosis. It's estimated that 70-80% of medical decision-making is based on laboratory tests, with the remaining being based on symptoms, knowledge and technology. For example, a urine culture can take up to five days. A throat culture can take even longer. Knowing which bacteria is causing a patient's infection is life saving; however, which antibiotics will kill it and which won't is not instinctual. It's one of those things where each batch of bacteria changes. That's why modern medicine is so lucky to have medical laboratories. These invaluable answers can be provided in under 24 hours, nowadays.

The technological advancements in medical laboratory science have produced a whole new field. These laboratories contain machines that can perform 120 laboratory tests an hour. Some can even perform blood typing, cross-matching and cell washing. Also new to medical laboratory science is the introduction of a machine into clinical chemistry, immunoassay and other areas that can perform hundreds of tests with only a few drops of blood (Meike, 2016). Some of the medical laboratories could fit on a desk. A sample of blood is placed in an easily duplicable cartridge and inserted into the machine. In under an hour, the machine can answer yes or no to 31 different analytes, maintains strict quality control on all reagents and even answers only if there is enough plasma for the unit to be statistically probable. Because of these quick and reliable medical laboratories, the care and outcome for the patient can be greatly improved.

5. Quality Assurance and Regulations in Medical Laboratories

All laboratory staff appreciate the importance of clear regulation of their activities. Lawyers and laboratory staff welcome clear and consistent direction on issues such as the proper procedures required to perform analytical work, arrange for accurate recording of the work done and how to operate system validation protocols. From a regulator's perspective, setting clearly defined standards against which to measure the conduct of a public service laboratory is paramount. At times there is a tension between detailed prescriptive guidance and the laboratory's opportunity for flexibility to accommodate advances in technology. The documentation must be adequate to ensure the quality and integrity of the data generated during the laboratory studies. Moreover, Standard Operating Procedures (SOPs) should be prepared and followed, to contribute to the consistency and reliability of the data. Study protocol or standard operation procedure for the sampling and sample preparation should be prepared. Then, it should be performed a thorough documentation of reagent preparation including preparation from primary standards. In cases of equipment cleaning, validating the



detection limit, a standard operational file containing the procedure description and the raw data should be available. Preparative operations should be thought as laboratories and procedures should involve the rationale for choosing experimental parameters. At least two sets of data files should exist, one for generation, validation process and submission and the other one for storage. Calibration data should be kept with the samples. When acquiring data via automatic systems, data transmission should be made according to procedure and any deviation from procedure must be justified and signed (Zima, 2017). (Karunarathna et al.2024)(Twyford et al.2024)(Pecson et al.2021)

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