Seventh Annual Research Meeting of the Noguchi Memorial Institute for Medical Research: Viral Infections

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SUMMARY

Viral infections, ranging from the common cold to severe illnesses like HIV/AIDS, Ebola, and SARS-CoV-2, are a major public health concern. The Noguchi Memorial Institute for Medical Research (NMIMR) has a comprehensive research program on viral diseases. During the seventh annual research meeting (ARM), presentations highlighted NMIMR's role in Ghana's preparedness for epidemic-prone diseases, national surveillance, and policy support. NMIMR hosts several key centres, including the National Influenza Centre and the Regional Reference Laboratories for Polio and Rotavirus. During the COVID-19 pandemic, NMIMR established Ghana's first testing facility and expanded testing capacity through training and novel methodologies like sample pooling. The Institute has tested hundreds of thousands of samples and conducted genomic sequencing to track SARS-CoV-2 variants. NMIMR's polio laboratory, the WHO Regional Reference Lab for Africa, processes samples from several West African countries. The lab's genomic sequencing has been crucial for tracking poliovirus and informing immunisation strategies. The institute also plays a key role in monitoring viral hemorrhagic fevers (VHF), and diagnosing diseases like Lassa fever, yellow fever, and Marburg. NMIMR's research and surveillance efforts have been pivotal in shaping Ghana's response to viral diseases, ensuring timely diagnosis, effective outbreak management, and informed policy-making.

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INTRODUCTION

Viral infections cause simple diseases such as the common cold and flu and severe illnesses such as HIV/AIDS, Ebola and SARS-CoV2. Given their public health importance, the Noguchi Memorial Institute for Medical Research (NMIMR) has a vibrant research programme on viral diseases. During the seventh annual research meeting (ARM) of the NMIMR, 2022, several presentations were given on viral research done at the institute. The presentations focused on the role of the NMIMR in the preparedness of Ghana to respond to epidemic-prone diseases, supporting the national surveillance programme in the country and providing timely and reliable information and data to help manage patients, respond to outbreaks and make policies to move the country forward.

Dr. John Odom presented on the virus research and policy impacts at the NMIMR. The NMIMR started virus research in 1984, a few years after its establishment in 1979 and confirmed the first poliovirus and HIV in 1986.[1] Studies on the trivalent oral poliovirus vaccine

(tOPV) in Ghana in the early 1990s concluded that the tOPV schedule starting at birth produces better results.[2] This resulted in the global adoption of the oral polio vaccination of children at birth. Studies were also conducted to assess the immunogenicity of measles vaccines in infants[3] and the antibody response to yellow fever vaccine in Ghanaian infants.[4] Recent research has focused on influenza, Monkeypox, Respiratory Syncytial Virus, rotavirus, norovirus, SARS-CoV-2, Monkeypox, Marburg and Lassa fever. The NMIMR currently hosts the National Influenza Centre (NIC), SARS-CoV-2 Regional Africa Pathogen Genomic Initiative (APGI) Hub and National Genomic Sequencing Centre, as well as the WHO Regional Reference Laboratory for Polio Diagnosis and WHO Regional Rotavirus Reference Laboratory for virus research.

The polio laboratory at NMIMR doubles as the African region's WHO Regional Reference Polio Laboratory. Samples from suspected cases of polio and environmental wastewater samples within Ghana, Benin, Liberia, Mali, Niger, Sierra Leone and Togo are received for virus isolation and differentiation. Genomic sequencing is carried out for all detected wild and vaccine-derived polioviruses to determine the genotype and origin of the virus. Since 1996, both Indigenous and imported wild polioviruses,[5] and circulating vaccine-derived poliovirus type 2 (cVDPV2) that were ever detected in Ghana, Benin and Togo[6] were isolated and sequenced at the NMIMR polio lab. Findings from the 1996 polio work have informed the polio surveillance in the above-mentioned countries' decision-making. Notable among these are decisions to conduct national immunisation days and supplemental immunisation days on polio in these countries.

NMIMR houses the only influenza laboratory in the country, which was established in 2007 and designated by WHO as a NIC in 2010. The laboratory supports influenza surveillance through research and diagnosis of influenza cases in the country. During the H1N1 outbreak in 2009, the influenza laboratory conducted all the diagnoses and provided valuable data that guided the National Surveillance program in responding to and managing the cases. Since 2005, the laboratory has been working with the Veterinary Service Department during avian flu outbreaks to diagnose and characterise avian flu viruses to provide information to guide the control of the outbreaks. The data from the NIC is fed into the Global Influenza Surveillance Response System, which contributes to the selection of subtypes that can be used to predict the next vaccine design. Recently, the NIC has expanded its scope by integrating the detection of SARS-CoV-2, para influenza viruses and Respiratory Syncytial Virus (RSV) into influenza-like illness activities (ILI). The NIC also processes ILI and severe acute respiratory illness (SARI) samples from countries within the sub-region and conducts training and supports countries to set up their influenza laboratories. The NIC conducted training for troops in all the military barracks in the country and supported them in improving biosecurity measures at the backyard poultry.[7,8]

The emergence of SARS-CoV-2 challenged the NIC to source for reagents and to commence COVID-19 testing in February 2020 until the first two cases were confirmed in the country. The NMIMR, therefore, became the first Institution in Ghana to set up a COVID-19 testing facility to start testing for SARS-CoV-2. The initial samples throughout the country were directed to NMIMR for testing. To expand COVID-19 testing capacity, the Institute rolled out a capacity-building program to train staff from Public Health laboratories and other private laboratories to perform PCR tests. The NMIMR also introduced sample pooling, a novel method that helped clear the backlog.[9]

The Institute tested 350,579 samples with 36,53 positives in 2020, 152,009 samples with 22,012 positives in 2021 and 17,093 samples with 1814 positives in 2022. To enhance the availability of reagents and equipment for COVID-19 testing in the country, NMIMR supported the Food and Drugs Board (FDA) to evaluate PCR reagents and equipment for COVID testing for approval. NMIMR and the West Africa Center for Cell Biology of Infectious Pathogens (WACBIP) together sequenced the initial COVID-19-positive samples for the country. Since then, the NMIMR has conducted genomic sequencing to characterise the different SARS-CoV-2 variants and determine the variants or lineages in circulation during the various waves so that the country can implement the appropriate response measures. NMIMR also trained other laboratories to build genomic sequencing capacity, eventually becoming a sequencing hub for Benin, Ghana, Niger, Sierra Leone, and Togo in the sub-region, with Africa CDC providing reagents and equipment.

A nationwide age-stratified cross-sectional study was conducted in 2021 to assess the extent of COVID-19 transmission in Ghana. About 5898 Naso/oropharyngeal swabs and venous blood samples were collected, and Swabs were tested using qRT-PCR. The serum from the blood was also tested using an ELISA kit. The overall seroprevalence was 67.9%, with Greater Accra having the highest rate of 76.0%. Seroprevalence was lowest in young children and highest in teens and young adults. (5-9 years, 52.2%; 10-14, 63.9%; 15-19, 72.6%; 30-39, 72.5%).

Of the 4,003 seropositive individuals, 69.2% were asymptomatic, and 26.4% did not adhere to infection prevention guidelines. Confirmatory testing with qRT-PCR showed an overall infection rate of 7.6%. The study concluded that more than half of the population sampled was exposed to COVID-19.

Drs. Kofi Bonney, Samuel Dadzie, and Joseph Osei presented on monitoring viral haemorrhagic fevers (VHF) in both human and vector populations. The NMIMR houses the molecular testing laboratory for VHF in the country and conducts surveillance into emerging and re-emerging Aedes-borne arboviral diseases of public health importance to support the Ghana Health Service. Lassa fever, yellow fever, Dengue fever, Chikungunya, Zika, Marburg and Ebola are some of the VHF tested. With this capacity, all suspected VHF samples in Ghana and some of its neighbouring countries are diagnosed at NMIMR. Entomological monitoring and evaluation are conducted on *Aedes aegypti* and *Aedes albopictus*, the vectors responsible for transmitting some diseases.

Prof. George Armah presented the Rotavirus Vaccine Story. The NMIMR hosts the WHO Regional Rotavirus Reference Laboratory. Research and diagnosis are conducted here on rotaviruses and noroviruses. The early phase of rotavirus research in Ghana saw collaborators from Japan joining the Ghanaian team for research into the pathogen in 1973. The only diagnosis method then was by electron microscopy. The NMIMR was supported by JICA and documented the importance of rotavirus in watery diarrhoea in Ghana and the West African sub-region. The NMIMR played a major role in conjunction with other collaborators in South Africa to set up the African Rotavirus Network in 1988. The Institute also set up active rotavirus sentinel sites across Ghana and other African cities to build evidence-based data on rotavirus epidemiology, incidence and circulating strains. The rotavirus genotyping capabilities were expanded across Africa by introducing genotyping and other molecular techniques to the network. Efficacy studies on available rotavirus vaccines were performed, and the aggregated data was analysed to provide evidence for the advocacy of rotavirus vaccines. The Institute was also instrumental in the rotavirus vaccine trials in Africa, which led to good efficacy data from Africa and Asia, significantly impacting severe rotavirus gastroenteritis. The vaccination resulted in a reduction in all causes of diarrheal illness by approximately 25%. There was also cross-protection against other rotavirus strains. Our studies further showed vaccine efficacy was lower (50-64%) in developing countries (Ghana, Kenya, Malawi, Mali) with higher mortality rates. The determinants for vaccine introduction were therefore communicated, and policymakers, public health workers and the Ministry of Health (MoH) were consulted. The rotavirus vaccine was finally introduced in Ghana in 2012 [10] alongside Botswana, Malawi and Tanzania for the RVI vaccine. With the introduction of the rotavirus vaccine in Ghana, the number of cases has reduced drastically (49% reduction in hospitalisation).

CONCLUSION

In conclusion, NMIMR has been pivotal in advancing viral disease research, surveillance, and public health interventions in Ghana and the African region. Through extensive studies on various viral infections, including polio, influenza, SARS-CoV-2, and viral hemorrhagic fevers, NMIMR has significantly contributed to disease control and prevention efforts. Work on vaccine efficacy and diagnostics has informed national and international health policies, leading to improved health outcomes. As NMIMR continues to innovate and expand its research capabilities, it remains a cornerstone in the fight against viral diseases and a vital resource for public health in Ghana and Africa.

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