Chapter

Fighting COVID-19: The Medical Laboratory Involvement

Obeta M. Uchejeso, Jwanse I. Rinpan, Mantu E. Chongs and Maureen O. Ekpere-Ezeugwu

Abstract

The coronavirus disease-19 (COVID-19) virus has infected many people across the globe. The health system particularly medical laboratory has been overwhelmed by the pandemic, and many health professionals including medical laboratory professionals have lost their lives during the fight against the virus. Medical laboratory science is the bedrock of medical practice and the role of medical laboratory science in containing the COVID-19 pandemic cannot be overemphasized as they are also behind the testing of clinical specimens from infected and any recovered patients. As disease detectives, Medical laboratory scientists and other medical laboratory professionals' role in the fight against the COVID-19 pandemic include; diagnosis, monitoring, development of vaccines, testing protocols, testing kits, offering advice to the guide government policy on containment of the virus.: Various methods and techniques such as virological cell culture, genomic sequencing, amplification, polymerase chain reaction (PCR) /gene Xpert systems, immunological testing, biosensors and rapid diagnostic techniques (RDTs) have been employed towards discovery, testing and epidemiology since the onset of COVID-19. The medical laboratory workers and other health workers are so visible at the COVID-19 frontline and are being recognized and applauded for the role played in the recovery of patients affected with the virus. The medical laboratory component is very germane in the COVID-19 vaccine research and vaccination so as to provide pre- and post-vaccination laboratory data.

Keywords: COVID-19, laboratory testing, medical laboratory, involvements, interventions, technologies, medical laboratory scientists

1. Introduction

Medical laboratory is a very important component in public health practice and operation especially in case of COVID-19. Medical Laboratory Science practice involves the analysis of human specimen like body fluids, excretion and various body swabs for the purpose of medical laboratory diagnosis, treatment and research [1] of which coronavirus is the one under study. It is important to note that medical laboratory science can also be called Clinical Laboratory Science or Medical Laboratory Technology depending on the nomenclature in the countries of practice [2].

The historical trend of COVID-19 pandemic [3–6] has adequately placed medical laboratory services in a very critical aspect in containment of the disease across the globe. The medical laboratories play a critical role in the detection, management, disease surveillance and control in provision of accurate health data for national

planning and decision making and COVID-19 is not an exception. Timely access and geographical availability of COVID-19 diagnostic testing remains a challenge in the health system and could affect ongoing containment measures [7] for the COVID-19.

The first medical diagnosis made by humans were done by ancient scientists through observation with their physical senses. The ancient Greek attributed all diseases to disorders of bodily fluids called humors, and during late medieval period, then later with the advent of microscope, the microscopy procedure on such specimens have revealed more [8] followed by later technologies, automations, sophistications and molecular testing in the current age.

This chapter shall review the medical laboratory involvement and intervention during COVID-19 era and the ongoing efforts towards supporting laboratory surveillance and response to COVID 19. It will equally show the capacity of medical laboratory perspectives in COVID-19 and provide more information on the medical laboratory testing strategy, towards developing and managing sudden capacities for testing relevant specimens at all levels of health system. Also, the approaches for ensuring laboratory testing sustainability in identifying new and suitable methods consistent with maximizing testing reagents, mobilizing human resources and guide towards implementation of public health measures towards COVID-19 containment, while exploring the recognition and protection policies for medical laboratory professionals during COVID-19 shall be presented.

2. Importance of medical laboratory during pandemic and public health issues

Obeta et al. [1] highlighted some importance of medical laboratory in public health matters to include rapid, accurate and prompt diagnosis for proper treatment and effective monitoring of patients' response to treatment. Medical laboratory provides up to 70% informed decisions regarding patients' hospital admissions and discharge. It guides physicians, nurses and other healthcare workers in choosing the correct laboratory tests and ensure the proper sample collection. Medical laboratory services equally carry out equipment installation, validation and repay in the healthcare laboratories. Medical laboratory component is key in infectious diseases surveillance like Ebola, Tuberculosis, HIV, Malaria and now COVID-19. Quality assurance of a healthcare facility and public health in general is made possible by medical laboratory research towards quality improvement.

Researches [1, 8–10] have shown the main functions of medical laboratory during the COVID-19 pandemic to include the following:

- Establishing appropriate accurate, and sustainable diagnostic testing capacities to respond to COVID-19 needs

- Ensuring surge (sudden) capacity to process a large volume of specimens to cope with COVID-19 epidemiological response needs.

- Conducting virological monitoring of the pandemic at local, state, national, regional and global levels.

- Ensuring timely release of laboratory data and linking data with surveillance data to inform public health decision making and response activities.

- Tracking the genetic evolution of COVID-19 and contributing in research and development of vaccines by characterization of viruses

To achieve adequate COVID-19 monitoring and surveillance, there is need for widespread and continuous testing of not only suspected cases or contacts, but even asymptomatic and apparently healthy population in order to achieve adequate COVID-19 trend monitoring in context of rapid human-to-human spread, and prompt identification of cases.

Undoubtedly, there are many benefits of large-scale population testing for COVID-19 as demonstrated in many high-income countries. For countries that have numerous challenges in their health care delivery system in terms of medical laboratory diagnostics, house-to-house case searching and community contact tracing for infectious diseases surveillance is adequate.

Medical Laboratory plays a crucial role in monitoring co-morbidities, diagnosing complications, assessment of treatment responses and assessing the disease prevalence in the community. Advancement of molecular techniques is mainly relying on understanding the genomic and proteomic composition of COVID-19.

WHO [5, 7] emphasizes "detect, protect and treat" to break the chain of transmission of SARS-COV-2 and COVID-19. Early medical laboratory testing and immediate treatment significantly decrease future COVID-19 cases. Medical laboratory assessment reveals diagnoses, confirms or rules out prognosis based on signs and symptoms, determines severity, monitors treatment responses or complications in COVID-19. The role of medical laboratories is more evident globally today as the battle against COVID-19 rages.

3. Medical laboratory and research towards discovery of COVID-19

On December 31, 2019, China alerted the WHO about the occurrence of several cases of an unusual pneumonia caused by an unknown virus among persons who had either visited or had consumed food from the live animal market in Wuhan city of China, the epicenter of the outbreak. Since then, the infection has spread to other Chinese cities as well as internationally, resulting in the current pandemic. On January 7, 2020, the WHO announced they had identified a new virus. The novel virus was named 2019-COV and was identified as member of the coronaviridae family which also includes SARS and MERS. China announced its first death from the virus on January 23, 2020 as rail and air departure were suspended on January 30, WHO declared the outbreak a global health emergency [4, 5, 7].

The medical laboratory has been duly involved and its involvement ranges from the discovery the pneumonia like virus to the description as SARS and MERS in nature, viral characterization and sequencing and the naming of the viral disease as new coronavirus and COVID-19 [11]. The role of the medical laboratory services from COVID-19 discovery to the management cannot be over emphasized.

4. Challenges and way forward for medical laboratory practice in COVID-19 era

There is no doubt that COVID-19 is new and so are the technologies for testing and research. COVID-19 era is filled with operational differences between the medical laboratory developed protocols and new commercial consumables protocols following the COVID-19 pandemic. However, the implementation of those new protocols is challenging and requires continuous training for the laboratory staff [12]. Another challenge is limited access to COVID -19 reagents. This restricted the number of testing of citizens to those that were having symptoms or at risk as there is fear of exhausting the limited COVID-19 reagents and consumables. In the testing proper, there is delayed

S/N	Challenges	Way forward
1	Misdiagnosis of COVID-19 due to poor training or use of quacks	Adequate training of qualified professionals
2	Poor working environment	Construct modern Medical Laboratory working environment
3	Poor working tools and equipment	Procure modern tools and equipment
4	Unstable power supply	Stabilize power supply and have a standby power supply or an alternative power
5	Poor team work among health professionals	Instill team spirit among practitioners
6	Lack of political will towards medical laboratory practices	Politicians should learn from COVID-19 lockdown to have the will to update medical laboratory facilities as they could be clients in such facilities
7	Corruption	Kill corruption surrounding COVID-19
8	Haphazard quality system	Standardize quality system
9	New technologies and technicalities associated with COVID-19	Imbibe new technologies and technicalities from the producers
10	Paucity of fund in COVID-19 laboratory services	Fund the medical laboratory services to the full with regards to COVID-19 and associated services
11	Unavailability of local testing kits	Give grant and fund research for production of local testing kits
12	Different countries have little no validated rapid kits	Mandate the regulatory bodies to validate more rapid kits to boost testing
13	Poor knowledge and research capacity	Encourage more research in laboratories
14	Non-involvement of medical laboratory component in COVID-19 vaccination	Involve medical laboratory component to give a basal parameter before vaccination and after some days of vaccination to assist in post vaccine research

Table 1.
Challenges and way forward for medical laboratory practice in COVID-19 era.

outbreak detection and reporting of COVID -19 cases maybe due to distance from testing and collection sites and the technicalities involved. Also there is limited access to clinically validated or regulatory approved molecular and serologic tests either through the WHO network, national regulators or through commercial manufacturers [13, 14].

As COVID-19 ravages the world, there are shortages and difficulties in importing large diagnostic kits in the country. There is also poor knowledge and research capacity on COVID-19. Aside from technical difficulties associated with COVID-19 testing, certain seasonal changes might equally affect the number of tests [9]. **Table 1** discusses the challenges and way forward towards offering COVID-19 medical laboratory services.

5. Medical laboratory methods, techniques and technologies applied for COVID-19 testing

The medical laboratory methods and technologies applied in testing COVID-19 includes: neutralization/virological cell culture test, COVID-19 genomic sequencing, nucleic acid testing (NAT) /amplification testing, polymerase chain reaction (PCR), real time PCR (RT- PCR) and Gene Xpert systems, immunological testing, biosensors, rapid diagnostic techniques (RDTs) [15]. These methods are illustrated in **Figure 1**.

Basically, virological cell culture test is the gold standard for virus discovery, pathogenesis research and strategy evaluation but since the emergence of COVID-19, PCR has been adopted as the gold standard and has been in use globally considering the shorter turnaround time. Genomic sequencing uses sophistication to track the

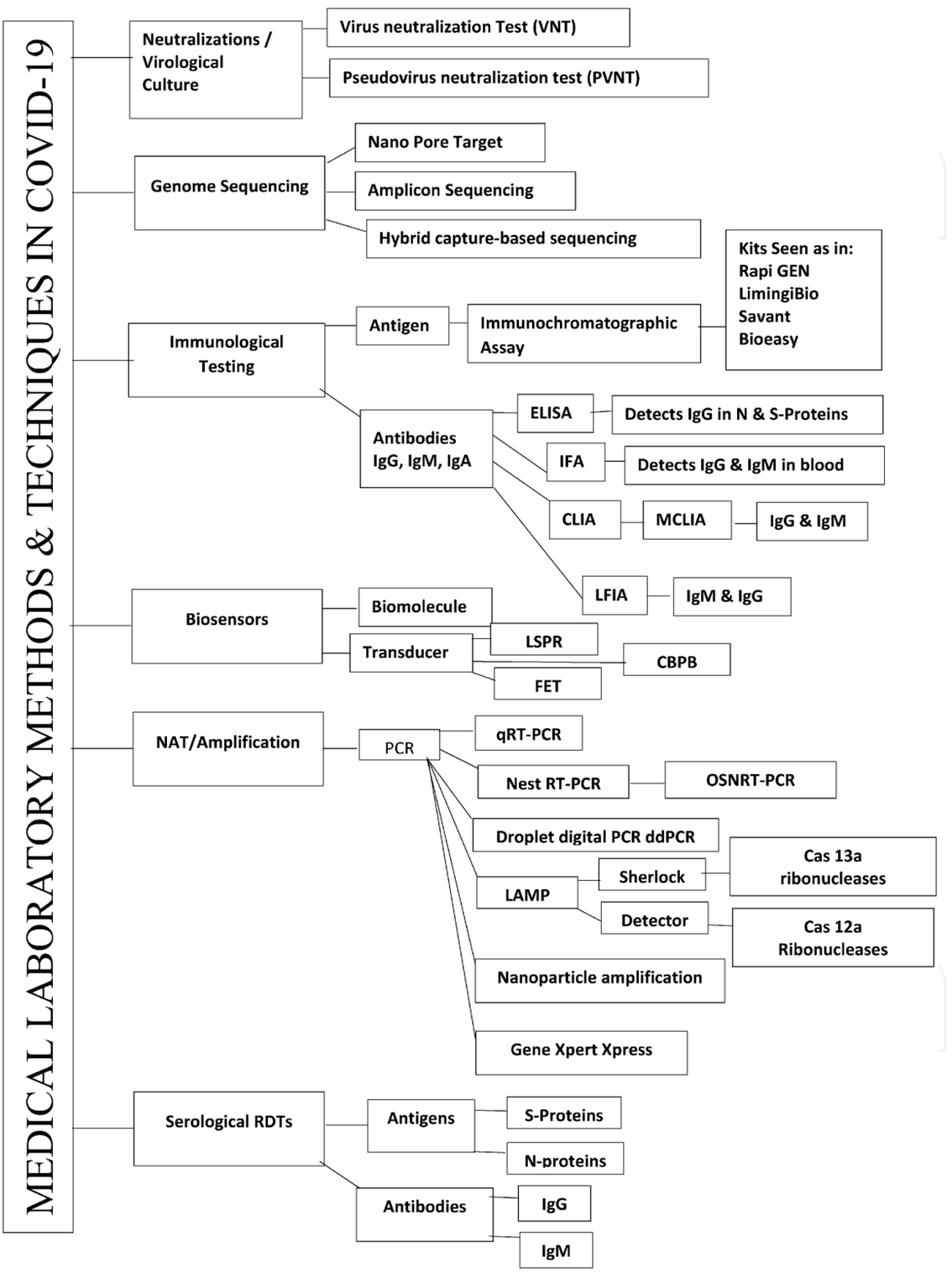


Figure 1.
Diagnostic methods and technologies employed in COVID-19 testing. KEY: CBPB, cell-based potentiometric biose; CLIA, Chemiluminescence immunoassay; ddPCR, droplet digital PCR; E-gene, envelope protein gene; ELISA, enzyme-linked immunosorbent assay; FET, field effect transistor; IFA, Immunoflorescence assay; LAMP, loop mediated isothermal amplification; LFIA, lateral flow immunoassay; LSPR, localized surface plasmon resonance (sensor); MCLIA, magnetic Chemiluminescence enzyme immunoassay; M, membrane protein gene; N-gene, Nucleocapsid protein gene; NAT, nucleic acid testing; PCR, polymerase chain reaction; ORF, open reading frame; OSN-qRT, PCR - one step nested RT-PCR; qRT-PCR, real-time quantification PCR; RDT, rapid diagnostic technique; RdRp, RNA-dependent RNA polymerasegene; S, spike proteins.

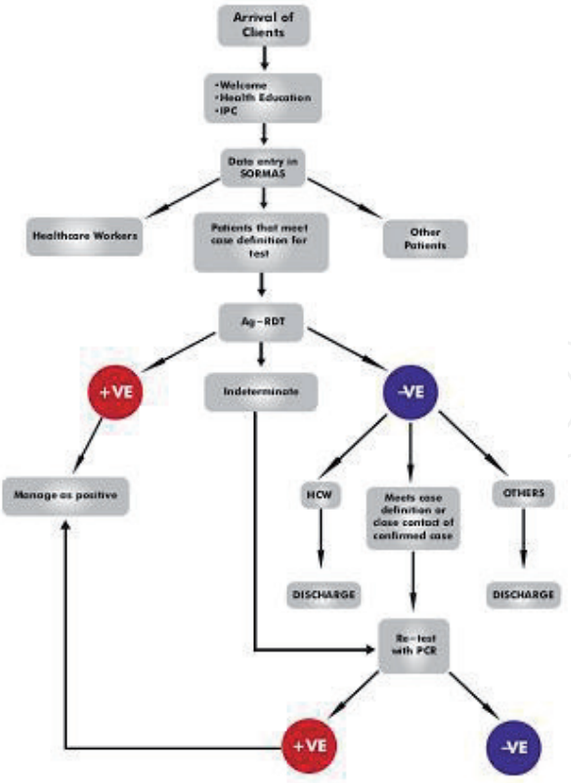


Figure 2.
NCDC medical laboratory testing algorithm in Nigeria while using RDTs.

pandemic and aids vaccine development [16]. Immunological testing is based on the quantification and detection of antigen and antibody interactions. Biosensors use selectivity features of a bimolecular and sensitivity of physiochemical transducers in COVID-19 testing. Rapid Diagnostic Techniques (RDTs) are new technologies which apply some of the above mentioned techniques to achieve shortest turnaround time and accessibility. Although each method has its advantages and disadvantages, it is advisable to employ at least two methods [15, 17–19] for quality medical laboratory testing especially when using RDTs as shown in **Figure 2**.

6. Medical laboratory interventions in COVID-19

As part of the global response to the COVID-19 pandemic, medical laboratory diagnosis has remained the corner stone to this intervention. Molecular assays performed on nasopharyngeal swab or other upper respiratory tract specimen are the most commonly used and reliable test for the diagnosis of COVID-19. A variety of RNA gene targets are used by different molecular assays.

The processes from sample collections, sample transport and actual testing for COVID-19 remains very important including all quality system measures put in place to ensure reliability and sensitivity. The medical laboratory research uses samples from nasopharyngeal swabs, oropharyngeal swabs, throat swabs, saliva, sputum, bronchoalveolar lavage fluid, conjunctival swabs, rectal swabs, whole blood, serum/plasma, stool, and urine [15].

It is evident that medical laboratory parameters have been adequately employed to access diagnosis like increased neutrophil, aspartate aminotransferase, alanine aminotransferase, C-reactive protein, lactate dehydrogenase and urea. There is also decrease in procalcitonin, albumin, and white blood cells like leukocytes, and lymphopenia and eosinopenia have been noted among COVID-19 patients. Also, medical

laboratory parameters have been employed in the assessment of the severity of the COVID-19 such as interleukin-6 (IL-6), d-dimer (d-D), glucose, fibrinogen, thrombin time, and C-reactive protein and fibrinogen. Some parameters are predictors during prognosis like IL-6 and D-Dimer, absolute lymphocyte count, lactate dehydrogenase, creatine kinase and absolute monocyte count which can predict whether the patient can be admitted into intensive care unit or not. During treatment, laboratory parameters are used to assess improvement in treatment and complications. For example; reduction in aspartate aminotransferase, alanine aminotransferase, creatine kinase and dehydrogenase shows response to treatment while increased procalcitonin and C-reactive protein indicates liver abnormality, high D-dimer, fibrinogen, prothrombin time predicts thromboembolism and new-onset renal failure [17, 20].

A medical laboratory, irrespective of location, modern, sophisticated or molecular in nature in the aspect of COVID-19 fight, has a huge role to play especially in the local certain where COVID19 testing has not reached. Many in such area may not know their status and no wonder the presence of a knowledgeable Scientist shall corroborate the medical laboratory implications of COVID-19 to be able to approach every client and sample in a safe and professional way.

There is always a manual that help members, states and partners as they set up comprehensive quality assurance measures for COVID-19 testing laboratory network. The guidance emphasizes the use of standardized registration formats as quality tool, Quality control (QC), enrollment of laboratories in external quality assessment (EQA) schemes and issues of external quality assessment performance data for continuous quality improvement of COVID-19 testing laboratories. It is an essential resource for a medical laboratory personnel to be involved in day-to-day testing of COVID-19.

Figures 2 and **3** shows testing Algorithm for Nigeria while using RDTs and approved medical laboratories (75–25 Gene Xpert and 50 PCR Labs) for COVID-19 respectively as released by Nigeria Centre for Disease Control (NCDC).

In medical laboratory testing of COVID-19, each country adopts their protocol based on targeted proteins as it suits them based on available testing techniques and methodology and as well the laboratory set ups and environment. For instance,

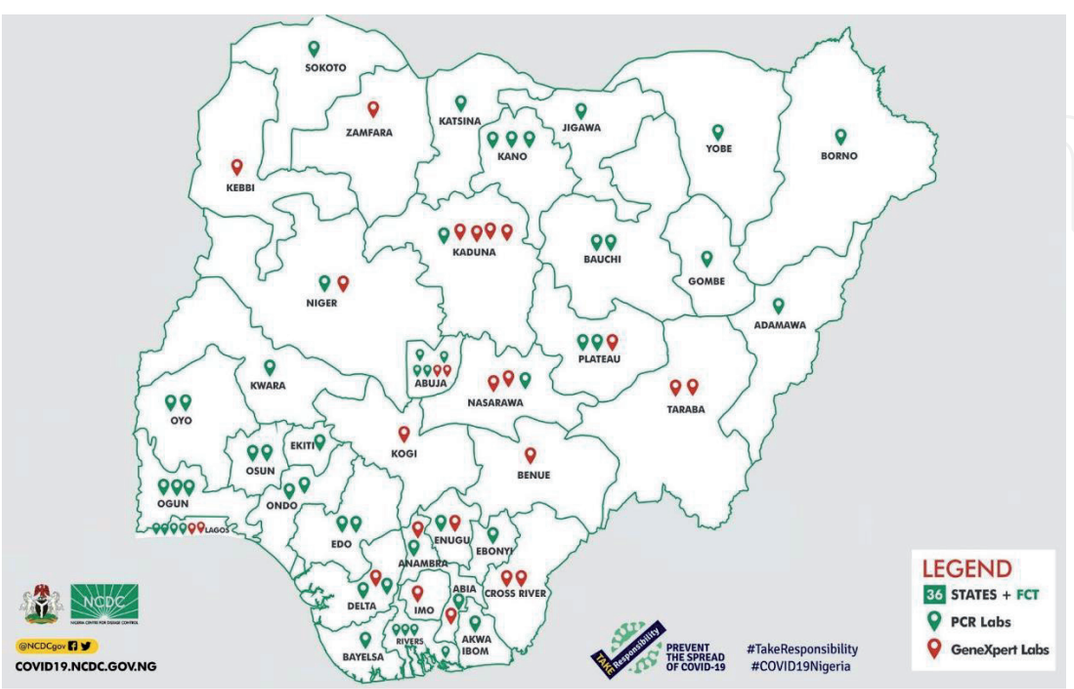


Figure 3.
NCDC approved medical laboratories for COVID-19 as at 23rd February, 2021.

USA protocol for testing targets N (N1, N2, N3) genes and Rp-RNase; China targets ORF 1ab and N-genes, Nigeria targets N-genes and ORF 1ab; Germany RdRp, E and N-genes, Japan and Thailand targets N-genes while Hong Kong targets ORF 1b-nsp-14 and N-genes [15, 17].

7. Recognition of medical laboratory professionals during COVID-19

The world biomedical day of 2020 awareness was solely dedicated to medical laboratory professionals across the globe because of their unique role in COVID-19.

In Nigeria and other countries, the emphasis on Testing is more of the recognition of the medical laboratories and professionals who toil to discover, test, monitor and research further towards COVID-19 elimination. Usually, medical laboratory professionals are not noticed for their great contribution to healthcare. They are rarely seen by people for their heroic contribution to patients' healthcare but cannot be underestimated as they perform series of tests that are crucial to ensuring accurate diagnosis and treatments that can help save patients' lives.

Medical laboratory professionals play a critical role in the diagnostics and testing of COVID-19 which they perform every day. A collaborative committee of 17 medical organizations including American Society for Clinical Laboratory Science (ASCLS), Association of Medical Laboratory Scientists of Nigeria (AMLSN) and American Society of Microbiology (ASM) in the year 2020 helped to coordinate the celebration of annual Biomedical science day in April, 2020 to increase public understanding of and appreciation for clinical laboratory personnel as COVID-19 rages worldwide [21]. Such recognitions usually come from government, organizations or various individuals all over the world.

Laboratory professionals use specialized instruments and techniques to analyze patient samples, such as blood, urine, body fluids, tissues and stool. They may be in a laboratory located in the hospital where the patient may be hundreds of miles away in a reference laboratory, however, no matter their distance to the patient, they produce results that directly affect the patient care. In addition to their day to day activities, laboratory professionals tackle threats to our national security and health such as disease outbreaks. They have played critical roles in fight against COVID-19. These effort have been appreciated by many governments across the globe [22, 23].

"We really need to hail the pathologist, medical technologists, and other laboratory professionals who are becoming unsung heroes of the COVID-19 pandemic" [21].

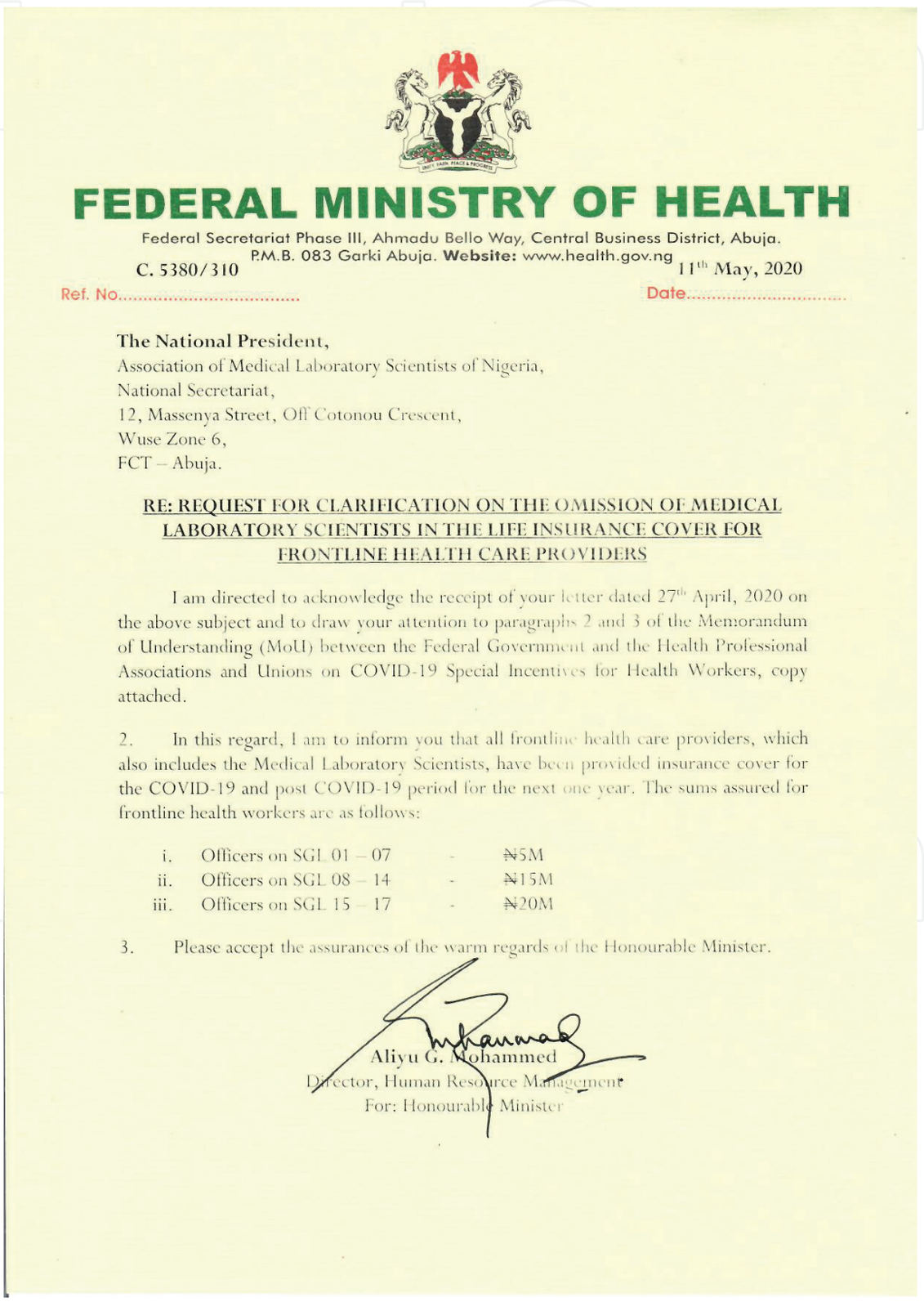
Now more than ever, is the chance for people all round the world to thank our unseen medical laboratory heroes and heroines. Each year medical laboratory professional's week celebrates the people who provides critical diagnostic information to help save lives and shows appreciation for the vital work they performed. Across the world, everyday people are applauding the brave health care workers on the front lines of the COVID-19 pandemic.

8. Effort towards protection of medical laboratory and other health workers during COVID-19

Protecting Health Care Workers (HCWs) during routine care of suspected or confirmed COVID-19 patients is of paramount importance during the pandemic. The protection ranges from adequate provision of personal protective equipment to provision of temporary accommodation to carter for during testing and treatment of COVID-19 patients outside homes, Life insurance packages, Special Hazard Allowances and other allowances and Commencement of Vaccination among

laboratory professionals/healthcare workers. In Nigeria, life insurance to medical laboratory scientists during the COVID-19 was given by the government through the Federal Ministry of Health (FMOH) as seen in **Figure 4** as a clarification that the profession is among the front line healthcare workers targeted in the programme.

Countries may differ in their approach to laboratory and healthcare workers protection and care during the COVID-19 as documented by several authors [24–30] and analyzed in **Table 2**. Such support may involve mental health support provided



FEDERAL MINISTRY OF HEALTH

Federal Secretariat Phase III, Ahmadu Bello Way, Central Business District, Abuja.
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C. 5380/310 — 11th May, 2020

Ref. No..... Date.....

The National President,
Association of Medical Laboratory Scientists of Nigeria,
National Secretariat,
12, Massenya Street, Off Cotonou Crescent,
Wuse Zone 6,
FCT – Abuja.

RE: REQUEST FOR CLARIFICATION ON THE OMISSION OF MEDICAL LABORATORY SCIENTISTS IN THE LIFE INSURANCE COVER FOR FRONTLINE HEALTH CARE PROVIDERS

I am directed to acknowledge the receipt of your letter dated 27th April, 2020 on the above subject and to draw your attention to paragraphs 2 and 3 of the Memorandum of Understanding (MoU) between the Federal Government and the Health Professional Associations and Unions on COVID-19 Special Incentives for Health Workers, copy attached.

2. In this regard, I am to inform you that all frontline health care providers, which also includes the Medical Laboratory Scientists, have been provided insurance cover for the COVID-19 and post COVID-19 period for the next one year. The sums assured for frontline health workers are as follows:

i. Officers on SGL 01 – 07 - ₦5M
ii. Officers on SGL 08 – 14 - ₦15M
iii. Officers on SGL 15 – 17 - ₦20M

3. Please accept the assurances of the warm regards of the Honourable Minister.

Aliyu G. Mohammed
Director, Human Resource Management
For: Honourable Minister

Figure 4.
Medical laboratory scientists clarified as frontline health workers covered for life insurance during COVID-19.

S/N	Countries	Government/employee support programme packages												
		Mental health	Salary	Childcare	COVID-19 allowance	Insurance	Food	Transport	Accommodation	CPD Units	Online training	Spiritual/ prayers	Social/ music & dancing	Authors
1	Australia	A	A	A	A	A	A	A	A	NS	A	NS	A	[28]
2	Bulgaria	A	A	NA	A	NS	NS	NS	NA	NS	A	NA	A	[27]
3	Canada	A	A	NA	A	NS	NS	NS	NA	NS	A	NA	A	[24]
4	China	A	A	NS	A	NS	NS	NS	NS	NS	A	NA	A	[30]
5	Denmark	A	A	A	NA	NS	NS	NS	NS	NS	A	NA	A	[27]
6	Finland	A	A	NA	NA	NS	NS	NS	NS	NS	A	NS	A	[27]
7	France	A	A	A	A	NS	NS	NS	NS	NS	A	NS	A	[27]
8	Germany	A	A	A	A	NS	NS	NS	NS	NS	A	NS	A	[27]
9	Ghana	A	A	NS	A	A	NS	NS	A	NS	A	A	A	[29]
10	Israel	A	A	A	NA	NS	NS	A	A	NS	A	A	A	[27]
11	Lithuania	A	A	A	A	A	A	A	A	NS	A	A	A	[27]
12	Malta	A	A	A	A	NS	A	A	A	NS	A	A	A	[27]
13	Nigeria	A	A	NA	A	A	P	NS	A	NA	A	A	A	
14	Romania	A	A	A	A	NS	A	A	A	A	A	A	A	[27]
15	UK	A	A	A	A	NS	A	NS	A	NS	A	NS	A	[27]
16	USA	A	A	A	A	NS	A	NS	A	NS	A	A	A	[24]

KEY: A, Available; NA, Not available; NS, Not sure; P, Partial.

Table 2.
Employee support (assistance) programmes by some countries for COVID-19.

by psychiatrists and psychologists to medical laboratory staff and other healthcare workers working on the frontline which may be in form of counseling or in-house psychologists outreach.

Employee support programme (ESP) or employee assistant programme (EAP) cannot be exhausted and depends on the government, private institutions or the healthcare workers involved. The list may include: mental health, salary, childcare, COVID-19 allowance, insurance, food, transport, accommodation, continuous professional development (CPD) units, online training, spiritual support in form of prayers, social lives using music and dancing and others as may be necessary.

Financial support, payment of salaries and job retention for Medical Scientists and other healthcare workers is a sine qua non, so that healthcare workers who were required to stay at home on preventive quarantine or levels of exposure are protected to receive their basic pay and class/grade allowances. Special allowances for COVID-19 are paid to frontline workers in Nigeria and other countries.

9. Conclusion

No doubt the COVD-19 is now a pandemic and the virus is really testing the resilience of our health delivery system. Medical laboratory science as the bedrock of diagnostic medicine and the role of medical laboratory science in containing any pandemic cannot be relegated to the background, not now or in the future. There is an urgent need to re-strategize in the effort towards fighting COVID-19 especially with regards to medical laboratory diagnosis as well as major component in infectious disease control globally.

All healthcare providers remain in the dark until the release of the medical laboratory test result on any new public health challenge COVID-19 as an example. Quality tools/equipment and conducive working environment provides quality results during public health challenges as noted during this COVID-19 pandemic.

The development of local medical laboratories to international standard are very germane to politicians as COVID-19 discourages medical tourism. Medical laboratories could do better with motivational packages such as recognition, hazard allowances and life insurance policies.

Severe Acute Respiratory Syndrome coronavirus-2 (SARS-COV-2) infection is a global pandemic. Health care workers role in patient management is predisposing and can serve as the means of hospital and community transmission.

Vast majority of health care workers are taking precautionary measures such as avoiding crowded places, washing of hands and the use of personal protective equipment (PPE) against coronavirus infection. This knowledge and attitude of health care workers shows excellent knowledge and possessed a positive attitude and good health practice towards the prevention of COVID-19. It is recommended that health care education of health care workers should continue in order to prevent and control infection.

Medical laboratory testing is very vital in public health emergencies [19] and in COVID-19 in particular thereby encouraging medical laboratory strengthening [31, 32], towards overcoming all laboratory associated challenges in COVID-19 [33–36].

This chapter hereby recommends the following:

a. Healthcare providers should always rely on the medical laboratory testing results in all public health issues and not only on COVID-19

b. There is need to update and quality crosscheck of all COVID-19 testing kits and equipment

c. Adequate construction and update of medical laboratory facilities in use for COVID-19 and other public health issues

d. Institutions involved in COVID-19 should sort for scientific and empirical data for all public health issues and vaccination as guide to public health policies

e. Government should provide and pay good hazard allowances and life insurance to all medical laboratory professionals

f. Train and retrain all medical laboratory professionals to be at the same pace with any upcoming wave of COVID-19

g. Adequate policies should be employed to stem out various challenges affecting optimum performance of various medical laboratories across the globe

h. Knowing fully well that Scientists contributed to the vaccine production research, it should be most appropriate that COVID-19 antibody testing should be carried out on individuals before vaccination to determine status. Not only that, various medical laboratory parameters should be carried out on all that are receiving vaccine before and after vaccine administration to help track changes and monitor health status of individuals who have received the vaccine candidates available currently for COVID-19.

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Conflict of interest

The authors declare no competing interests.

Notes/Thanks/Other declarations

Obeta M. Uchejeso conceptualized the Chapter, All authors contributed equally in the chapter manuscript preparation, editing and approved the final manuscript for submission.

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References

[1] Obeta MU, Maduka KM, Ofor IB, Ofojekwu NM (2019). Improving Quality and Cost Diminution in Modern Healthcare Delivery: The Role of the Medical Laboratory Scientists in Nigeria. International Journal of Business and Management Invention (IJBMI), 08(03) 08-19.

[2] Obeta MU, Maduka MK, Ejinaka OR. (2020). Medical Laboratory Science; the Distortion of Nomenclature across the Globe. New Zealand Journal of Med. Lab. Science. Pg 52

[3] Zhu N, Zhang D, Wang W, et al. (2019). A novel coronavirus from patients with pneumonia in China, 2019. N Engl J Med 2020; 382:727-733.

[4] Etukudoh NS, Ejinaka RO, Olowu FA, Obeta MU, Adebowale OM, Udoudoh M P. (2020). Coronavirus (COVID-19); Review from A Nigerian Perspective. Am J Biomed Sci & Res. - 9(1). DOI: 10.34297/AJBSR.2020. 09.001347

[5] WHO (2020). Director-General's opening remarks at the media briefing on COVID-19 – 11March 2020. https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-oncovid-19---11-march-2020

[6] Nassiri N (2020) Perspective on Wuhan Viral Pneumonia. Adv in Pub. Health, Com and Trop Med: APCTM-106. Kosmos Publishers.

[7] WHO (2020) Laboratory testing for coronvirus disease 2019 (COVID-19) in suspected human cases interim Guidance.

[8] Ozuruoke DFN (2014). History of Medical Laboratory Science: Nigerian Perspective. Pundit Publishers, Lagos

[9] NCDC (2020). Guidance on the Use of Antigen Rapid Diagnostic Kits for Diagnosis of SARS-COV-2 Infection in Nigeria. Accessed on 28th October, 2020 from www.ncdc.gov.ng

[10] Obeta MU, Ejinaka RO, Ofor IB, Ikeagwulonu RC, Agbo E C, Abara US. (2020). "Nigerian COVID-19 (Coronavirus) Patients Update, the Realities with Medical Laboratory Diagnostic Sites." American Journal of Epidemiology and Infectious Disease, vol. 8, no. 1 (2020): 13-15. doi: 10.12691/ajeid-8-1-3.

[11] Sheikhzadeh E, Eissa S, Ismail A, Mohammed Zourob M. (2020). Diagnostic techniques for COVID-19 and new developments. Talanta 220 https://doi.org/10.1016/j.talanta.2020.121392

[12] Bamidele JA and Rana KM (2020) Challenges of healthcare delivery in the context of COVID-19 Pandemic in Sub-Saharan Africa. Iberoamerican Journal of Medicine 02 100-109 http://doi.org/10.5281/zenodo.3755414

[13] MLSCN (2020). Press Release on the pre-market validation of COVID-19 test kits. Accessed on 15th October, 2020 from www.mlscn.gov.ng

[14] WHO (2004). Laboratory biosafety manual, third edition. Geneva: World Health Organization; 2004.

[15] Obeta M. Uchejeso, Nkereuwem S. Etukudoh, Okoli C. Chukwudimma (2021). Nigerian Medical Laboratory Diagnosis of COVID-19; from Grass to Grace as Chapter 5 of Intelligent Computing Applications for COVID-19: Predictions, Diagnosis, and Prevention (Ed.) Saba and Rehman, CRC Press Tailor and Francis Group

[16] Lu R, Zhao X, Li J, Niu P, Yang B, Wu H, Wang W, Song H, Huang B, Zhu N, Bi Y, Ma X, Zhan F, Wang L, Hu T, Zhou H, Hu Z, Zhou W, Zhao L,

Chen J, Meng Y, Wang J, Lin Y, Yuan J, Xie Z, Ma J, Liu WJ, Wang D, Xu W, Holmes EC, Gao GF, Wu G, Chen W, Shi W, Tan W. (2020). Genomic characterization and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding, Lancet 395 (10224) 565-574

[17] Tomo S, Karli S, Dharmalingam K, Yadav D, Sharma P. (2020). The clinical laboratory: a key player in diagnosis and management of COVID-19. The Journal of International Federation of Clinical Chemistry and Laboratory Medicine; eJIFCC2020: 31(4) 326-346

[18] Li C, Zhao C, Bao J, Tang B, Wang Y, Gu B. (2020).Laboratory diagnosis of coronavirus disease-2019 (COVID-19). Clinica Chimica Acta 510: 25-46 https://www.who.int/csr/don/05-january-2020-pneumoniaof-unkown-cause-china/en/

[19] Kiros T, Kiros M, Andalem H, Hailemichael W, Damite S, Eyayu T, Getu S, Tiruneh T. (2020). Laboratory Diagnosis of COVID-19: Role of Laboratory Medicine. J Clin Chem Lab Med. 3.142. DOI: 10.35248/clinical-chemistry-laboratory-medicine.20.3.142

[20] Ikeagwolunu RC, Obeta MU, Ugwu IN (2020). Systematic review of laboratory parameters predicting severity and fatality of COVID-19 hospitalised patients New Zealand Journal of Medical Laboratory Science; 74: 165-180

[21] ASM (2020). Celebrating Medical Laboratory Professionals – We Save Lives Every Day. ASM

[22] Darkdaily (2020). Clinical Laboratory Scientist in British Columbia Gets Recognition for Identifying the Province's First Case of COVID-19. https://www.darkdaily.com/clinical-laboratory-scientist-in-british-columbia-gets-recognition-for-identifying-the-provinces-first-case-of-covid-19/

[23] Rohde R. (2020). Beating Pandemics like COVID-19 requires more Medical Laboratory Professionals. https://www.forbes.com/sites/coronavirusfrontlines/2020/04/22/beating-pandemics-like-covid-19-requires-more-medical-laboratory-professionals-this-virologist-explains/amp/

[24] AHA (2020). COVID-19: Caring for Our Health Care Heroes during COVID-19. American Hospital Association

[25] WHO (2020). Health workforce policy and management in the context of the COVID-19 pandemic response; Interim guidance. WHO/2019-nCoV/health_workforce/2020.1

[26] Kirk AK, Brown DF (2003). Employee assistance programs: A review of the management of stress and wellbeing through workplace counselling and consulting. Australian Psychologist 38(2); 138-143 DOI: 10.1080/00050060310001707137

[27] Williams GA, Scarpetti G, Bezzina A, Vincenti K, Grech K, Kowalska-Bobko I, Sowada C, Furman M, Gałązka-Sobotka M, Maier CB. (2020). How are Countries Supporting their Health Workers during COVID-19? Eurohealth; 26(2) 59-64

[28] KPMG (2021). COVID-19 Assistance Programme at a Glance.

[29] AFDB (2020). Ghana COVID-19 RESPONSE SUPPORT PROGRAMME APPRAISAL REPORT RDGW/ECCE/AHHD/ECGF/PGCL DEPARTMENTS accessed on 27th March, 2021 from: https://www.afdb.org/sites/all/libraries/pdf.js/web/viewer.html?file=https%3A%2F%2Fwww.afdb.org%2Fsites%2Fdefault%2Ffiles%2Fdocuments%2Fprojects-and-operations%2Fghana_-_covid-19_response_support_programme_-_project_appraisal_report.pdf#page=1&zoom=auto-13,842

[30] Lu Q, Cai Z, Chen B, Liu T. (2020). Social Policy Responses to the Covid-19 Crisis in China in 2020. International Journal of Environmental Research and Public Health; 17, 5896; doi:10.3390/ijerph17165896

[31] Naidoo D, Ihekweazu C. (2020) Nigeria's efforts to strengthen laboratory diagnostics – Why access to reliable and affordable diagnostics is key to building resilient laboratory systems. Afr J Lab Med. 2020;9(2), a1019 https://doi.org/10.4102/ajlm. v9i2.1019

[32] Bayot ML, & Sanchez RS. (2020). Coronavirus disease (COVID-19) testing using the GeneXpert System: A technical guide on laboratory systems strengthening for COVID-19 pandemic response. 1st Edition. Coach MLB Consulting. Metro Manila, Philippines.

[33] Tang YW, Schmitz JE, Persing DH, Stratton CW. (2020). Laboratory diagnosis of COVID-19: current issues and challenges. J Clin Microbiol 58:e00512-e00520. https://doi.org/10.1128/JCM.00512-20

[34] Abdullahi IN, Emeribe AN, Akande AO, Ghamba PE, Adekola HA, Ibrahim Y, Dangana A. (2020). Challenges of COVID-19 testing services in Africa J Infect Dev Ctries 2020; 14(7):691-695.

[35] Akinyemi KO, Fakorede CO, Anjorin AAA, Abegunrin RO, Adunmo O, Ajoseh SO, Akinkunmi FM. (2020) Intrigues and Challenges Associated with COVID-19 Pandemics in Nigeria. Health, 12, 954-971. https://doi.org/10.4236/health.2020.128072

[36] Enitan SS, Akele RY, Agunsoye CJ, Olawuyi KA, Nwankiti AJ, Oluremi AS, Ofodile CA, Olayanju AO, Alaba OEG, Enitan CB (2020) Molecular Diagnosis of COVID-19 in Nigeria: Current Practices, Challenges and Opportunities. Journal of Infectious Diseases & Case Reports SRC/JIDSCR 116-129. DOI: https://doi.org/10.47363/JIDSCR/2020(1)116.