

Professional Autonomy in the Running of Medical Diagnostic Laboratories in Nigeria

Erhabor O*¹, Okara GC², Adias TC³, Erhabor T⁴, Erhabor U.⁵

1. Blood Transfusion Faculty, West African Postgraduate College of Medical Laboratory Science, 2. West African Postgraduate College of Medical Laboratory Science, 3. Federal University Otuoke Bayelsa State, Nigeria, 4. Medical Laboratory Science Council of Nigeria 5. Applied Public Health Department, School of Community Health and Midwifery, University of Central Lancashire, United Kingdom.

ABSTRACT

Background: Autonomy in practice is one of the essential elements in defining professionalism in medical and other fields of practice. In the Nigerian health-care sector, several inter-professional conflicts had existed, in some cases requiring administrative and legal interpretation of scope of professional responsibilities and regulatory control.

Objective: The review highlights the importance derivable from the implementation of professional autonomy in the running of medical laboratories in Nigeria.

Method: We used direct database search and Medical Subject Headings (MeSH), to search the following terms and their variants: Medical Laboratory Service Delivery, Professional Autonomy, Medical Laboratory Science, Service delivery, and Clinical Pathology. Authors independently extracted data including first author's name, study design and date of publication. **Results:** Professional defined roles of Medical Laboratory Scientists/Biomedical Scientists/Clinical Scientists are different from the roles of Clinical Pathologists in all settings reviewed. Framework for professional regulation ensures that direction and supervision are offered intra-professionally. **Conclusion:** Autonomy, division of labour, team-work, working within one's scope of practice and competence (professionalism) is key to safe practice in healthcare delivery system globally and will facilitate the rendering of best and holistic medical care to well-meaning Nigerians.

Keyword: Professional Autonomy, Medical Laboratories, Nigeria.

*Corresponding author: n_osaro@yahoo.com; +234-813-962-5990

ORCID: Erhabor Osaro @ <https://orcid.org/0000-0003-0738-6762>

Adias Teddy Charles @ <https://orcid.org/0000-0001-7057-5035>

Author's contributions: This study was carried out and approved in collaboration between all the authors who take responsibility for its accuracy and integrity. EO designed the study; ET sourced for funding; OGC wrote the protocol; ATC contributed in literature search; EU contributed in discussions; EO drafted the manuscript; OGC supervised the study; EO wrote the final manuscript; ATC proofread the final version for publication.

Received: 09/13, 2020; **Accepted:** 09/22, 2020; **Published:** 09/25, 2020.

Citation: Erhabor O, Okara GC, Adias TC, Erhabor T, Erhabor U. Professional Autonomy in The Running of Medical Diagnostic Laboratories in Nigeria. *J Med Lab Sci*, 2020; 30 (3): 107-135

Nota Bene: Some part of this review article was previously published in Open Journal of Internal Medicine (OJIM), which is listed in Beall's list of potential predatory journals and publishers, but was spuriously retracted without due process (Retraction ID:1320347).

A Publication of the Association of Medical Laboratory Scientists of Nigeria, under a Creative Commons Attribution Non-Commercial 4.0 International Public License (CC BY-NC 4.0).

INTRODUCTION

Professional autonomy can be defined as the specialized and independent authority to make decisions bordering on one's profession without hindrance from other professional groups. It is working within one's scope of practice, competence and license. An unbiased implementation of professional autonomy is key to harmony and the development of professions in the healthcare sector (1). It is the quality or state of self-determining, self-directing and having authority to make decisions, enabling professionals to exercise judgment in accordance with their professional knowledge base, scope of practice, competence and regulatory framework. It is a duty of care working within the legal, ethical and regulatory frameworks that govern a profession (2). Medical Laboratory Scientists work in the medical laboratory to ensure the provision of accurate, reliable and timely laboratory test results that enable physicians render a quality, evidenced-based and safe care to patients. Scope of practice from a healthcare perspective has to do with area/s within which a professional can practice safely and legally within their scope of professional practice, qualification and competence. A clear understanding of the roles and scope of one's professional practice is vital for quality patient care and harmonious working relationships among the healthcare team whose major focus should be patient-centred. It is also important in curriculum development and in the evaluation of performance of any professional group (3).

Medical laboratory service delivery is 24 hours a day, 7 days a week and 365 days a year business that enhances the delivery of an accurate and timely laboratory results upon which diagnosis and evidenced-based management of patients are

grounded. Professional autonomy is also vital in the rendering of out-of- hours/call duty service in healthcare care delivery ensuring that healthcare professionals work within their scope of practice and competence while on call. However, to ensure autonomous and unsupervised practice on call, the Medical Laboratory Science Council of Nigeria (MLSCN) requires that Medical Laboratory Scientists whose names are listed on the call-duty roster to work unsupervised on call must meet the following minimum requirement; qualified, have a current practicing license, trained on the bench based on laboratory protocols/SOPs, tested for competency, undergone risk assessment and certified proficient by the laboratory manager. This is to ensure that the staff is competent and understands the need for safe working procedures and emergency action plans to allow for a safe and effective practice to protect the interest of the vulnerable public (4-5). Professionals should be encouraged to work within their scope of practice. Scope of practice is the area or areas of one's profession in which they have the knowledge, skills and experience to practise legally, legitimately, safely and effectively in a way that meets the regulatory standards of the profession and does not pose any danger to the public, other healthcare professionals and to the professional (6).

The aim of this review is to discuss pathology as a bridge between science and medicine, the evidenced-based medical laboratory science practice in some developed economies, professional roles of Medical Laboratory Scientists and Clinical Pathologists, Medical Laboratory Science as a different autonomous profession from Clinical Pathology, headship of medical laboratory science directorate and constituting departments and the need for the implementation of evidence -based and

A Publication of the Association of Medical Laboratory Scientists of Nigeria, under a Creative Commons Attribution Non-Commercial 4.0 International Public License (CC BY-NC 4.0).

holistic practices in the medical laboratories in Nigeria.

Evidenced-Based Medical Laboratory Science Practice in Nigeria and other Developed Countries

In Nigeria, a Medical Laboratory Scientist undertakes a five-year course of study in the University to obtain Bachelor of Medical Laboratory Science (B.MLS) degree in Medical Laboratory Science. In the first four years the student attains overall competence in all the specialties of Medical Laboratory Science. The final year is reserved for undergraduate specialization in any of the specialties of Medical Laboratory Science. On the successful completion of the five-year degree programme, students obtain registration with the MLSCN after the completion of a one-year internship in a recognized and accredited hospital. This registration enables them to take up careers in Medical Laboratory Sciences as Medical Laboratory Scientists, in teaching, specialist and general hospitals, primary health care settings, research institutes, ministry of defence, national blood transfusion service, pharmaceutical companies and other relevant sectors. Medical Laboratory Science is one of the fastest growing and evolving healthcare professions worldwide. The Profession is regulated in Nigeria by the Medical Laboratory Science Council of Nigeria (MLSCN). The MLSCN is a Federal Government of Nigeria statutory regulatory agency established by an act of parliament (Act 11 of 2003, Cap M25 Laws of the Federation of Nigeria, 2004) as a parastatal of the Federal Ministry of Health. Like other healthcare professions with humble beginnings, the Institute of Medical Laboratory Technology of Nigeria was established by promulgated Decree Number 56 on the 19th November 1968 by the Federal

Military Government of Nigeria under General Yakubu Gowon, the then Military Head of State. MLSCN regulates the practice of Medical Laboratory Scientists. The MLSCN regulates the practice of a significant number of Medical Laboratory Scientist (7) in Nigeria. Specialties in Medical laboratory science includes medical microbiology, clinical chemistry or chemical pathology, haematology, blood transfusion science, virology, histopathology, histochemistry, immunology, cytogenetics, exfoliative cytology, parasitology, forensic science, molecular biology, laboratory management, or any other related subject as may be approved by the Council. They manage the analytical phase of laboratory diagnosis by analysing human and animal tissues, body fluids and excretions for the purpose of medical laboratory diagnosis, treatment and research. They provide accurate and timely laboratory reports that clinicians need to make informed decision in the effective management of patients. They are also involved in the production of biologicals, design and fabrication of equipment (8). Medical Laboratory Scientists are involved in over 70% of diagnoses in the Nigerian healthcare delivery sector and handle millions of patient samples every year. The profession of medical laboratory science is an organogram-based one. Seating at the apex of the Medical Laboratory Scientists organogram is the Director of Medical Laboratory Services equivalent to the Laboratory Service Manager in the UK, Medical Laboratory Director in the USA and Laboratory manager in Australia, Canada and New Zealand. The directors of medical laboratory services are highly qualified (often have a postgraduate and management qualification) with impeccable years of experience in the laboratory and a track record of quality improvement in medical laboratory services. They are in charge of the general

A Publication of the Association of Medical Laboratory Scientists of Nigeria, under a Creative Commons Attribution Non-Commercial 4.0 International Public License (CC BY-NC 4.0).

administration of the Directorate of Medical Laboratory Services” which has component departments. Medical Laboratory Scientist in Nigeria can pursue higher education to advance or further specialize in their career. A significant number now have a masters (M.Sc.), Doctor of Philosophy (Ph.D.), management qualification and fellowship of the MLSCN and the West African

Postgraduate College of Medical Laboratory Science (FWAPCMLS) particularly those at directorship levels. Many are involved in cutting-edge scientific research and have grown through the rank and file in academics becoming professors in the different specialties of Medical Laboratory Science. Figure 1 shows the organogram of Medical Laboratory Scientists in Nigeria.

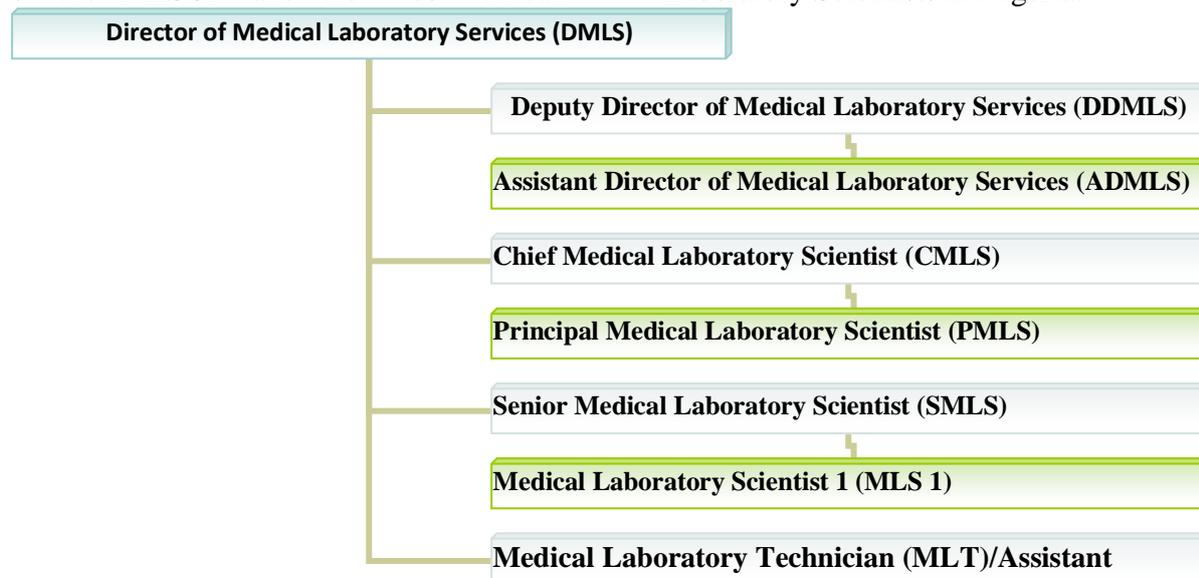


Figure 1: Organogram for Medical Laboratory Scientist in Nigeria

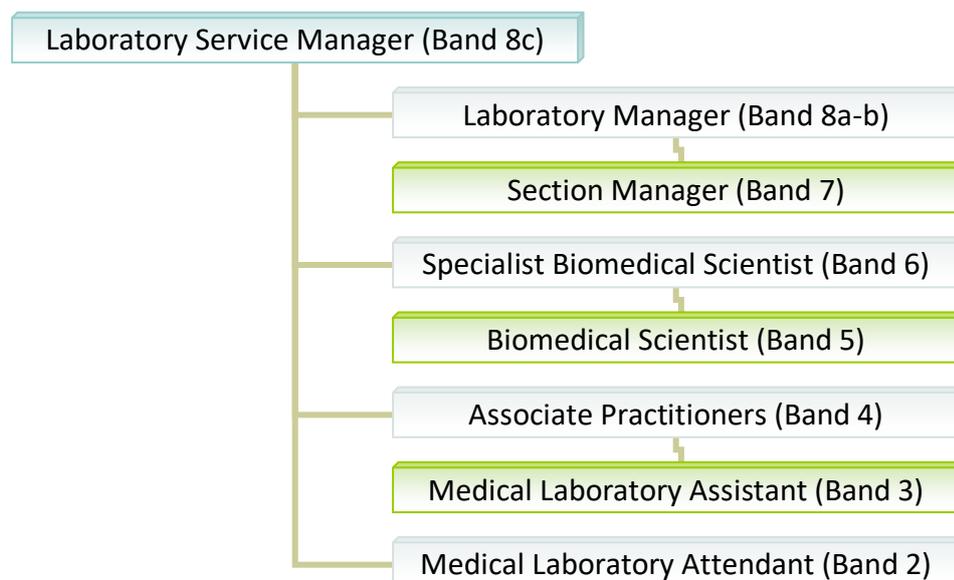


Figure 2: Organogram for Biomedical Scientists in the UK

A Publication of the Association of Medical Laboratory Scientists of Nigeria, under a Creative Commons Attribution Non-Commercial 4.0 International Public License (CC BY-NC 4.0).

United Kingdom

The Biomedical Science Profession is regulated in the United Kingdom by the Health and Care Professions Council (HCPC) while the Institute of Biomedical Science (IBMS) is the professional body (9). Founded in 1912 the IBMS represents approximately 20,000 members employed mainly in National Health Service (NHS), private laboratories, veterinary laboratories, the National Blood Transfusion Service, Health Protection Agency (HPA), Medical Research Council, Department for Environment, Food and Rural Affairs, Ministry of defence (MOD) as well as in other related commercial fields and in Universities (10). Registration with the HCPC is a legal requirement for Biomedical Scientists working in the UK. The IBMS assesses and accredits undergraduate or higher-level courses and qualifications for candidates seeking registration (11). The Institute also awards its own Certificate of Competence in Biomedical Science and works with the HCPC to approve laboratories for registration training (12). The Institute is also licensed to award the designations Registered Scientist and Technicians. The IBMS was granted licence by the Science Council by Royal Charter in 2003 to award the designation Chartered Scientist to qualifying and deserving IBMS members (13). The designation Chartered Scientist (CSci) is a mark of excellence awarded to scientists practising at their full professional level and who stay up-to-date and have made a mark in their scientific field. List of other chartered professions include biologist, accountant and surveyor. The function of the IBMS among others include: setting standards of practice in Biomedical Science to protect the interest of the vulnerable public, represent the interests of biomedical science to the UK

government, media and universities, advises UK government departments and national organisations on all matters relating to biomedical science, assesses competence for biomedical scientists to practise, assesses qualifications for registration with the regulatory HCPC, accredits university degrees in Biomedical Science, organises a continuing professional development (CPD) scheme and provides assessors for recruiting senior staff to laboratories.

The Academy for Healthcare Science (AHCS) is a United Kingdom body which brings together the Healthcare Science Professions under a common umbrella (14). It plays an important role in the statutory regulation of Healthcare Scientists following the completion of modernising scientific careers training programme (15) and works closely with the National School of Healthcare Science (16). The Academy for Healthcare Science has four main roles; provision of a unified professional voice for the healthcare science workforce, act as the all-encompassing body for issues related to education, training and development in the UK health system and beyond (maintaining professional standards and quality management of education and training), ensures that healthcare science professions have a high profile that influences and informs the health and care system in the UK and provide engagement and support for wider strategic scientific initiatives. Career pathway for Biomedical Scientist in the UK is straight forward. Upon qualification with a degree in biomedical science and completion of registration portfolio, a candidate becomes potentially appointable as a biomedical scientist (band 5). To progress to the post of a specialist biomedical scientist (band 6) in the NHS, one will usually need to

A Publication of the Association of Medical Laboratory Scientists of Nigeria, under a Creative Commons Attribution Non-Commercial 4.0 International Public License (CC BY-NC 4.0).

complete the IBMS Specialist Diploma. Progression from specialist to section manager (band 7) usually requires an MSc or the IBMS Higher Specialist Diploma. With further years of experience and qualifications, it is possible to reach the top of the profession by becoming a consultant biomedical scientist, laboratory manager (Band 8a) and laboratory service manager (Band 8b and c) (17). The medical laboratories in the UK are managed by Laboratory Service Managers or Laboratory managers who are often biomedical scientists with several years of relevant experience working through the ranks and file in the laboratory (Band 8b and c) including having a management qualification. These managers are often responsible for the safe and efficient day-to-day operational management of the laboratory including management of laboratory inventory control, waste management, housekeeping, instrument management, software and IT management, management of internal quality control and external quality assessment including accreditation, documentation and information governance as well as leading a team of laboratory staff (biomedical scientists, technicians, assistants and administrative staff in the laboratory) to ensure the delivery of excellent and timely medical laboratory service that enhances patient care (18-20). The role of the Biomedical Scientist in the UK has evolved significantly over the years. Biomedical Scientist can now cross train and go on the Clinical Scientist Register regulated by the Health and Care Professions Council (HCPC). Clinical scientists are statutory regulated healthcare professionals. The HCPC has standards of proficiency for clinical scientists (21). There are 3 potential routes or pathways through which a Biomedical Scientist can train to become a clinical scientist; training via the 3-year NHS Scientist Training Programme

(STP) and registration with the HCPC (22), via the IBMS certificate of attainment (23) or through the Certificate of Equivalence route from the Academy of Healthcare Science (AHCS). The STP program is a three years curriculum and includes a mixture of academic study and practical work experience. On completion of the STP programme, the candidate is awarded a Certificate of Completion of the Scientist Training Programme by the National School of Healthcare Science. The STP program is a postgraduate degree (Masters-level) program with associated clinical placement. The Clinical Scientist can train further by completing a five-year Higher Specialist Scientist Training programme. The HSST programme and curriculum is a doctorate level training program and include dealing with in-depth and highly complex clinical role similar to medical or clinical consultants requiring sound clinical judgement, scientific expertise, leadership and dealing with uncertainty in the direct management of patient (24). On completion of the Specialist Scientist Training (HSST) programme and passing the requisite fellowship examination of the Royal College of Pathology UK, the Clinical scientists become appointable as a consultant in laboratory departments in the NHS, private or voluntary sectors. The role of the clinical scientist includes dealing with complex scientific and clinical roles. It is often associated with high risk, low volume tasks which requires the application of sound clinical judgement about complex clinical situations (25). They perform specialist investigations for enabling the diagnosis and management of disease processes. They are often involved in cutting edge science, ground-breaking research and technological innovation, providing expert care and high-quality service to patients, leading to improvements in quality of life (26). They are fundamental to deciding the definitive

A Publication of the Association of Medical Laboratory Scientists of Nigeria, under a Creative Commons Attribution Non-Commercial 4.0 International Public License (CC BY-NC 4.0).

diagnosis of a wide range of diseases and use technological advances in order to drive improvements in longer term monitoring of disease. They often advise medical doctors on tests and interpret medical laboratory data and results using their understanding of disease processes supported by broader knowledge and experience within their specialist area of healthcare science (27). Consultant clinical scientists are providing expert scientific and clinical leadership alongside and, at the same level as their medical consultant colleagues (28). Consultant clinical scientists in the UK are helping to shape the future guidelines and the implementation of new and emerging technologies to help advance patient care (29). Figure 2 shows the organogram of Biomedical Scientists in the United Kingdom.

United States of America

In the United States, a Medical Laboratory Scientist (MLS), Medical Technologist (MT), or Clinical Laboratory Scientist (CLS) typically earns a Bachelor's degree in Medical Laboratory Science, Clinical Laboratory Science, or Medical Technology. There are three major certification agencies in the United States of America for clinical laboratory scientists [American Association of Bioanalysts (AAB), American Medical Technologists (AMT) and the American Society for Clinical Pathology (ASCP)] (30). All three national accrediting agencies will certify scientists in the clinical laboratory as generalist (clinical chemistry, haematology, immunology, immunohaematology/blood bank, and medical microbiology). Today, the Medical or Clinical Laboratory Scientists who perform the majority of the testing in medical laboratories in the United States of America possess the equivalent of an associate degree or a baccalaureate degree

(31). Those within supervisory roles (section heads, shift supervisors and managers) usually have some type of post-baccalaureate education or certification, whether it be specialist certification, a graduate certificate, or a master's degree in laboratory, science, business, or related fields. Laboratory directors possess a PhD degree with specialized board certifications in laboratory disciplines (30). All laboratories that provide testing for the purposes of diagnosis and treatment of disease in humans in the US must possess a certificate under the Clinical Laboratory Improvement Amendments of 1988 (CLIA), appropriate to the level of complexity of the testing performed (32). As in other countries, staffing shortages have become a major issue in many clinical laboratories in the United States (boomer retirement, inadequate recruitment and retention). For the decade 2010-2020, workforce needs are expected to grow by 13%. This translates into about 11,300 positions per year that will need to be filled, with only about 5000 new graduates per year coming out of various programs (32-34). Medical Laboratory Scientists in the US can pursue higher education to advance or further specialize in their career; Doctor of Medical Laboratory Science for specialization, education and management roles, Doctor of Philosophy for management and directorship roles in the clinical laboratory as well as for academic research and professorship. In 2005, a task force was commissioned by the American Society for Clinical Laboratory Science (ASCLS, formerly ASMT) to explore the practice levels and educational needs for laboratory professionals (35). Medical Laboratory Scientist with Doctor of Philosophy (Ph.D.) degree in a biological science or Doctor of Clinical Laboratory Science and who are board certified by a CLIA-approved entity are qualified to be appointed as a medical laboratory director

A Publication of the Association of Medical Laboratory Scientists of Nigeria, under a Creative Commons Attribution Non-Commercial 4.0 International Public License (CC BY-NC 4.0).

which qualifies them to oversee or direct almost all types of clinical laboratories (36).

Australia

The Australian Institute of Medical Scientists (AIMS) provides assessment of laboratory employees' professional skills and qualifications (37). They assess the suitability of a staff to work as a Medical Laboratory Scientist. In Australia, most Medical Laboratory Scientists are employed in public hospitals or private diagnostic laboratories (38). They conduct medical laboratory tests and apply knowledge and methodology from various scientific disciplines providing evidenced-based information to assist doctors in the diagnosis, treatment and prevention of human disease. Duties includes; determining the nature, cause and progress of disease through the testing of blood, body fluids and tissues in medical and pathology laboratories. Medical Laboratory Technicians help with laboratory tests on blood, body fluids and tissues in medical and pathology laboratories under the direction of Medical Laboratory Scientists and operate diagnostic and monitoring of laboratory equipment. In Australia, medical laboratory scientists complete a four-year undergraduate degree program in medical laboratory science or Master of Medical Laboratory Science. These programs are accredited by the Australian Institute of Medical Scientists (AIMS) (39). The roles and responsibilities of Laboratory managers who are medical laboratory scientists are huge and often includes; planning, organising, directing and coordinating a range of activities in the medical laboratory. They perform administrative duties, supervise and assist other staff members, oversee tests and experiments and present the results to clients ensuring a timely delivery of

accurate laboratory results. They also often manage and coordinate the financial, human and material resources of the laboratory, provide scientific advice to clients, and preparing statistical and performance data for reports (40-41).

Canada

The Canadian Society for Medical Laboratory Science (CSMLS) is the national certifying body for medical laboratory technologists and medical laboratory assistants. In Canada, three-year college or technical school programs are offered that include seven semesters, two of them comprising an unpaid internship. The student graduates before taking a standard examination (Canadian Society for Medical Laboratory Science, or CSMLS, exam) to be qualified as a medical laboratory technologist (MLT) (42). Many MLTs go on to receive a Bachelor of science degree after they are certified. Canada is currently experiencing an increasing problem with staffing shortages in medical laboratories. In Canada Medical Laboratory Technologists conduct a variety of medical laboratory tests to facilitate the diagnosis, treatment and prevention of disease. Medical Laboratory Technologists performs a range of duties: conduct analyses of blood, urine and other body fluids, prepare and microscopically examine tissue section, conduct blood group, type and compatibility tests for transfusion purposes, set up, operate and maintain laboratory equipment and conduct quality control assessment (IQC and EQA) of testing techniques. They work in hospitals, medical laboratories and clinics, Canadian Blood Services, Research institutes, Universities and government research laboratories. The laboratory manager who is a Medical Laboratory Technologist is at the peak of the medical laboratory organogram and in charge of the day to day running of the

medical laboratory. To be appointable as a laboratory manager in Canada, you must have a Baccalaureate degree in medical laboratory technology, be a good standing member of the College of Medical Laboratory Technologists of Ontario (CMLTO), have a minimum of three years formal or informal leadership experience, and at least 5 years relevant experience in a hospital or clinical laboratory setting (43). The laboratory manager's role include but not limited to the following; managing the design, implementation, maintenance, reporting and improvement of the quality management system, managing the laboratory information management system (LIMS), laboratory safety, point of care testing teams, overseeing all risk management and patient safety -related issues including incident management, risk mitigation, leading and managing a robust internal and external quality improvement program to ensure a continuous quality improving medical laboratory service, ensuring that the medical laboratory is compliant with regulatory/accreditation requirements, providing quality management education to laboratory staff to enhance continuous professional development, evaluating service performance and make recommendations to management regarding best practice, ensuring that patient/customer needs are met, providing advice to hospital management regarding quality management and risk management issues, ensuring the mentoring and appraisal of laboratory staff by implementing emotional intelligence and exhibiting excellent communication and offering professional leadership as well as supervising the delivery of call duty/out-of-hours service (44-45).

New Zealand

In New Zealand, a Medical Laboratory Scientist must complete a bachelor's degree in Medical Laboratory

Science or Biological or Chemical Science recognized by the Medical Sciences Council of New Zealand. Once they graduate, they must have worked for at least six months under supervision, be registered with the Medical Sciences Council of New Zealand, and hold a current Annual Practicing Certificate (46). The future of Medical Laboratory Science practice in New Zealand is rapidly evolving and growing influenced by two major variables, the science and the environmental systems. The science being driven by clinical needs, financial need, systems and processes while the environment system is driven by professional regulation and social need (47). Medical Laboratory Scientists in New Zealand perform laboratory tests on blood, other body fluids and tissue samples which provide information to assist in the diagnosis, treatment and prevention of disease; test samples for the presence of disease and potential causes; test and study blood, tissue and fluid samples; evaluate test results and communicate results to requesting clinicians; test, set up, use and maintain laboratory equipment; maintain laboratory quality assurance and safety standards; supervise and train subordinate staff such as medical laboratory technicians and develop new methods and equipment for laboratory testing (48). In New Zealand, laboratory managers who are Medical Laboratory Scientists oversee the day-to-day operations of medical laboratories to ensure the delivery of accurate and timely diagnostic results, develop procedures and maintain quality standards for specific laboratory procedures, train, supervise, and mentor laboratory scientists, technicians assistants and students, oversee laboratory safety policies, training, and enforcement and manage inventory, stock, audit and organize supplies and chemicals (49-50).

A Publication of the Association of Medical Laboratory Scientists of Nigeria, under a Creative Commons Attribution Non-Commercial 4.0 International Public License (CC BY-NC 4.0).

Performance of Delineated roles in Medical Laboratory Science and Pathology

Pathology is the study of disease. It is the bridge between science and medicine (51). While the Medical Laboratory Scientist manages the medical science side, the Clinical Pathologist manages the clinical part of the bridge. In Nigeria, all healthcare professionals (Medical Laboratory Scientists and Clinical Pathologists inclusive) should operate within their scope of well-defined legal frameworks as enacted by the National Assembly (Parliament) of Nigeria. Nigeria like many other democracies worldwide is not a draconian state of a banana Republic. Cases of conflicts including those between one professional group and another in the public health sector are in most cases resolved through the constitutionally recognized superior courts of law (52). One of such courts is the National Industrial Court of Nigeria (NICN).

The professions of Medical Laboratory Scientists and Clinical Pathologists in Nigeria are regulated by two Acts of Parliaments (53-55). In addition to these regulatory laws, statutory Schemes of Service (55) allow for the orderly conduct and running of public sector health services as approved and published by the Office of the Head of Civil Service of the Federation of Nigeria are also in force and operational for each healthcare profession. Clear and Explicit Provisions of the Medical Laboratory Science Council of Nigeria law (Cap M25 Laws of Federation of Nigeria 2004) under section 4 (h) states as part of the functions of the Board of the Council to: “inspect, regulate and accredit medical laboratories”. Also, in section 19 subsection (1 d) further states that “The Board may make rules for the maintenance of good standard of medical laboratory practice and services with respect to regulation and control of private practice including statutory inspection, approval

and monitoring of all medical laboratories including those adjoined to clinics, private and public health institutions”. Also, the Statutory Scheme of Service for Medical Laboratory Scientists (55) under section 2.9 sub-section 2.9.1 clearly provides as the function of the Director of Medical Laboratory services: “Taking charge of General Administration of the Medical Laboratory Services Department”. It seems clear ignorance for any law-abiding individual who believes in the rule of law to pretend to ignore these codified laws in the statute books of Nigeria under a Constitutional democratic Government. A recent judgement by the NICN seating in Abuja (Case no: NICN/ABJ/284/2014) on 27th January, 2016 affirmed this position (“It is clear that the scope of the areas of coverage of the Medical Laboratory Science Council of Nigeria Act, 2003 is wider than that of the Medical and Dental Practitioners Act, 1988” (56).

In the UK and most developed countries there are groups of professions with distinct roles within pathology; Medical Laboratory or Biomedical Scientists, Clinical Pathologists (medical doctors with specialist laboratory training) and Clinical Scientists (Scientist with specialist clinical training) (57). The roles and responsibilities of these professionals are clear, unambiguous and clearly spelt out. Biomedical Scientist continues to manage medical laboratories providing, accurate, precise, reproducible and timely laboratory results to enable clinicians offer evidence-based care to patients while the Clinical Pathologists manage the clinical part of the service using results generated by medical laboratory scientists to offer clinical advice to their clinical colleagues as well as manage patients with disease conditions within their area of specialty. Medical Laboratory Scientist is the protected title by the law of the Federal Republic of Nigeria (53) to be used by professionals qualified to work unsupervised within the

A Publication of the Association of Medical Laboratory Scientists of Nigeria, under a Creative Commons Attribution Non-Commercial 4.0 International Public License (CC BY-NC 4.0).

medical laboratories to perform regulated duties as medical laboratory scientists in the following medical laboratory science disciplines; clinical biochemistry, haematology, microbiology, immunology, virology, histology, cytology and blood transfusion services (55, 56, 58). Medical Laboratory Science is practised in healthcare delivery to provide objective data for diagnosis, research and monitoring the effectiveness of treatment, surveillance and control of diseases. Clinical Pathologists on the other hand are specialist medical practitioners who often diagnose and treat diseases in the post-analytical phase based on accurate and timely laboratory results produced by Medical Laboratory Scientists, render clinical interpretation or consultation based on the results of laboratory tests to their clinical colleagues in the area of speciality, offer advice on further investigations required on a patient, manages patients with diseases in their area of speciality, monitor patient response to treatment and may be involved directly in the performance of certain specialist procedures in their field of speciality required in the delivery of care (59).

Professional roles of Medical Laboratory Scientists

In the developed world, medical laboratories are managed by the medical laboratory service managers, medical laboratory managers or medical laboratory directors who are qualified Medical Laboratory Scientists or Biomedical Scientists (in the UK) with the requisite degree in Medical Laboratory Science or Biomedical Science, licensed by the regulatory body, often have a management qualification and significant years of experience working in the medical laboratory post qualification. In the Nigerian setting the Director, Deputy or the Assistant Director as of Medical Laboratory Services is the laboratory

manager. They are professionally regulated by the Medical Laboratory Science Council of Nigeria (53). The responsibilities of Medical Laboratory Scientists amongst others include: provision of medical laboratory diagnostic information and services, specimen preparation procedures; development and implementation of analytical procedures including writing user manuals; evaluation of LIMS; reporting of medical laboratory results according to protocols; certification of instrument performance, management and troubleshooting procedures, proactive maintenance and replacement; establishment of a robust internal quality control programme and participation in external quality assurance programme including accreditation, setting up of quality standards; ensuring staff training and compliance; responsible for inventory control management of laboratory reagents and consumables including forecasting and budgeting; coordinates the carrying out of pre-acceptance testing of laboratory supplies; manages medical laboratory revolving funds; maintain medical laboratory productivity by monitoring and scheduling workload and making operational or staffing adjustment; maintain the generation of quality and timely laboratory results; performing laboratory staff proficiency testing or competence before allowing Medical Laboratory Scientist to work unsupervised on the bench and on call duty out-of-hours; manages document control; recommend improvements to hospital management; establishes priorities; coordinate a robust internal quality control program and external quality assessment including accreditation; instils a problem solving culture of root cause analysis as problem solving tool; maintain the security and confidentiality of patient data, implements new programs, tests, methods, instrumentation and procedures by investigating alternatives; maintaining

A Publication of the Association of Medical Laboratory Scientists of Nigeria, under a Creative Commons Attribution Non-Commercial 4.0 International Public License (CC BY-NC 4.0).

medical laboratory staffing by recruiting, selecting, orienting and training of junior employees; maintains medical laboratory staff performance (appraisals) by counseling, mentoring and disciplining employees; ensures that laboratory staff maintain their practicing license, professional and technical knowledge by engaging in continuous professional development (CPD) and ongoing monitoring of competence; review professional publications; participate in professional societies; help in the orientation of new staff, trainee physicians, nurses, students and visitors to the medical laboratory; provide strategic direction concerning medical laboratory service delivery; coordinating scientific research endeavors in the laboratory; and provides administrative support and supervision for the hospital by acting as manager of Medical Laboratory Scientists on call duty to ensure delivery of excellent and timely medical laboratory service delivery aimed at optimising patient care (36, 41, 43, 45, 49, 55, 60). Medical Laboratory Scientists in Nigeria are key to delivery of an excellent laboratory service delivery to patients. They often manage the analytical phase and generate precise, accurate and timely medical laboratory results and reports on biological samples and body fluids by implementing a robust internal quality control measure and participation in external quality assurance program.

Need for the Implementation of Evidence-Based Practices in the Medical Laboratories in Nigeria

Laboratory Service Managers are Medical Laboratory Scientists or Biomedical Scientists who manage the human (Medical Laboratory or Biomedical Scientist, Medical Laboratory Technicians and Medical Laboratory Assistants) and material (equipment, reagents and consumables) endowment in the medical

laboratory enabling the delivery of accurate, precise and timely laboratory result needed for the evidenced- based management of patients.

Working in the medical laboratory is like working in a manufacturing plant where raw materials are transformed into finished products. In the case of the medical laboratory, Medical Laboratory Scientists converts raw materials (patients' samples, equipment, reagents and consumables) to finished products (accurate, precise and timely laboratory results). These diagnostic results become raw material that clinicians need to offer an evidence-based quality care to patients.

Clinical Pathologists on the other hand are clinicians who contribute significantly to the provision of high quality efficient and effective health care. They are medical practitioners with 4 years specialist training in one of the specialities in Pathology. They are responsible for the clinical management of patients with diseases in their area of specialty as well as using their specialist knowledge in the interpretation of complex laboratory test results and advising on further laboratory investigations appropriate to the diagnosis and monitoring of patients. For example, The Royal College of Pathologists (UK) anticipates that training of five years' duration is required to satisfactorily complete the chemical pathology curriculum. However, to ensure flexibility, the College advises that the minimum duration of training is four years (61). Residency training culminating to a resident doctor becoming a clinical consultant in any of the pathology disciplines in Nigeria takes about 4 years (62). In developed countries, Clinical Pathologists often do not interfere in the work and statutory roles of the medical laboratory scientist. They often concentrate on their professional responsibilities effectively managing their patients. The Clinical Pathologist in

A Publication of the Association of Medical Laboratory Scientists of Nigeria, under a Creative Commons Attribution Non-Commercial 4.0 International Public License (CC BY-NC 4.0).

haematology for example run their weekly or bi-weekly haematology clinics; deliver care to patients with haematological disease conditions in their field of specialty; manage their day case patients; carrying out specialist procedures such as collection of bone marrow, examination of blood and marrow films; provide clinical support by interpreting complex laboratory results generated by Medical or Biomedical Scientists; managing their clinical haematology budget, carrying out clinical research; assisting other clinicians in the diagnosis and treatment of disease whilst supporting other hospital departments including accident and emergency, intensive care, operating theatres, special care baby units and haematology oncology as well as offering specialist advice to other clinicians on patients admitted with conditions in their area of specialization (63).

Out-of-hours/Call Duty Roster and Duties in the Medical Laboratory in Nigeria

Medical Laboratory Service delivery worldwide has become 24 hours a day, 7 days a week and 365 days a year business aimed at offering round-the-clock quality and timely laboratory result required for the evidenced-based clinical management of patients (64). Medical laboratory and other clinical services often have a shift pattern covering both the traditional hours and out-of-hour periods in a bid to ensure round-the-clock working. In some areas they have an on-call service during out-of-hour periods. These shift/on call practices are traditional to haematology and blood transfusion, clinical biochemistry and medical microbiology. Although this continuous access to laboratory service delivery improves the laboratory turnaround times and is vital to patient care, it does have a significant impact on quality, training and incentives. Factors such as training, competence, impact on

work-life balance, fatigue and associated increased risk of human error, optimal staffing including supervisory and adequate remuneration must be taken into consideration (65). Similarly, the Institute of Medicine's report, entitled "Resident duty hours: Enhancing sleep, supervision and safety", published in January 2009 made a number of recommendations including new limits on resident physician work hours and workload, increased supervision, a keen focus on resident physician safety and training in a bid to protecting the vulnerable public and the resident physicians themselves from preventable harm (66-67). In developed countries and in Nigeria, Medical Laboratory Scientist and Clinical Pathologist have always had their individual and different call duty roster as autonomous professions to carry out their very distinct and non-conflicting roles on call. However, there has been a recent clamor in certain quarters in Nigeria to have residents who are undergoing training to become Consultant Clinical Pathologists on the same Medical Laboratory Scientists' call duty roster to carry out unsupervised the delineated and regulated function of Medical Laboratory Scientists (to carry out routine testing on patient samples in medical laboratories) (68). This clamor to have trainees who have not been trained based on laboratory testing protocols, trained to use sensitive and expensive laboratory analyzers, have not been competency tested, who are not licensed as Medical Laboratory Scientists and who have not been certified competent by the laboratory service manager (Director, Deputy Director or Assistant Director of Medical Laboratory Services) to perform Medical Laboratory services unsupervised does not seem ethical and can potentially put the lives of patients at risk (69). It is against the principle of division of labour in the delivery of multidisciplinary healthcare delivery.

A Publication of the Association of Medical Laboratory Scientists of Nigeria, under a Creative Commons Attribution Non-Commercial 4.0 International Public License (CC BY-NC 4.0).

Also, it is not within the scope of practice and competence for these trainees to work unsupervised to take calls in the Medical Laboratories to test patients' samples with the hope of generating medical laboratory results upon which the evidence-based management of patients will be premised (other than for supervised training and research purposes). Evidenced-based best practices in developed economies requires that these residents are on their clinical call duty roster under the supervision of their Clinical Consultants to manage patients with conditions in their consultant's specialty. Similarly, it is outside the scope of practice for Medical Laboratory Scientists to be on the same call duty roster with Clinical Pathologists to, for example perform invasive procedures like bone marrow aspiration that is outside their scope of competence. There is nowhere in the developed world where resident doctors or trainees in Pathology are on the same call duty roster as Medical Laboratory/Biomedical Scientists. The duties of these residents in Pathology while on call under the supervision of their consultants are predominantly clinical to offer clinical advice in their area of specialty to their clinical colleagues. Clinical Pathologists in developed countries play very important roles in patient care including being on call to train and supervise their residents, manage their patients on admission as well as offer their specialty-related clinical advice to their colleagues (70-71). Working in the medical laboratory particularly out-of-hours on call is not an easy task (65). The MLSCN expects Medical Laboratory Scientists to be on call duty rosters to ensure the safe and effective delivery of accurate, precise, reproducible and timely medical laboratory service for the effective evidence-based management of patients. Medical Laboratory Scientists are trained based on standard operating procedures and operational protocols on the

appropriate use of laboratory automation, laboratory information management system and troubleshooting. There is also the requirement for appropriate supervision of the medical laboratory scientist on call by the laboratory manager to offer advice and direction on complex cases and when challenges arise (72-75). There is huge emphasis globally on the optimum training of the health workforce. There is need for the implementation of these evidence-based best practices so that trainees are effectively trained by their consultants or supervisors. It is vital that consultants as supervisors create ample time for the effective training of their residents and other junior doctors (76-77). There is also the potential that this will facilitate the training skills of the consultants. Clinical Pathologists have a professional obligation and duty of care to contribute to the education, training and supervision of trainees and less experienced colleagues (78). The evidence-based best practice way forward to prevent this unethical practice of residents in pathology taking call in the medical laboratories unsupervised is for the Consultant Pathologists as supervisors of these residents to include their residents in their clinical call duty rosters and liaise with the laboratory manager (director, deputy director or assistant director as the case may be) to organize sessions during laboratory hours to enable Medical Laboratory Scientists to also invest in their training enabling them to develop the relevant practical-related medical laboratory skills and knowledge they require (79). Medical Laboratory Scientist in Nigeria in the spirit of team-work and harmonious working relationship with members of other professional groups are keen to maintain their role in enhancing the practical component of the training of residents in pathology in Nigeria. Medical education globally is increasingly being supervised by individuals who are not

necessarily medical doctors. Such people might supervise the learning of trainees from a number of different professional groups (80-81).

Headship of Medical Laboratory Department

From the perspective of Nigeria, the medical laboratory team include; Medical Laboratory scientists, Medical Laboratory Technicians and Medical Laboratory Assistants. It should be noted that this group of professionals are the true components of the laboratory workforce as captured by the WHO in its global health observatory data (82). The practice of this team is regulated by the MLSCN while the clinical laboratory team (clinical pathologists, residents and house officers) are regulated by the Medical and Dental Council of Nigeria (MDCN). Members of the team regulated by the MLSCN constitute up to 90% of professionals in the laboratory. Medical Laboratory Scientists or Biomedical Scientists are key players in the healthcare team. They work in healthcare delivery to aid the diagnosis of disease and evaluate the effectiveness of treatment through the analysis of body fluids and tissue samples from patients. They constitute the “engine room” of modern medicine providing evidence (accurate, precise and reproducible test results) that help clinicians make informed decisions that facilitate the diagnosis and optimum treatment and management of patients. The Director of Medical Laboratory Services is at the head of the medical laboratory organogram as laboratory manager, laboratory service manager or laboratory director (55, 56, 58) who supervises this mix of professional groups. They often interact and work together as a team to provide an excellent medical laboratory service delivery. The team produces accurate and timely laboratory results and reports that clinicians need to make informed decision

in the management of patients. Headship of medical laboratory departments to offer an excellent medical laboratory service delivery providing precise, accurate and reproducible laboratory result should be by the most qualified laboratory manager as the head of the technical team. Teams in most industries are becoming significantly professionally diverse and multidisciplinary. However, for this to foster collective capabilities, high performance and productivity, it is vital that leadership/headship of the team is inclusive and not a life-long monopoly of one of the composite professions (83).

Implementation of this evidence-based best practice creates a sense of value, equity, fairness, confidence and inspiration to the team (84). Until equity, fair play, fairness, rule of law and zero tolerance for bias is implemented in the medical laboratories and the healthcare system in Nigeria, peace and significant development are likely to be eluded. Equity in headship of medical laboratory departments in hospitals must be based on fairness and equity. It must reflect the composite members of the team. It should be based on the principle of he who the cap fits let him wear rather than being the birth right or a lifelong monopoly of only a composite member of the team. Directors, Deputy and Assistant directors of medical laboratory service are significantly qualified with many having postgraduate qualifications (MSc or Ph.D), fellowship training and certification including by the MLSCN and the West African Postgraduate College of Medical Laboratory Science (WAPCMLS) in the various specialties of Medical Laboratory Science as well as having a management qualification and significant impeccable years of experience having worked through the rank and file in the medical laboratory offering a continually improving quality medical laboratory

A Publication of the Association of Medical Laboratory Scientists of Nigeria, under a Creative Commons Attribution Non-Commercial 4.0 International Public License (CC BY-NC 4.0).

service. These laboratory managers manage professionally and administratively a significant number (up to 90% or more) of the medical laboratory team (medical laboratory scientist, medical laboratory technicians and attendants). It is against the principle of equity and inclusiveness for a member of a different autonomous professional group who is not necessarily more qualified, may not have a management qualification, may not have as much years of experience working in the medical laboratory and whose professional group constitutes less than 10% of the workforce in the laboratory to have the lifelong, birth right monopoly of headship of medical laboratory department. This is one of the reasons for the anarchy and chaos we see in the medical laboratory departments in Nigeria.

The Federal Government Approved Scheme of Service (55), Act No. 11 of 2003 (53) and two recent National Industrial Courts of Nigeria (NICN) judgments (56, 58) (*“Declaration that by the virtue of the scheme of service approved by the Federal Government of Nigeria for the cadre of the Medical Laboratory Scientist, responsibility for the supervision, management and control of Medical Laboratory Departments is placed on the Director of Medical Laboratory Services”*) on the issue of headship of Medical Laboratory Department in Nigeria is clear and unequivocal. It is now left to the Health Minister, the Federal Ministry of Health, Office of the Head of Service of the Federation, the Attorney General of The Federation, Chief Medical Directors of teaching hospitals, Medical Directors of Federal Medical Centres, other members of the healthcare delivery team, lovers of equity, fairness, democracy and rule of law in Nigeria to advocate for the full implementation of best practices as enshrined in the codified statutes books

A Publication of the Association of Medical Laboratory Scientists of Nigeria, under a Creative Commons Attribution Non-Commercial 4.0 International Public License (CC BY-NC 4.0).

and the Federal Government approved scheme of service in a bid to ending this anathema that has significantly affected the morale and by extension the quality of medical laboratory service delivery in Nigeria.

The Profession of Medical Laboratory Science is different from Clinical Pathology

Healthcare delivery globally has become significantly multi-disciplinary and specialized. Harmonious working relationship among professions in the health team requires that there is mutual respect among the different professional groups; that the composite members of the team -work within their autonomous clearly defined professional boundaries and within their scope of practice, competence and legal framework. This is fundamental to improving the health indices and ensuring the delivery of holistic and best possible care to patients. In developed countries, healthcare professionals collaborate well. Members of the multi-professional health team work together to deliver the best possible healthcare services to patients. The team spirit is usually very high as each members of the team has a sense of belonging and feel equally valued (85). Headship of department is often reflective of the professionals that make up the department, their qualification and experience. Healthcare professionals in developing countries can learn from these evidence-based best practices. These implementations are critical to the smooth running of hospitals including the medical laboratory and can potentially prevent the inter-professional conflict and unhealthy rivalry that is menacing to tear the health sector in Nigeria apart at the detriment of the patients. Medical Laboratories should be headed by a qualified Medical Laboratory Scientist and hospitals should ideally be headed by health administrators

or by a qualified member of any of the professionals that make up the health team that meet the minimum inclusive and fair requirements for being appointed rather than it being the lifelong right or monopoly of a single professional group in the team. This will bring about inclusiveness and a sense of belonging among the health team.

Regulatory Framework

Medical laboratory Science is an important healthcare profession. The profession is regulated by the MLSCN based of the Medical Laboratory Science Council of Nigeria Act 2003 (53), the Institute of Biomedical Science (23) and Health Care Professions Council (21) in the case of the UK, American Association of Bioanalysts (AAB) (86), American Medical Technologists (AMT) and the American Society for Clinical Pathology (ASCP) in the USA (42), the Canadian Society for Medical Laboratory Science (CSMLS) in Canada (87), The Australian Institute of Medical Scientists (AIMS) in Australia (35) and the Medical Sciences Council of New Zealand (48). It is an autonomous profession different from Clinical Pathology which is regulated by the MDCN in Nigeria (Medical and Dental Practitioners Act (54) or the Royal College of Pathology in the UK (28) and the General Medical Council. Medical laboratory Science and Clinical Pathology are complementary professions with clear cut roles and clear-cut scope of practice. Neither profession has a superintending role over the other. Several industrial court judgements in Nigeria have re-affirmed the fact that the profession of Medical Laboratory Science is an autonomous profession as declared by law (53, 56). Medical laboratory scientist roles are clearly delineated in the approved statutory scheme of service for Medical Laboratory Scientists in Nigeria vide circular No. B.63279/T/35 dated 22nd February, 2001

(55). The Medical laboratory Scientist manages the medical laboratory and their ancillary staff that are regulated by the MLSCN (medical laboratory scientist, medical laboratory assistants and medical laboratory assistants) using their scientific knowledge, well-maintained and appropriately stored diagnostic reagent in testing biological samples and body fluids and generating accurate, precise and reproducible medical laboratory results and reports which clinicians including Clinical Pathologists need in the post-analytical phase to make an informed decision in the management of patients. The role of the Medical laboratory scientist can be likened to working in a manufacturing facility where raw materials are transformed to finished products. Medical laboratory scientist converts raw materials (biological samples and reagents) to finished products (accurate precise and reproducible results and reports) which become evidence-based raw materials which our clinical colleagues including Clinical Pathologists need to make evidence-based and informed decision in offering the best possible care and management of patients. The Scheme of service approved by the Federal Government of Nigeria (56) and the National industrial court judgements attest to the fact that Medical Laboratory Science (53, 58) is an autonomous profession entitled to autonomous practice within their field and scope of competence; *“that by virtue of the Medical Laboratory Science Council of Nigeria Act No. 11, 2003, only persons qualified and fully registered as Medical Laboratory Scientists can practice the profession in Nigeria subject only to the provision in section 22(2) of the act; that by virtue of the scheme of service approved by the Federal Republic of Nigeria for the cadre of the Medical Laboratory Scientist, responsibility for supervision, management and control of the Medical*

A Publication of the Association of Medical Laboratory Scientists of Nigeria, under a Creative Commons Attribution Non-Commercial 4.0 International Public License (CC BY-NC 4.0).

Laboratory Department is placed on the director of Medical Laboratory Services and that Pathologists of whatever grade who are not registered as Medical Laboratory Scientist are not entitled to practice the profession in any manner, design or disguise whatsoever” (56). The Federal Ministry of Health (FMOH), other clinicians, other members of the healthcare team and well-meaning Nigerians should join in the evidence-based advocacy as declared by several NICN judgements that Medical Laboratory Scientists (Medical Laboratory Directors) be allowed to carry out their legally enshrined roles within their scope of practice without any encumbrances, concentrating on carrying out their statutory and regulated roles of managing medical laboratories and generating accurate, precise, reproducible and timely medical laboratory results and reports to allow for the evidence-based management of patients. The NICN (56) in her wisdom declared in a previous judgement that pathology has grown unwieldy because of the share of varieties of duties dovetailed onto it, such that, it was necessary to divide it into two by means of specialization and division of labour. Pathology is the bridge between science and medicine (81). It makes sense that the scientific aspect of the bridge is managed and headed by the Medical Laboratory Scientist. Division of labour in the Nigerian health sector and other sectors is vital in enhancing productivity, excellent service delivery and for societal benefits (88). The implementation of these evidence-based best practices is needed to allow for harmony (89) **in the Nigerian health sector and** will facilitate the rendering of best possible and holistic medical care to patients and society.

Error management in Medical Laboratory Service Delivery

A Publication of the Association of Medical Laboratory Scientists of Nigeria, under a Creative Commons Attribution Non-Commercial 4.0 International Public License (CC BY-NC 4.0).

Medical Laboratory Scientists are like the oracles of modern healthcare practice. They produce precise, accurate and reproducible diagnostic results and reports that clinicians and surgeons need to make an informed therapeutic decision. It is a general requirement in Medical Laboratory Science practice and by regulatory (MLSCN and the IBMS) and accreditation agencies (CPA, UKAS) that Medical Laboratory Scientists/Biomedical scientists be qualified, adequately trained and have initial competency and ongoing competency assessments to continue to be allowed to work unsupervised in the diagnostic laboratory (90-91). To be certified competent, a Medical Laboratory Scientist must be aware of how to perform the required laboratory task, have the required skill to perform the task, be able to perform the task safely and effectively without supervision, and knows how to troubleshoot testing, reagent, sample and equipment-related errors that has a potential to produce erroneous result (92). The Laboratory Manager as the technical supervisor is responsible for identifying gap and training needs and ensuring that training needs of staff are taken care of as well as implementing a competency program to ensure that staff performing a diagnostic task continues to engage in continuing professional development (CPD) training and education that are relevant and appropriate for the staff evolving roles (93). Competency assessment is a Laboratory Manager’s way of ensuring and verifying that a staff is competent to perform a delegated laboratory testing task. This is often to ensure that precise, accurate, reproducible and timely diagnostic results are available for the effective management of the patients. By certifying a staff competent to carry out a task, the manager is taking responsibility including legal for the actions and inactions of the staff particularly if diagnostic errors are made

by the staff and independent investigation proves that the staff was not competent or was negligent (duty owed by the medical laboratory scientist was not performed or sub optimally performed resulting in the patient suffering harm) in the first place.

In developed countries, clinicians are faced with a plethora of diagnostic tests to apply to patients to guide their clinical management. The quality, effectiveness, and efficiency of patient care should be foremost in the clinician's mind. Laboratory Managers/Directors should make every effort to guide clinicians in appropriate laboratory test ordering, interpretation, and resulting actions (94). A laboratory error is defined as a defect during the entire testing process (from ordering tests to reporting results) which can impact the quality of laboratory services. Errors, near misses and other adverse events that occur in the medical laboratory can either be pre-analytical, analytical and post-analytical (95). The analytical phase begins when the patient specimen is prepared in the laboratory for testing, and it ends when the test result is interpreted and verified by the Medical Laboratory Scientist in the medical laboratory. Common causes of analytical errors include; lack of experience, inadequate training and competency challenges associated with lack of proficiency on the safe operation and troubleshooting of laboratory analyzers (96). The role of the Medical Laboratory Scientist in medical laboratory service delivery is not an easy task. Diagnostic errors are defects that can occur during the ordering, sample collection, processing, testing, reporting, interpretation and dissemination of laboratory results to the requesting clinician. Errors in the medical laboratory service delivery can have a negative impact on diagnosis and effective management of patients. Errors in the diagnostic laboratory can occur during the 3 phases involved in the diagnostic

laboratory process (pre-analytical, analytical and post-analytical). Pre-analytical errors occur during test ordering, sample collection and transport to the laboratory. Analytical errors are those that occur during sample processing, analysis and generation of results while post analytical errors are those that occur in the reporting and dissemination of the report to the requesting clinician (97). Laboratory errors have far reaching implications on the quality of care offered to patients and cost. It is critical that management strategies are implemented to prevent the likelihood of these errors occurring by the deliberate identification of actions and steps in the process that can potentially cause the greatest risk of such errors.

One of the ways to prevent diagnostic errors particularly during the analytical phase is to ensure that professionals rostered to work on the bench unsupervised out-of-hours on call have the requisite qualification, licensing, training and competence. It is counterproductive to request a person who is not qualified, licensed, adequately trained and competency tested to work in the diagnostic laboratory unsupervised. Apart from the potential to cause colossal damage to expensive laboratory equipment and wastage of reagents, there is also the risk of diagnostic errors occurring. These errors can negatively impact the patient often resulting in litigations and payment of compensation. There has been clamour in some developing countries for registrars in pathology to be rostered other than for supervised training and research to work on call unsupervised in the medical laboratory often to use equipment and testing protocol that they have not been trained, competency tested and certified on by the laboratory manager or technical supervisor. This practice is not only unethical but unsafe. This unethical practice can potentially put patients at risk.

A Publication of the Association of Medical Laboratory Scientists of Nigeria, under a Creative Commons Attribution Non-Commercial 4.0 International Public License (CC BY-NC 4.0).

It is critical that evidence-based best practices are implemented in developing countries to prevent harm to patients and wastage of scarce national resources paid as compensation to patients when these preventable errors occur (64, 81,98-99). These funds paid out as compensation could be used to improve the test menu, continuing professional development of the laboratory workforce and by extension the quality of laboratory service delivery.

Team-work and Division of Labour in Healthcare Delivery in Nigeria

The term division of labour from a healthcare service delivery perspective can be defined as the separation or split-up of professional responsibilities so that the composite professional groups can specialize and work within their licensing, qualification, scope of practice standards of proficiency and competence (100). The scope of practice is a term used to describe areas in which a professional has the requisite knowledge, skills and experience required to enable them practice safely and effectively in the interest of the vulnerable public. Professional competence plays a prominent role in the guidelines established by the MLSCN and other professional regulatory agencies (13, 24, 37, 53-55, 83, 87, 101). It is no longer news that effective team working is key to the delivery of an effective patient-centred health care delivery and safety. There is increasing advocacy globally for the parallel development of the different professions in the healthcare sector but with an emphasis on patient centred teamwork approach. A team can be defined as a distinct group of two or more individuals who cooperate harmoniously, interdependently and flexibly towards the achievement of a common and valued objective, mission or goals (102). From the healthcare and business perspectives, it involves healthcare professionals working within their delineated roles to bring to the

table accountable value that can be harmonized collaboratively (shared responsibility) to accomplish shared goals of provision of the best possible high-quality care to the customer or patient (103). Healthcare delivery has evolved significantly over the last 2 decades becoming highly sophisticated, specialized, rapidly evolving and significantly collaborative. The days of the risky, unaccountable one all-knowing physician and practice in isolation is over (104-106). It has become glaringly clear that no single professional in the healthcare team can offer a holistic specialized good quality care that patient deserves. There is a paradigm shift from lone or solo practice to inter-professional team-based health care delivery system with different healthcare professionals working collectively in an environment where each member feels valued and there is shared responsibility to achieve a common goal (107). There are core values that make for effective team working; honesty (being open, trustworthy, effective communication, transparency, reporting and raising concern about safety, effective management of risk, accountability and owing up when mistakes are made or in the face of an unexpected negative outcome); creativity (bringing onboard peculiar value and having a continuous quality improvement mindset by seeing errors, mistakes, negative outcome, accidents, incidents and near misses as opportunity for learning and improvement); discipline (playing by the rules and within the ambit of necessary legal framework, working as a team but within one's scope of practice and competence and not having I know-it-all mindset or approach), humility (being humble, refraining from belief that one's training or perspective is superior to that of other members of the team and having a statesman's inclusive mindset of he who the cap fits in terms of training and

A Publication of the Association of Medical Laboratory Scientists of Nigeria, under a Creative Commons Attribution Non-Commercial 4.0 International Public License (CC BY-NC 4.0).

experience and scope of practice irrespective of their professional affiliation let him wear it approach); inquisitiveness or curiosity (reflecting on lessons learnt from one's practice with the aim of building a culture of continuous quality improvement) (108).

There are a number of principles that characterize effective team working in the healthcare delivery sector; shared objectives (collective interest of all the professional groups rather than that of an individual profession as well as shared ownership); clearly defined and non-overlapping roles (professional responsibilities and accountability, division of labour allowing for shared achievement, respect for the individual value and diverse opinion offered by the composite professions in the health team, the different composite professionals working within their legal standards, frameworks, scope of practice and competence); effective communication (information sharing, making sure that the composite professions in the healthcare team are carried along and on the same page on matters surrounding patient care at all times), setting measurable goals or objectives (setting specific, measurable, attainable, relevant and timely goals, feedback oriented process, performance tracking to drive continuous quality improvement (109-110) and operating an action planned oriented teams [what is to be done, why, who is to do it and time frame within which to get the task done] and leadership (representative and inclusive of all composite members of the team with opportunity available for any member of the team that meet the team's agreed minimum requirements having the potential to become the head or leader, mentoring, delegation, coordination of collective efforts of the team). There is increasing advocacy across industries including for division of labour, coordination and integration of services.

A Publication of the Association of Medical Laboratory Scientists of Nigeria, under a Creative Commons Attribution Non-Commercial 4.0 International Public License (CC BY-NC 4.0).

Health care delivery has become fundamentally collaborative, complimentary, interdependent and increasingly complex (111-113). No one individual professional group can assure the delivery of the best possible or highest standard of care that patients and our customers need and deserve.

Conclusion

Medical Laboratory Science is an important autonomous healthcare profession different from clinical pathology. None of the professions have a superintending role over the professional practice of the other. Medical Laboratory Scientist/Biomedical Scientist manages the science side of pathology by analysing biological samples and body fluids using appropriately stored reagents and proactively maintained laboratory equipment to generate accurate, precise, reproducible and timely laboratory results and reports that clinicians and surgeons require to make informed decision in the effective management of patients. Clinical pathologists play important clinical roles in patients care by managing patients with diseases in their area of speciality as well as offering clinical advice to their clinical colleagues in the post analytical phase based on accurate laboratory result generated by the Medical Laboratory Scientists in the analytical phase. To foster harmony, division of labour and holistic healthcare delivery that Nigerians deserve, it is critical that medical laboratory scientists, clinical pathologists and other members of the health team work within their professional knowledge base, licensing, scope of practice, competence and regulatory framework. The Director, Deputy Director or Assistant Director of Medical Laboratory Services as the case may be should be the head of medical laboratory departments and medical laboratory service delivery as required by their statutory schemes of service and by

the law. Clinical Pathologists should concentrate on managing their clinical laboratory practice managing patients in their area of specialty and offering clinical advice on complex laboratory results generated by the medical laboratory scientist in the post analytical phase. It is best practice for medical laboratory scientist as a distinct autonomous profession to have their own call duty roster and carry out their regulated clearly delineated professional duties on call while Clinical Pathologists should have their own distinct clinical roster and concentrate on their clinical roles while on call. Residents in pathology are always welcome to medical laboratories for the purpose of research, practical training and orientation. It is however risky, unsafe and outside their scope of practice and will put patients at risk for these trainees who have not been trained on laboratory testing protocols, proactive management of laboratory equipment and competency tested to have their names captured on the call-duty roster without adequate provision for supervision to work in medical laboratories to perform delineated roles of the Medical Laboratory Scientist. The implementation of these evidence-based best practices has the potential to restore harmony, equity and fair play in medical laboratories in Nigeria and enhance the laboratory service offered to patients and clients.

Conflict of interest declaration.

All the authors are Medical Laboratory Scientists and member of the Association of Medical Laboratory Scientists of Nigeria (AMLSN).

Acknowledgements.

Authors are grateful to Dr C. Anyeagbu for taking out time to critically review this article.

A Publication of the Association of Medical Laboratory Scientists of Nigeria, under a Creative Commons Attribution Non-Commercial 4.0 International Public License (CC BY-NC 4.0).

Data Availability.

The data used to support the findings of this study are included in the article. The raw data of this study will be made available on reasonable request.

Funding.

This study was funded collectively by the authors.

REFERENCES:

1. Skår R. The meaning of autonomy in nursing practice. *J Clin Nurs*, 2010; 19:2226-2234.
2. Weston MJ. Defining control over nursing practice and autonomy. *J Nurs Administration*, 2008; 38: 404-408.
3. Halcomb E, Stephens M, Bryce J, Foley E, Ashley C. The development of professional practice standards for Australian general practice nurses. *J Adv Nurs*, 2017; 73:1958-1969.
4. O'Hara SP, Renton-Skinner P, Thorne AJ. Evolution of the species 1: competency assessment—playing with fire. *Biomed Scientist*, 1998; 42:836–839.
5. Institute of Biomedical Science. Professional pathways of Biomedical Scientists: general guidance for professional education and training. London: IBMS, 1997.
6. Chadi N. Breaking the Scope-of-Practice Taboo: Where Multidisciplinary Rhymes with Cost-Efficiency. *Mcgill J Med*, 2011; 13:44.
7. Adebowale N. COVID-19: Nigeria's Laboratory Scientists Pledge to Support, Improve Country's Testing Capacity. April 9, 2020. Premium Times. <https://www.premiumtimesng.com/coronavirus/386874-covid-19->

- nigerias-laboratory-scientists-pledge-to-support-improve-countrys-testing-capacity.html.
8. Abdollahi A, Saffar H, Saffar H. Types and Frequency of Errors during Different Phases of Testing at a Clinical Medical Laboratory of a Teaching Hospital in Tehran, Iran. *North Am J Med Sci*,2014; 6(5): 224–228.
 9. Institute of Biomedical Science. The Big Question: Statutory Regulation. 28 November 2017. <https://thebiomedicalscientist.net/science/big-question-statutory-regulation>.
 10. IBMS website. Archived from the original on 26 March 2014. Retrieved 22 March 2014.
 11. Institute of Biomedical Science (IBMS). Clinical Laboratory Standards for IBMS. Qualifications and Guidance for Training Laboratory Management and Approval. Version 3, August, 2008.
 12. IBMS Certificate of Competence by Equivalence (Biomedical Scientist) for HCPC registration as a biomedical scientist guidance for candidates. <https://www.ibms.org/resources/documents/ibms-certificate-of-competence-by-equivalence-guide/>.
 13. Institute of Biomedical Science. Application for Chartered Scientist (CSci) Professional Registration with the Science Council (2018). <https://www.ibms.org/resources/documents/application-for-chartered-scientist-csci-professional>. Assessed 5th June 2018.
 14. Academy for Healthcare Science. About the Academy for Healthcare Science. Retrieved 18 April 2013a.
 15. Academy for Healthcare Science. Academy for Healthcare Science opens route to Clinical Scientist Registration following HCPC approval. Department of Health. Retrieved 18 April 2013b.
 16. Academy for Healthcare Science. Education and Training. Retrieved 13 January 2014.
 17. Biomedical scientist. Prospects. <https://www.prospects.ac.uk/job-profiles/biomedical-scientist>.
 18. NHS Blood and Transplant (NHSBT). Reference Laboratory Manager (HCPC registered). <https://www.jobs.nhs.uk/xi/vacancy/916129210>.
 19. Lab Manager. Job Description, Duties and Requirements. Sep 26, 2019. https://study.com/articles/Lab_Manager_Job_Description_Duties_and_Requirements.html.
 20. Sodexo. Our vacancies. Laboratory Services Manager. <https://www.sodexojobs.co.uk/jobs/job/Laboratory-Services-Manager/40728>.
 21. Health and Care Professions Council (HCPC). The standards of proficiency for clinical scientists. <https://www.hcpc-uk.org/standards/standards-of-proficiency/clinical-scientists/>
 22. Dunlop A. A day in the life of a Clinical Scientist. Careers. <https://portlandpress.com/biochemist/article-pdf/40/1/40/851830/bio040010040.pdf> by UK user on 09 August 2020.
 23. Institute of Biomedical Science (IBMS). New IBMS route to Clinical Scientist registration. <https://www.ibms.org/resources/news/announcing-the-ibms-new-route-to-clinical-scientist/>.

24. Royal College of Pathologist. Train to be a consultant clinical scientist. <https://www.rcpath.org/discover-pathology/careers-in-pathology/train-to-work-in-pathology/train-to-be-a-consultant-clinical-scientist.html>.
25. Academy of Healthcare Science (AHCS). Career Framework for Healthcare Scientists. <https://www.ahcs.ac.uk/equivalence/equivalence-guidance/career-framework-for-healthcare-scientists/>.
26. NHS Employers. Part of the NHS confederation. Consultant clinical scientist guidance. <https://www.nhsemployers.org/your-workforce/recruit/employer-led-recruitment/consultant-clinical-scientist-guidance-project>.
27. Academy for Healthcare Science. Clinical Science Professional Bodies. <https://www.ahcs.ac.uk/professional-bodies-council/clinical-scientist-professional-bodies/>.
28. The Royal College of Pathology. Become A Consultant Clinical Scientist. <https://www.rcpath.org/discover-pathology/careers-in-pathology/become-a-consultant-clinical-scientist.html>.
29. Academy for Healthcare Science. Clinical Science Professional Bodies. <https://www.ahcs.ac.uk/professional-bodies-council/clinical-scientist-professional-bodies/>.
30. Education and Training in Laboratory Medicine in the United States. *EJIFCC*, 2013; 24:1-3.
31. Klipp J. Who wants to work in a lab. *MLO Med Lab Obs*, 2000; 32:24-29.
32. Public Health Service Act, Sec. 353, Subpart 2 – Clinical Laboratories, found at http://wwwn.cdc.gov/clia/pdf/PHSA_353.pdf. Last accessed 3 March 2013.
33. Garcia E, Asma M, Ali RM, Soles MA, Lewis DG. The American Society for Clinical Pathology's 2014 Vacancy Survey of Medical Laboratories in the United States. *Am J Clin Pathol*, 2015; 144:432-443.
34. Beckering R, Brunner R. The lab shortage crisis: a practical approach. *MLO Med Lab Obs*, 2003; 35:48-50.
35. Beck SJ, Briden MF, Epner PL. Practice Levels and Educational Needs for Clinical Laboratory Personnel. *Clin Lab Sci*, 2008; 21: 68-77.
36. Full Time Job. Laboratory Director. HCA Healthcare. Jacksonville, FL, USA. https://careers.hcahealthcare.com/jobs/5449056-laboratory-director?tm_job=23437-9576&tm_event=view&tm_company=2537.
37. Australian Institute of Medical Scientists. Membership Options. <https://www.aims.org.au/membershipinformation/membership-options>.
38. Australian Institute of Medical Scientists. Guidelines for Employer Assessments. <https://www.aims.org.au/documents/item/252>.
39. Australian Institute of Medical Scientists. University Program Accreditation. <https://www.aims.org.au/services/university-accreditation>.
40. Government of Western Australia. Department of Training and Workforce Development. Laboratory Manager. <https://www.jobsandskills.wa.gov.au/jobs-and->

- careers/occupations/laboratory-manager.
41. Government of Western Australia. Department of Training and Workforce Development. Laboratory Manager. <https://www.jobsandskills.wa.gov.au/jobs-and-careers/occupations/laboratory-manager>.
42. Medical Laboratory Technician, MLT (ASCP) Examination Content Guide". American Society of Clinical Pathology. Archived from the original (PDF) on 2013-11-05. Retrieved 2013-11-05.
43. Medical Laboratory Technologists & Assistants Jobs in Canada. <https://pwp.vpl.ca/siic/guides/medical-laboratory-technologists-assistants/#job-overview>.
44. Regional Manager of Laboratory Services. Western Memorial Regional Hospital, Corner Brook. Permanent Full-time role. <https://ca.indeed.com/Medical-Laboratory-Science-jobs?vjk=e541c7597c9fc5ad>.
45. Manager, Laboratory and Health Services Dynacare, Manitoba, Full-Time role. <https://ca.indeed.com/jobs?q=laboratory%20manager&l&vjk=4d0460ea5c1d1c3c>.
46. Romano RC, Allen TC, Blessing MM. The essential role of pathologists in health care and health policy. *Arch Pathol Lab Med*, 2015; 139:441-444.
47. Hewett R. Laboratory Manager LabPLUS, Auckland City Hospital, Auckland. The future of medical laboratory science – a personal perspective of Dr Who. *NZ J Med Lab Science*, 2008:56-60.
48. Medical Sciences Council of New Zealand. Policy and Guidelines: Supervision and Direction for Medical Laboratory Science Practitioners. 2019-Aug-V2- MSC Supervision and Direction (MLS).
49. Medical Laboratory Scientist. Careers NZ. New Zealand Government. Retrieved 2016-10-17. <https://www.careers.govt.nz/jobs-database/science/science/medical-laboratory-scientist/>.
50. PayScale. Average Laboratory Manager Salary in New Zealand. https://www.payscale.com/research/NZ/Job=Laboratory_Manager/Salary.
51. Efobi N, Ehima R. Legal systems in Nigeria: overview. Thompson Reuters Practical Law. [https://uk.practicallaw.thomsonreuters.com/w-018-0292?transitionType=Default&contextData=\(sc.Default\)&firstPage=true](https://uk.practicallaw.thomsonreuters.com/w-018-0292?transitionType=Default&contextData=(sc.Default)&firstPage=true).
52. Arias IM. Bridging the Bed-Bench Gap: Contributions of the Markey Trust. National Research Council (US) Committee on the Evaluation of the Lucille P. Markey Charitable Trust Programs in Biomedical Sciences. Washington (DC): National Academies Press (US). 2004.
53. Medical Laboratory Science Council of Nigeria (MLSCN) Act 11, 2003 (Cap M25 Laws of Federation of Nigeria 2004).
54. Medical and Dental Council of Nigeria (MDCN) Act (Cap M8 Laws of Federation of Nigeria 2004).
55. Federal Republic of Nigeria Schemes of Service for Medical Laboratory Scientist. B.63279/T/35, February, 2001.
56. National Industrial Court of Nigeria in the Abuja Judicial

- Division. Judgement Before HIS Lordship Hon. Justice B.A. Adejumo OFR. Suit No. NICN/ABJ/284/2014, 27th January, 2016.
57. Hallworth M, Hyde K, Cummings A, Peake I. The future for clinical scientists in laboratory medicine. *Clinical Laboratory Haematology*, 2002; 24: 197–204.
58. National Industrial Court of Nigeria in the Enugu Judicial Division. Judgement Before HIS Lordship Hon. Justice O.O. Arowosegbe). Suit No. NICN/EN/53/2017, 27th July, 2020.
59. Lenicek Krleza J, Honovic L, Vlastic Tanaskovic J, Podolar S, Rimac V, Jokic A. Post-analytical laboratory work: national recommendations from the Working Group for Post-analytics on behalf of the Croatian Society of Medical Biochemistry and Laboratory Medicine. *Biochem Med*, 2019; 29(2): 020502.
60. NHS Blood and Transplant (NHSBT). Reference Laboratory Manager (HCPC registered). <https://www.jobs.nhs.uk/xi/vacancy/916129210>.
61. General Medical Council. https://www.gmc-uk.org//media/documents/Curriculum_Chemical_Pathology_7_Jun_07_v.Curr_0068.pdf_30_556786.pdf.
62. Ikenwa C. Residency program in Nigeria. March 16, 2020. <https://nigerianinfopedia.com/residency-training-program-in-nigeria-duration-enrollment/>. 2020.
63. Haematology (doctor). Health Careers, <https://www.healthcareers.nhs.uk/e>xplore-roles/doctors/roles-doctors/pathology/haematology-doctor.
64. Eze CK. 24/7 Laboratory Service. Biomedical Scientist. Biomedical news, views and analysis, 26 March 2018.
65. Erhabor O, Njemanze C. Challenges of a negative work load and implications on morale, productivity and quality of service delivered in NHS laboratories in England. *Asian Pac J Trop Biomed*, 2014; 4: 421-429.
66. Blum AB, Shea S, Czeisler CA, Landrigan CP, Leape L. Implementing the 2009 Institute of Medicine recommendations on resident physician work hours, supervision, and safety. *Nat Sci Sleep*, 2011; 3: 47–85.
67. Rodziewicz TL, Hipskind JE. Medical Error Prevention. In: *StatPearls*. Treasure Island (FL): StatPearls Publishing; May 5, 2020.
68. Laboratory Scientists Decry Hijack of Practice by Medical Doctors. This Day Newspaper, July 22, 2019 6:04 am. <https://www.thisdaylive.com/index.php/2019/07/22/laboratory-scientists-decry-hijack-of-practice-by-medical-doctors/>.
69. Singh H, Thomas EJ, Petersen LA, Studdert DM. Medical errors involving trainees: A study of closed malpractice claims from 5 insurers. *Arch Intern Med*, 2007; 167:2030–2036.
70. Siraj A, Kokkinou MV, Jeffery K, Oosterhuis W, Shine B, Schuh A, Theodoridis T. The role of the physician in laboratory medicine: a *J. Clin Pathol*, 2012: 10.1136/jclinpath-2012-201042.
71. Kilminster SM, Jolly BC. Effective supervision in clinical practice

- settings Siraj Siraj: a literature review. *Med Edu*, 2000; 34:827-840.
72. Medical Laboratory Science Council of Nigeria. Guideline on Staffing Requirements of Medical Laboratory Science Practitioners. MLSCN/2018/GL008.
73. Studder DM, Mell MM, Gawande AA, Gandhi TK, Kachalia A, Yoon C, *et al*. Claims, errors, and compensation payments in medical malpractice litigation. *N. Engl. J. Med*, 2006; 354: 2024-2033.
74. Medical Laboratory Science Council of Nigeria (MLSCN). Quality Policy Manual. Document No. QM. Control Copy No. 12. 06 November 2012.
75. Medical Laboratory Science Council of Nigeria (MLSCN). Guidelines for In-Vitro Diagnostics (IVDs) Regulation in Nigeria. MLSCN/2018/003. March, 2018.
76. Murphy MJ, Paterson JR, Neithercut WD. On-call duties in chemical pathology: a survey of junior medical staff in the UK. *Ann Clin Biochem*, 1994; 31:184-187.
77. Galloway PJ, Bayly G, Badminton M. Clinical experience of trainees in chemical pathology: a survey of junior medical staff in the United Kingdom. *J Clin Pathol*, 1998; 51:711.
78. General Medical Council. The doctor as teacher. London: GMC. doi:10.1136/jcp.51.9.711a. 1999.
79. Johnson N. Training of junior doctors: the responsibility of consultants and trainers. *Postgrad Med J*, 2001; 77:745-746.
80. Kilminster SM, Delmotte A, Frith H, Jolly BC, Stark P, Howdle PD. Teaching in the new NHS: the specialised ward-based teacher. *Med Educ*, 2001; 35:437-443.
81. Arias IM. Training basic scientists to bridge the gap between basic science and its application to human disease. *N. Engl. J. Med*, 1989; 321:972-974.
82. Global Health Observatory data repository. Medical and Pathology Laboratory Personnel. https://apps.who.int/gho/data/node.main.HWFGRP_00120?lang=en.
83. The Civil Service. How will you help make your workplace more inclusive? <https://civilservice.blog.gov.uk/2017/10/16/how-will-you-help-make-your-workplace-more-inclusive/>.
84. Bourke J, Espedido A. Why Inclusive Leaders Are Good for Organizations, and How to Become One. *Harvard Business Reviews*, March 29, 2019. <https://hbr.org/2019/03/why-inclusive-leaders-are-good-for-organizations-and-how-to-become-one>.
85. Beck SJ, Briden MF, Epner PL. Practice levels and educational needs for clinical laboratory personnel. *Clin Lab Sci*, 2008; 21:68-77.
86. American Association of Bioanalysts (AAB). Certification. <https://www.aab.org/aab/Certification.asp>
87. Canadian Society for Medical Laboratory Science (CSMLS). First Steps to Certification. <https://www.csmls.org/Certification/Become-Certified-Internationally-Educated-Profes/First-Steps-to-Certification.aspx>.
88. Smith A. The wealth of Nations. New York, Bantam Classics, 2003 Edition. 2003, p 1-21.
89. Omisore AG, Adesoji RO, Abioye-Kuteyi EA. Interprofessional Rivalry in Nigeria's Health Sector:

- A Comparison of Doctors and Other Health Workers' Views at a Secondary Care Center. *Int Q Community Health Educ*, 2017;38(1):9-16.
90. Medicare, Medicaid and CLIA programs; regulations implementing the Clinical Laboratory Improvement Amendments of 1988 (CLIA)—HCFA. Final rule with comment period. *Fed Regist*, 1992; 57:7002-7186.
91. Boone DJ. Assessing laboratory employee competence. *Arch Pathol Lab Med*, 2000; 124:190-191.
92. Sharp SE, Elder BL. Competency assessment in the clinical microbiology laboratory. *Clin Microbiol Rev*, 2004; 17:681-694.
93. Tiehen A. Competency assessment: establishing a program. *Clin. Lab. Manage Rev*, 1999; 13:275-285.
94. Lundberg GD. How clinicians should use the diagnostic laboratory in a changing medical world. *Clin Chim Acta*, 1999; 280:3-11.
95. Berwick DM, Leape LL. Reducing errors in medicine. *BMJ*, 1999; 319:136–137.
96. Spath P. Equipment-related errors in the workplace. *Hosp Peer Rev*, 2001; 26:56-66.
97. Agarwal R. Quality-Improvement Measures as Effective Ways of Preventing Laboratory Errors. *Lab Med*, 2014; 45: e80–e88.
98. Studder DM, Mell MM, Gawande AA, Gandhi TK, Kachalia A, Yoon C, *et al*. Claims, errors, and compensation payments in medical malpractice litigation. *N. Engl. J. Med*, 2006; 354: 202-203.
99. Allen TC, Stafford M, Liang BA. Pathology and Medical Malpractice: Academic and Trainee Empirical Review of Cases by State of Texas Physicians. *Am. J. Clin. Pathol*, 2014; 141: 501–509.
100. Meriläinen M, Turkki L. Working time use and division of labour among nurses and health-care workers in hospitals - a systematic review. *J Nurs Manag*, 2016; 24:1027-1040.
101. Overholser JC, Fine MA. Defining the boundaries of professional competence: Managing subtle cases of clinical incompetence. *Prof. Psychol.: Res. Pract*, 1990; 21: 462-469.
102. World Health Organization Being an effective team player Available from: URL: http://www.who.int/patientsafety/education/curriculum/who_mc_topic-4.pdf Accessed 2 December 2014.
103. Naylor MD, Coburn KD, Kurtzman ET, Prvu Bettger JA, Buck H, Van Cleave J. *et al*. Inter-professional team-based primary care for chronically ill adults: State of the science. Unpublished white paper presented at the ABIM Foundation meeting to Advance Team-Based Care for the Chronically Ill in Ambulatory Settings Philadelphia, PA; March 24–25, 2010.
104. Mitchell P, Wynia M, Golden R, McNellis B, Okun S, Webb CE, *et al*. Core Principles and Values of Effective Team-Based Health Care Discussion Paper. Washington, DC: Institute of Medicine. 2012.
105. Gawande A. Cowboys and Pit Crews Harvard Medical School Commencement Address. 2011.
106. Erhabor O, Adias TC. Harmony in health sector: a requirement for effective healthcare delivery in Nigeria.

- Asian Pac J Trop Med*, 2014; 7S1: S1-5.
107. Grumbach K, Bodenheimer T. Can health care teams improve primary care practice? *JAMA*, 2004; 291:1246-1251.
108. Mitchell P, Wynia M, Golden R, McNellis B, Okun S, Webb CE, et al. Core Principles and Values of Effective Team-Based Health Care Discussion Paper. Washington, DC: Institute of Medicine; 2012.
109. Rosen MA, Diaz Granados D, Dietz A.S, Benishek LE, Thompson D, Pronovost PJ, *et al*. Teamwork in healthcare: Key discoveries enabling safer, high-quality care. *Am Psychol*, 2018; 73:433-450.
110. Regis College. How to Build an Effective Team in a Health Care Setting. Master of Health Administration. <https://online.regiscollege.edu/blog/build-effective-team-health-care-setting/>.
111. Organizational Goal Setting in Healthcare: Best Practices. Health Streams. February 16, 2018. <https://www.healthstream.com/resources/blog/blog/2018/02/16/organizational-goal-setting-in-healthcare-best-practices>.
112. Heath C, Staudenmayer N. Coordination neglect: How lay theories of organizing complicate coordination. *Res. Organ. Behav*, 2000; 22:153–191.
113. Kohn LT, Corrigan, JM, Donaldson MS. To err is human: Building a safer health system, vol. 6. Washington, DC: National Academies Press. 2000.