

Overcoming the Challenges of Early Infant Diagnosis of HIV in Low- And Middle-Income Settings

¹ADENIYI DAVID S, ²OYERO STEVE K.

¹ Infectious Diseases Laboratory-APIN Center, Molecular Biology Unit, Jos University Teaching Hospital, Jos, Plateau State, Nigeria

² Pathology Department, Jos University Teaching Hospital, Jos, Plateau State, Nigeria

Abstract: The possibility of an HIV-free generation is authenticated by the many successes recorded in the EID and PMTCT programs globally. And though many children are still being infected with HIV, the Early Infant Diagnosis (EID) of HIV using the highly sensitive DNA PCR technology coupled with the early initiation of ART and co-trimoxazole prophylaxis in HIV-exposed and HIV-infected infants have gone a long way in reducing the global HIV scourge. Many national governments have failed abysmally in effectively coordinating their national HIV programs; and many still depend solely on international donor funding. These failures have led to many gaps, loopholes, and challenges being encountered in the EID-PMTCT programs. This review seeks to proffer the solutions to these all encompassing challenges facing EID of HIV and invariably paving way for the successful implementation of the PMTCT programs in Nigeria.

Keywords: Human Immunodeficiency Virus (HIV), Early Infant Diagnosis (EID), Prevention of Mother-to-child Transmission (PMTCT), Mother-to-Child Transmission (MTCT), Polymerase Chain Reaction (PCR), Antiretroviral Therapy (ART), Dried Blood Spot (DBS), Primary Healthcare Center (PHC) Ebola Virus Disease (EVD) Point of Care (POC).

1. INTRODUCTION

The debilitating effects of the Human Immunodeficiency Virus (HIV) on the global public health system are no longer a new piece of information. And the rampaging impact of HIV on the individual, families, and communities gives us a sober outlook on the race we have against time in saving our future generations. In Nigeria, about 360,000 children were living with HIV in 2011¹. Over 90% of HIV infections among children occur through Mother-to-child Transmission (MTCT)². And though there has been a steady declining rate of HIV infection among pregnant women at some delivery settings³⁻⁴, which is an encouraging development in the Prevention of Mother-to-Child Transmission (PMTCT) of HIV programs, yet, MTCT of HIV can also occur in utero and postnatally from breastfeeding⁵.

In a meta-analysis of some studies conducted in untreated infants at sub-Saharan Africa, Marston M, et al, estimated a 52% and a 78% survival rates for infants infected perinatally and during breastfeeding respectively; and also with 20% having died by 90 days⁶. In 2011, only 57% of the estimated 1.5 million pregnant women living with HIV in low- and middle-income countries received effective antiretroviral drugs to avoid vertical transmission of HIV to their children⁷. For the 21 priority countries in sub-Saharan Africa, the overall PMTCT coverage rate stood at 61% during pregnancy and at delivery with an abysmal decrease to 28% during breastfeeding⁷. And of the 65 reporting countries in 2010, only 28% of infants born to mothers living with HIV had an HIV test within the first 60 days of life⁸.

Early infant Diagnosis (EID) of HIV using Dried Blood Spot (DBS) allows for the diagnosis of HIV as early as six weeks of age. Babies diagnosed early in life stands a better chance of thriving and living a healthy life when commenced on

prophylactic antibiotics such as co-trimoxazole soon after birth and Antiretroviral therapy (ART) as soon as medically indicated⁹. The recommendation of the World Health Organization (WHO) is that all infants born from mothers who tested positive during pregnancy should have their blood samples tested for EID at four to six weeks of age¹⁰. The increase in funding by all major stakeholders and the global communities has dramatically increased the number of laboratories offering EID services in sub-Saharan Africa since 2005. There are however many concerns as to the effectiveness of many existing national programs at identifying HIV-exposed and HIV-infected infants and children and linking them in a timely manner to required care and treatment¹¹.

2. HIV DIAGNOSIS IN INFANTS AND CHILDREN

The WHO in 2010 issued the revised Recommendations on the Diagnosis of HIV infection in infants and children¹⁰. But while early diagnosis of HIV infection is essential for the prompt commencement of ART¹², and consequently affording the infants and children a better chance at surviving childhood and living a long, healthy life⁹, only polymerase chain reaction (PCR) is the most accurate diagnostic method of choice for all infants and children below 18 months of age.

Serologic tests are not useful in these children because of the persistence of maternal antibodies in infants¹³. PCR tests directly for the Human Immunodeficiency Virus DNA rather than the HIV antibody⁹. PCR tests using DBS has a proven efficacy with sensitivity of 100 percent, and a specificity of 99.6 percent¹⁴. The introduction of EID technologies is an important step in the fight against HIV/AIDS; and the general use of this method of HIV diagnosis in infants will further help funding agencies, donor partners, national governments, and implementing partners in analyzing the results of national PMTCT programs.

3. HIV TREATMENT IN INFANTS AND CHILDREN

Early treatment of HIV has been proven to dramatically decrease morbidity and mortality from HIV infection¹⁵⁻¹⁷; however, it is vital and most crucial for HIV-infected infants to be diagnosed as early as possible in order to initiate life-saving treatments before the virus begins to take its toll¹⁸.

ART availability to infected children is still as low as 28%; and in 2011, 230,000 of children living with HIV globally died from AIDS-related illnesses⁷. Infants presenting with advanced disease before diagnosis is made usually stands a lesser chance of survival even when ART is initiated¹⁹. Also, despite the increasing access to ART, HIV-related mortality remains high in sub-Saharan Africa²⁰⁻²².

According to Newell ML, et al, without any therapeutic intervention, approximately one-third of HIV infected infants will die before the age of one year; and half will not survive until their second birthday²³. Violari A, et al also indicated a tremendous increase in survival if HIV-infected children have access to early EID and ART¹².

4. OVERCOMING THE CHALLENGES OF EARLY INFANT DIAGNOSIS OF HIV

Myriads of challenges confront the EID and PMTCT programs especially in Africa^{18, 24-27, 29}. But the many successes also recorded^{4, 9, 13, 26-28, 30}, produces a resounding echo of hope for the future. DBS testing using PCR allows for diagnosis of HIV as early as six weeks of age⁹ although an earlier age of testing is been strongly advocated as the first testing at six weeks of age may be a little late³¹

The last 10 years has seen remarkable progress in the implementation of the PMTCT programs²⁸ and this is despite all the well documented challenges confronting the EID program^{18, 24-27, 29}. Thus it is essential that accurate and timely EID of HIV infection in infants and children is done in order to ensure the prompt initiation of ART in eligible infants and children. By this, the PMTCT program can also be adequately evaluated and better managed. The EID program like many other evolving programs has many challenges; but these obstacles can be overcome with patience, tenacity, and well structured organized planning. The followings are some of the ways in which these challenges can be overcome:

1. Adequate training of Healthcare Personnel: The specialized training of healthcare workers and most especially Medical Laboratory personnel in molecular diagnostic techniques, and in the use of the advancing medical diagnostic technologies available to the effects of EID of HIV is of paramount importance in our quest for success in the PMTCT programs. Most training in this highly sensitive area of laboratory medicine is solely sponsored by donor funding partners

like the Center for Disease Control and Administration (CDC). The trainings are almost always limited to a few specialized personnel who are usually overworked since the majority of other healthcare workers have little to no knowledge about molecular diagnostics techniques and methods.

It is strongly advised that molecular biology and its varying diagnostics and research techniques be as a matter of urgency, introduced as a course into all medical programs in Nigeria. The few healthcare workers with adequate knowledge in this field of medical diagnostics should endeavor to step down the knowledge. There should be regular on the job trainings of other healthcare personnel; and collaborating partners and national governments should provide more funding for the continuous education and trainings of more healthcare personnel towards carrying out these specialized diagnostic techniques. Also of major importance are the training of Medical Laboratory Technicians and Assistants in the methods of good DBS sample collection, packaging, and storage from neonates, infants, and children respectively.

2. Sample transportation: Poor transportation networks create a huge gap leading to long turnaround time between the date of sample collection and the date results are returned to sending sites. Many losses to follow-up are occasioned by this excessively long turnaround time. Samples meant for EID are sometimes piled up for several weeks and even months before been sent to the Central PCR Laboratories for assay. Many HIV-infected infants would have died by the time some of these samples are reaching the referral laboratories. Some of the HIV-infected infants would already be on hospital admission beds presenting with HIV-related end stage diseases and symptoms; while some would have started showing clinical signs and symptoms of HIV infection before their samples gets to the PCR Laboratories for diagnosis.

Bad road networks especially from the interior rural areas where most of the Primary Healthcare Centers (PHC) are located in Nigeria constitute a very huge challenge to the success of the EID and PMTCT programs.

Thus the national government needs to do more in the construction of good roads and communication networks. More vehicles should be made available for the PMTCT and EID programs. All general hospitals in all major towns should become hubs to which proximal rural healthcare centers and other healthcare facilities can bring their EID samples and also refer their EID cases. Motorcycles should be provided for EID and PMTCT rural healthcare workers in order to facilitate the ease of transportation of these samples to the various designated hubs. Also, primary healthcare centers (PHC) and other smaller healthcare facilities where EID services are rendered can make use of the Express Mail Delivery Services (EMS) of the Nigerian Postal Service for safe, fast, and secured delivery of DBS samples to PCR Laboratories.

3. Integrating EID into Immunization Programs: An effective EID service should be able to identify all HIV-exposed infants and their mothers, make available HIV testing services to them, and promptly refer their test results to the appropriate caregiver in a timely manner¹⁸. The success recorded in the National Program on Immunization (NPI) should be translated into successes in the EID and PMTCT programs respectively. But these successes will only be made a reality if HIV screening and testing services are made available to all babies and their mother's at the times of immunization visits.

The government could make new policies and design a new HIV screening protocol to this effect. Also, a very strong and robust referral system should be put in place for the effective management, follow-up, and monitoring of all HIV-exposed and all HIV-infected infants, children, and their mothers.

4. Prompt Initiation of ART for HIV-infected Infants: Failure to identify HIV-exposed or subsequent HIV infection in children has led to the lack of initiation of ART in many HIV-infected infants¹⁸. Many of these HIV-positive infants are brought in for hospital admissions at the point of disease presentation; at which point their chances of survival have been markedly reduced.

Although it has been argued that the early initiation of ARV especially nevirapine in HIV-infected children could lead to the development of some nevirapine-resistant strains of HIV³², which could definitely be a downside to the benefits of early initiation of ART in HIV-infected pediatrics, the greater chance at life, given to these precious infants and children should never be overlooked. Thus the prioritization of the quick and timely notification of infants HIV-positive test results and the prompt referral of such infants for immediate ART initiation is of utmost importance.

5. Effective Referral Programs: A poor and weak referral linkage has been one of the major challenges to the success of the EID program. Sometimes children shows signs and symptoms of HIV infection; but inadequate documentation and

incorrect filling of relevant EID of HIV request and referral forms have led to many HIV-infected children not being diagnosed; and hence, the subsequent death of these children been almost always ascribed to other forms of infection or disease conditions.

The pediatrics HIV infection referral gap in Nigeria is so wide as compared to that of HIV-infected adults. Thus many infants have died of HIV-related illnesses without being diagnosed of HIV. This is largely because they were never given the chance or benefit of being tested for HIV. It is therefore imperative that healthcare workers and most especially those at pediatrics units be effectively and adequately trained on the acts of proper referral linkages as soon as they suspect a child of being HIV-positive. These trainings should include proper documentation as per the filling of registers, EID referral and request forms, the lines and hierarchy of communication between healthcare facilities, means and modes of communication, and mechanisms for feedbacks and correspondence. A positive attitudinal change towards documentation should also be imbibed by healthcare workers.

6. Adequate Data Management System: It has been affirmed that the lack of national standardized and comprehensive data tools; and inadequate staff training on how to correctly use these streams of data, has prevent a reliable monitoring and evaluation of the EID program at sites, states, and national levels; this has invariably resulted in the limited quality improvement activities¹⁸.

The need for a national EID register and the harmonization of the national EID database is of paramount importance in our match towards an effective EID program. Data managers should be adequately trained and equipped with all the needed data management tools at all EID sites and at the national level. An effective link should also be initiated between the EID database, the PMTCT, and the pediatrics ART programs.

7. Effective Tracking of Patients: It is a well known fact that many HIV-positive mothers give false names, false contact addresses, and false contact phone numbers in order to avoid being contacted by healthcare workers. This willful act of deception is borne either out of sheer fear, self denial of their HIV status, or perhaps just another measure to avoid being stigmatized by friends, neighbors, and other relations. Others whose HIV-exposed babies have been confirmed to be HIV-positive refuse bringing their infants to the pediatric ART clinics. These all as a matter of fact boils down to a lack of proper knowledge and an understanding of the consequences of their actions.

All these acts on the part of some of these HIV-positive mothers are also borne out of ignorance as to the greater risk and disadvantages they are putting themselves and their babies into. It therefore strongly advised that the use of “expert patients”³³ be encouraged for a more robust and positive shift in the HIV-positive mothers and infants tracking paradigm. These “expert patients being HIV-positive themselves can be better able to relate with other HIV-positive individuals.

Also, healthcare workers attending to this group of mothers and their babies should be further trained on how to show empathy while attending to this group of patients at the ART clinics. Adequate education of HIV-positive mothers on the dangers of avoiding ART and other HIV infection care programs for both themselves and their HIV-infected babies should be emphasized. The general public and the government are not left out in the task of carrying out more community and public awareness campaigns and programs; including radio and television jingles on the dangers of discrimination and stigmatization against HIV-positive individuals. The government should also make policies to criminalize any act of discrimination or stigmatization against people living with HIV.

8. Preventing loss to Follow-up: As a general challenge with the PMTCT program, many infants are lost to follow-up at each stage of the EID program. A study has suggested a loss of about 85% in one year³⁴. Excessively long turnaround time of EID, infant’s death prior to receiving the EID test result, weak referral linkages, and long waits at clinics have all contributed to the loss to follow-up at the pediatrics HIV clinics. It should also be noted that even in a successful PMTCT program, the survival of HIV-infected infants is poor without early diagnosis, rapid initiation of therapy, and retention in care; hence, strategies to overcoming educational, cultural, and structural barriers are needed to improve patient outcome in the EID program³⁵.

Much still needs to be done in reducing the EID test turnaround time; and the mechanisms for referral linkages must also be improved upon. Death among these infants must also be reduced to the barest minimum if not completely eradicated through the use of prophylaxis and tuberculosis (TB) case-finding. There should be uninterrupted ART supplies; provision of ART regimens that are non-toxic, simple, and free at all point of care (POC) should be made available, ART

clinics should be decentralized, and the frequency of visits for stable patients should be reduced. Also, ART services should be linked with the community; hence reducing indirect patient costs and using ART services to deliver other useful interventions³⁶.

9. Providing complete care for HIV-exposed Infants: The high loss to follow-up among HIV-exposed infants especially in sub-Saharan Africa³⁷⁻³⁹ poses a very great challenge to the success of the PMTCT and the EID programs in the region. Morbidity and mortality among this group of infants remain high though many reasons and factors have been attributed to these losses⁴⁰⁻⁴³.

A comprehensive package of care should therefore be offered to these infants and their mothers. These cares should include HIV testing, co-trimoxazole prophylaxis, clinical monitoring, extensive infant feeding counseling, and appropriate ARV prophylaxis at all service sites¹⁸.

10. Revisiting the Testing Algorithm: The challenges confronting EID programs due to the new WHO, 2010 EID guidelines¹⁰ is that more loss to follow-up and deaths occurred by six weeks of age. However, diagnosing infants infected with HIV at birth through vertical transmission, have been demonstrated to have a success rate of about 76% when highly sensitive testing platforms such as the Roche® Cobas Ampliprep and Cobas Taqman (CAP/ATM) system is used for the testing⁴⁴.

According to Theo Smart, while daily nevirapine for the duration of breastfeeding protects exposed uninfected infants, this same daily dosing of nevirapine monotherapy almost certainly would lead to significant drug resistance in children who are already infected; and thus leave ART programs with little option to use more expensive *kalettra*®-based regimens³².

Emerging evidence is also now showing that multi drug usage in infant and maternal prophylaxis can cause delay in HIV diagnosis beyond six weeks of age^{31, 45}. Thus it is therefore strongly advised that the first PCR DNA testing for HIV-exposed infants be done at birth without obviating the need for the current testing algorithms.

11. HIV Screening at Delivery Settings: Usually, pregnant women who enroll for antenatal care services would normally be aware of their HIV status as this is part of the preliminary routine tests carried out at all healthcare facilities rendering antenatal services. On the other hand, a majority of pregnant women do not register for antenatal care; hence, they do not receive prenatal care. However at late pregnancy or at the point of delivery, these women present themselves at the delivery centers without knowing their HIV status. It is therefore imperative that all pregnant women presenting at labor should be screened for HIV using the antigen-antibody screening method. This rapid HIV testing method will help healthcare workers to identify HIV-exposed infants; and hence, promptly initiating the array of cares that are needed by such infants and their mothers.

A few studies have shown successes in this PMTCT approach^{4, 46}. Also, the need to re-screen pregnant women who had received pre and antenatal care at the time of delivery can not be overlooked as some of these women might have sero-converted from being HIV-negative at the time of initial antenatal screening to being HIV-positive at the point of delivery; especially if they were at the window period of the infection at the time of their initial rapid HIV screening. It is also imperative that healthcare professionals especially laboratory scientists, nurses, and medical doctors be properly trained and educated on the values and importance of correct and consistent screening of pregnant women at delivery settings. The healthcare personnel in the labor wards should also be adequately trained on the use of the rapid HIV testing methods; and how to correctly interpret such test results.

12. Community and Private Sector Participation: Many pregnant women access care services outside the more conventional public healthcare services hospitals and centers. Many go to birth attendant houses to deliver their babies due to varying superstitious beliefs. While some still patronizes the many private healthcare facilities spread across the country. The majority of these healthcare centers do not participate in the national PMTCT and or the EID programs as they have not been carried along by the national government's health policies. Too many HIV-exposed infants eventually get infected with HIV and subsequently die of HIV-related illnesses at these healthcare centers.

It is therefore of utmost urgency that all private healthcare givers, community leaders, social groups, peer groups, and religious bodies be carried along; and also functions in tandem with the global community in the common fight for an

HIV-free generation. The government needs to sponsor more social awareness campaigns. Multinational and national companies should fulfill their cooperate-social responsibilities by supporting and funding HIV-AIDS awareness and preventive programs. Schools, colleges, and universities need to increase HIV awareness among their students.

The place of private partnership in the fight against HIV cannot be overemphasized. Private hospitals, clinics, and maternity homes should as a matter of urgency be co-opted into the national PMTCT and EID programs in order to reducing the gap between the private and the public sector of our national PMTCT programs. Healthcare workers from the private sector should be adequately trained in the field of PMTCT, EID, and ART modalities. The government and their funding partners on the PMTCT and EID programs should also make funds and other essential materials available to the private sector in order to effectively empower them in their supportive roles.

A system of check and balances on the judicious use and management of funds and other materials made available for this onerous task of PMTCT should also be put in place towards ensuring the accomplishment of their intended purposes. A system of regular progress reports, monitoring, evaluation, and sheer accountability should be put in place.

13. Effective Counseling: HIV-positive mothers who were not diagnosed antenatally stand a likely chance of transmitting the HIV to their infant postnatally. It is also well known that the high post-partum attrition of infants HIV testing after the cessation of breastfeeding also put these HIV-exposed children at the risk of being infected by their HIV-positive mothers.

Studies have indicated the insufficiency of the information or the poor counseling provided to HIV-positive mothers as it relates to breastfeeding and the provision of infant formula towards achieving a safer infant feeding practices^{47, 48}. Also, very little counseling have been given to HIV-positive mothers on the possible effects of early nevirapine ART prophylaxis administration on their infants⁴⁸ especially in relation to delayed HIV detection in such infants or children^{31, 45}; and the possible development of HIV-related drug resistance³².

More counseling trainings are needed for healthcare workers involved in the counseling of HIV-positive mothers. These group of counselors need to have a deeper understanding and knowledge of the trends and developments in the field of HIV care for both HIV-positive mothers and their infants or children. Governments, together with implementing and funding partners must ensure that adequate, timely, and appropriate evidence-based counseling information are passed across to HIV-positive mothers. Only by this can the success of the PMTCT and EID programs be adequately guaranteed.

Counselors must also be absolutely objective in their counseling sessions so as to enable these HIV-positive mothers make informed decisions as it relates to the wellbeing of their babies and their personal health as well. Pregnant women must also be adequately counseled during their antenatal clinic visits as to preparing themselves for another rapid HIV screening when they come for delivery; especially for those who tested HIV-negative during their antenatal visits.

14. Dispatch of EID test Results: The time lag between the date of sample collection at the various sites, the date at which samples were received at the PCR central laboratory, the date samples were assayed or tested, and the date of test result dispatch, has greatly increased the average turn-around time of EID from between three weeks and four weeks to about two to three months sometimes. Different logistical bottlenecks lead to several weeks and sometimes months of delay – the luxury of which time lag many HIV-exposed infants do not have; as they may likely be in a race against time to surviving.

The timely and appropriate introduction of the “SMS Printer” machine for the dispatch of EID test results should go a long way in helping to reducing the EID turnaround time. Many test results that lie waiting for collection sometimes could be easily sent in text messages format to the receiving sites with the click of a button on the on the computer system. This will reduce the hassle of long distance transportation. Healthcare workers who are involved in the utilization of the “SMS Printer” should be adequately trained on its effective use. All the necessary logistical supports and modalities for the effective and smooth running of this new system of EID result dispatch should be put in place by the implementing partners. It is not just enough to purchase these new machines, but most paramount also is the training of those who are to use these new equipments for the furtherance of the PMTCT and EID programs.

15. Adequate Logistical Management System: Among the challenges facing the EID program is the problem of logistics management. In Nigeria, the poor bureaucracies and bottlenecks along the chains of supplies of kits and consumables for the successful functioning of the PCR laboratories have caused the deaths of many HIV-infected infants

not a few. Sometimes months of delay in the supply of some of these consumables and or kits has resulted in the failure to carry out EID tests. This has inevitably resulted in the long turnaround time sometimes witnessed in the release of EID test results by central PCR laboratories.

Irregular power supply and power shortages, inadequate power backups for the very expensive PCR equipments, these all constitute another major barrier to the success of the EID program.

It is therefore advised that the many bottlenecks and middle-men along the chains of supply of PCR testing kits and consumables should be eliminated; and a direct link be established between the central or national EID coordinating office and the companies producing these kits and consumables. Such that direct orders and requests for supplies of kits and consumables can be made and deliveries of consignments and acknowledgments of receipts of items can be made without delays. Annual equipment servicing and maintenance should also be carried out regularly by the equipment manufacturers sole certified representatives.

Also, all PCR laboratories should have dedicated backup power sources. Such laboratories should also be solar powered, and an electricity power inverter should be connected to the PCR machines or equipments in order to guarantee a non-stop EID of HIV services for the effective and successful implementation of the PMTCT program.

16. Collaboration between Implementing Partners: The successful implementation of the EID program will require a collaborative effort from all stake holders involved. The Federal Ministry of Health (FMOH) should be responsible for the coordination of all activities involved in the EID program. This will go a long way in harmonizing the effort of all funding and implementing partners towards providing a more robust and wholistic service delivery to those in need of these interventions.

The effective scaling-up and an accurate measure of the success of the PMTCT program can also be attained when all stakeholders harmonizes their efforts at attaining the one dream of an HIV-free generation. Research and successes should be shared and celebrated across board. Challenges should also be collectively tackled and overcome.

17. Donor Funding for EID: The general decrease in the funding for HIV programs especially on the part of international donor agencies and funding partners, is due in part to competing emerging health issues such as the Ebola Virus Disease (EVD), the global economic recession, and or, the need to making different national governments more responsible in the face of the ongoing battle against the HIV-AIDS pandemic, and also, the need for countries and implementing partners to developing a more formidable self sustenance strategies.

However, due to many years of dependence on foreign donors, many national governments have still not been able to adjust to the new concept of self sustenance and good resource management. Over the years, many national governments have defaulted in the payments of their counterpart funding towards the HIV-AIDS programs.

It is therefore imperative that all national governments fulfill their parts by paying up their counterpart funding. The human and material resources in the filed of HIV-AIDS diagnosis, care, and management, should be developed and improved upon. The annual fiscal budget should make available a tangible part of the health budget for HIV-AIDS programs. The gradual commercialization of PCR laboratories to services outside the scope of HIV-AIDS care may also help in generating funds that could be used for structural, equipment, and other maintenance services.

It should be noted that all efforts at sustaining the HIV-AIDS programs will only come to fruition when respective national governments rise up to their responsibilities and duties without shirking their jobs and tasks on the shoulders of donor agencies and supporting partners who are increasingly burdened by emerging needs and demands.

18. Use of Point of Care (POC) Technologies: In Nigeria at the present, there are no Point of Care (POC) tests available for EID testing. However, many POC technologies such as the SAMBA® point of care EID and viral load machine are anticipated to have smaller sizes, low costs per-test, a shorter turnaround time, and lower throughput requirements compared to established PCR systems like the Roche CAP/CTM.

These POC testing will increase testing for HIV-exposed infants in a timely manner, it will reduce reliance on sample transportation, it will improve prompt clinical decision making and patient retention. The use of POC testing will greatly improve EID service delivery and the coverage of the PMTCTC programs. Many of the POC technologies consume minimal power; hence, they can be powered by smaller deep cell batteries and Uninterrupted Power Supply (UPS)

machines. Also, smaller power generating sets can be used to power them. PCR point of care equipments is most suitable for clinics, rural areas, and primary healthcare centers (PHC).

Thorough and adequate trainings of healthcare personnel, especially laboratory personnel on the use of these POC technologies, correct interpretation of test results, and the management of data generated, coupled with best laboratory practices, are also of utmost importance.

19. Expanding Laboratory Capacities: Many central PCR laboratories are over stretched with the laboratory staff grossly overworked. Many centers in Nigeria have only one PCR system to run both EID and HIV viral load assays for thousands of patients. The ever increasing demand on these few available systems have led to months of equipment downtime which invariably delays the EID turnaround time. And despite the stately technological advancements employed in the use of these highly expensive equipments, their breakdowns are also as stately and they are too expensive to maintain.

There is the problem of space inadequacy in most of these laboratories. Many Scientists in these laboratories worked in cramped up spaces without offices. Many come to work as early 6a.m. and sometimes close as late as 8p.m. with very little remuneration. Also, the number of PCR and technologically trained medical scientists in Nigeria are relatively few; and with the increasing awareness of the private sector on the lucrative nature of molecular diagnostics, many of these specialized and highly trained medical scientists are being tempted to jump the ship in a search for greener pastures. This neglected but highly sensitive aspect of the national HIV-AIDS program is greatly hampering the success of the EID program, and in effect slowing down the gains of the PMTCT program.

It is therefore in the view of the author that more PCR platforms or systems should be made available to all PCR laboratories. Adequate backup equipments should also be provided for these laboratories. This will help reduce the workload on the existing platforms or systems. Larger laboratories with better work spaces should be constructed and made available to the scientists doing this HIV-AIDS diagnostics work. A conducive and spacious work environment will help improve their productivity as they can work with more freedom and less stress. Also, adequate compensation and remunerations should be made available to these scientists. Continuous education and regular trainings and attendance of update courses on evolving and advancing technologies in the field of molecular biology diagnostic methods is also essential for this group of scientists. The training of more scientists in the field of PCR technology and continuous on the job trainings is also strongly advocated.

5. CONCLUSION

Though many problems and challenges beset the EID program, yet, there are answers and solutions to these challenges. The effectiveness of these answers and solutions will inevitably tell on the success of the EID program and consequently on the overall success of the PMTCT program. Much, however depends so much on the successful harmonization of the efforts of all stakeholders involved in the HIV-AIDS programs. And as the number of HIV-infected children continues to grow due to obvious loopholes and gaps which could be concertedly fixed, provided there is the good will on the part of national governments, it is imperative therefore, that in our stride and fight towards eradicating the HIV-AIDS global pandemic from our world, we must never forget that the only legacy required of this generation is that of fostering an HIV-free generation.

Contribution of Authors: The design, literature review work, and write-up of this article are original efforts of the authors.

REFERENCES

- [1] National Agency for the control of HIV/AIDS: National policy on HIV/AIDS. Abuja Nigeria. October, 2009.
- [2] Federal Ministry of Health. National guidelines on prevention of mother to child transmission of HIV in Nigeria. National AIDS-STI Control Programme (NASCP). Abuja, 2005.
- [3] Sagay AS, Musa J, Adewole AS, Imade GE, Ekwempu CC, Kapiga S, et al. Rapid HIV testing and counseling in a northern Nigerian setting. Afr J Reprod Health. 2006 Apr; 10(1): 76-80.

International Journal of Novel Research in Life Sciences

 Vol. 2, Issue 3, pp: (16-26), Month: May - June 2015, Available at: www.noveltyjournals.com

- [4] Imade GE, Sagay AS, Musa J, Ocheke AN, Adeniyi DS, Idighri M, et al. Declining rate of infection with maternal human immunodeficiency virus at delivery units in north-central Nigeria. *Afr J Reprod Health*. 2013 Dec; 17(4 Spec No): 138-45.
- [5] Kourtis AP, Bulterys M, Nesheim SR, and Lee FK. Understanding the timing of HIV transmission from mother to infant. *JAMA*. 2001; 285: 709-712.
- [6] Marston M, Becquet R, Zaba B, Moulton LH, Gray G, Coovadia H, et al. Net survival of perinatally and postnatally HIV-infected children: a pooled analysis of individual data from sub-Saharan Africa. *Int J Epidemiol*. 2011 Apr; 40(2): 385-96. doi: 10.1093/ije/dyq255. Epub 2011 Jan 18.
- [7] Together we will end AIDS. UNAIDS. 18 July 2012 report launch. Washington DC.
- [8] UNAIDS Progress Report Summary. 2011. EID coverage rates at the end of 2011 were not reported in the more recent UNAID progress Report, 2012.
- [9] Pathfinder International. Early Infant Diagnosis of HIV through Dried Blood Spot Testing: Pathfinder International/Kenya's Prevention of Mother to Child Transmission Project. October, 2007.
- [10] WHO: WHO recommendations on the diagnosis of HIV infection in infants and children. http://whqlibdoc.who.int/publications/2010/9789241599085_eng.pdf. Geneva; 2010. Accessed 15 April, 2011.
- [11] Chatterjee A, Tripathi S, Gass R, Hamunime N, Panha S, Kiyaga C, et al. Implementing services for Early Infant Diagnosis (EID) of HIV: a comparative descriptive analysis of national programs in four countries. *BMC Public Health*. 2011 Jul 13; 11:553. doi: 10.1186/1471-2458-11-553.
- [12] Violari A, Cotton MF, Gibb DM, Babiker AG, Steyn J, Madhi SA, et al. CHER Study Team. Early antiretroviral therapy and mortality among HIV-infected infants. *N Engl J Med*. 2008 Nov 20; 359(21):2233-44. <http://dx.doi.org/10.1056/NEJMoa0800971>
- [13] Ugochukwu EF, and Kanu SO. Early infant diagnosis of HIV infection in southeastern Nigeria: prevalence of HIV infection among HIV-exposed babies. *West Afr J Med*. 2010 Jan-Feb; 29(1):3-7.
- [14] Sherman GG, Stevens G, Jones SA, Horsfield P, and Stevens WS. Dried Blood Spots Improve Access to HIV Diagnosis and Care for Infants in Low-Resource Settings. *J Acquir Immune Defic Syndr*. 2005 Apr 15; 38(5):615-7.
- [15] Chiappini E, Galli L, Tovo PA, Gabiano C, Gattinara GC, Guarino A, et al. Virologic, immunologic, and clinical benefits from early combined antiretroviral therapy in infants with perinatal HIV-1 infection. *AIDS*. 2006 Jan 9; 20(2):207-15.
- [16] Danel C, Gabillard D, Le Carrou J, Anglaret X, Moh R, Eholie S, et al. Early ART and IPT in HIV-infected African adults with high CD4 count (Temprano trial). 2015 Conference on Retroviruses and Opportunistic Infection (CROI), Seattle Washington Feb 23-26, abstract 115LB, 2015.
- [17] Bearden D, Steenhoff AP, Dlugos DJ, Kolson D, Mehta P, Kessler S, et al. Early Antiretroviral Therapy is Protective against Epilepsy in Children with Human Immunodeficiency Virus Infection in Botswana. *J Acquir Immune Defic Syndr*. 2015 Feb 2. Online edition. doi: 10.1097/QAI0000000000000563 (2015).
- [18] The Interagency Task Team (IATT). IATT Laboratory & Child Survival Working Group – Early Infant Diagnosis. GSG Mid Term Review Meeting, December 6-7, 2012.
- [19] Whitescarter J, Miotti P, Bazin B, Blesson S, Arrive E, Marquis B, et al. Low risk of death, but substantial program attrition, in pediatric HIV treatment cohorts in sub-Saharan Africa. *J Acquir Immune Defic Syndr*. 2008 Dec 15;49(5):523-31. doi: 10.1097/QAI.0b013e3181818aadce.
- [20] Obimbo EM, Mbori-Ngacha DA, and Ochieng JO. Predictors of early mortality in a cohort of human immunodeficiency virus type 1-infected African children. *Pediatr Infect Dis J*, 2004; 23:536-543.
- [21] Pillay T, Adhikari M, and Mokili J. Severe, rapidly progressive human immunodeficiency virus type 1 disease in newborns with co-infections. *Pediatr Infect Dis J*, 2001; 20:404-410.

International Journal of Novel Research in Life Sciences

 Vol. 2, Issue 3, pp: (16-26), Month: May - June 2015, Available at: www.noveltyjournals.com

- [22] Spira R, Lepage P, and Msellati P. Natural history of human immunodeficiency virus type 1 infection in children: a five-year prospective study in Rwanda. Mother-to-Child HIV-1 Transmission Study Group. *Pediatrics*, 1999; 104:e56.
- [23] Newell ML, Coovadia H, Cortina-Borja M, et al. Mortality of infected and uninfected infants born to HIV-infected mothers in Africa: a pooled analysis. *Lancet*. 2004 Oct 2-8; 364(9441): 1236-43.
- [24] Adebimpe WO. Challenges facing early infant diagnosis of HIV among infants in resource poor settings. *Afr J Reprod Health*. 2013 Mar; 17(1):122-9.
- [25] Stevens W, Sherman G, Downing R, Parsons LM, Ou C-Y, Crowley GM, et al. Role of the Laboratory in Ensuring Global Access to ARV Treatment for HIV-infected Children: Consensus Statement on the Performance of Laboratory Assays for Early Infant Diagnosis. *Open AIDS J*. 2008; 2: 17-25.
- [26] Ijotre P, Anena I, and Namanya Y. overcoming the challenges of early infant diagnosis of HIV: TASO Masindi experience. : 7th IAS Conference on HIV Pathogenesis and Treatment: Abstract no. MOPE 100.
- [27] Mercy GC, Bruno PM, Zahra PT, Ib CB, Jan G, Martha L. et al. Early infant diagnosis of HIV in three regions in Tanzania; successes and challenges. *BMC Public Health* 2013, 13:910. doi:10.1186/1471-2458-13-910
- [28] Justin M, and Kwasi T. HIV early infant diagnostic: Opportunity and challenge to prevent mother-to-child transmission of HIV. FHI 360-Degree blog post 2013. <http://degrees.fhi360.org/hiv-early-...>
- [29] Cherutich P, Inwani I, Nduati R, and Mbori-Ngachad D. Optimizing paediatric HIV care in Kenya: challenges in early infant diagnosis. *Bull World Health Organ*. Vol. 86(2), 155-160. Feb. 2008. <http://dx.doi.org/10.1590/S0042-96862008000200018>
- [30] Gbadegehin A, Adenibuyan OA, Adegbesan MA, Salu OB, and Omilabu SA. Efficacy of HIV PCR techniques to diagnose HIV in infants born to HIV infected mothers at LASUTH. *Nig Q J Hosp Med*. 2010 Jul-Sep; 20(3): 129-32.
- [31] Sherman G. Recognizing risk in HIV-exposed and HIV-infected infants and children. Diagnosing HIV infection in infants: are we there yet? 19th Conference on Retroviruses and Opportunistic Infections, Seattle. 2012.
- [32] Theo S. Early infant diagnosis for HIV: is it taking place early enough? Published: 13 March 2012. www.aidsmap.com/Early-infant-...
- [33] Karina K, and Fabian C. Tracking the rise of the “expert patient” in evolving paradigms of HIV care. *AIDS care*. 2010; 22: 21-28.
- [34] Sherman G. “PMTCT from research to reality – results from a routine service”. *S Afr Med J*. 2004; 94(4): 289-92.
- [35] Catherine M-C, Andrew V, Lydia L, Victor L, Phenyio L, Esther M. et al. Follow-up of Infants Diagnosed with HIV – Early Infant Diagnosis Program. Francistown, Botswana, 2005-2012. *CDC Morbidity and Mortality Weekly Report (MMWR)*. February 21, 2014/ 63(07); 158-160.
- [36] Harries AD. Improving access and retention in ART programs. Fifth IAS HIV Conference on Pathogenesis, Treatment and Prevention, Cape Town, South Africa, Symposium, July 2009.
- [37] Horwood C, Haskins L, Vermaak K, et al. PMTCT programme in Kwazulu-Natal, South Africa: an evaluation of PMTCT implementation and integration into routine maternal, child and women’s health services. *Trop Med Int Health*, 2010; 15: 992-999.
- [38] Manzi M, Zachariah R, Teck R, Buhendwa L, Kazima J, Bakali E, et al. High acceptability of voluntary counseling and HIV-testing but unacceptable loss to follow-up in a prevention of mother-to-child HIV transmission programme in rural Malawi: Scaling-up requires a different way of acting. *Trop Med Int Health*, 2005; 10: 1242-1250.
- [39] Ndongwe F, Muigai E, Millicent K, et al. Systems to support retention of HIV-exposed infants in care in Central and Eastern Kenya. Paper presented at: Kenya National PMTCT Implementers Meetings; July 18-20, 2011; Nairobi, Kenya.

- [40] Chopra M, Daviaud E, Pattinson R, et al. Saving the lives of South Africa's mothers, babies, and children: can the health system deliver? *Lancet*. 2009; 374: 835-846.
- [41] Nyandiko WM, Otieno-Nyunya B, Musick B, Bucher-Yiannoutsos S, Akhaabi P, Lane K, et al. Outcomes of HIV-exposed children in Western Kenya: efficacy of prevention of mother-to-child transmission in a resource-constrained setting. *J Acquir Immune Defic Syndr*. 2010; 54: 42-50.
- [42] Ioannidis JP, Taha TE, Kumwenda N, Broadhead R, Mtimavalye L, Miotti P, et al. Predictors and impact of losses to follow-up in an HIV-1 perinatal transmission cohort in Malawi. *Int J Epidemiol*. 1999; 28: 769-775.
- [43] Jones SA, Sherman GG, and Varga CA. Exploring socio-economic conditions and poor follow-up rates of HIV-exposed infants in Johannesburg, South Africa. *AIDS care*. 2005; 17: 466-470.
- [44] Lillian RR, Kalk E, Bhowan K, Berrie L, Carmona S, Technau K, et al. Early diagnosis of in utero and intrapartum HIV infection in infants prior to 6 weeks of age. *J Clin Microbiol*. 2012 Jul; 50(7): 2373-7. doi: 10.1128/JCM.00431-12. Epub 2012 Apr 18.
- [45] Shapiro DE, Balasubramanian R, Foler MG, Dominguez K, Tookey P, Masters J, et al. Time to HIV DNA-PCR positivity according to maternal/infant antiretroviral prophylactic regimen in non-breastfed HIV-infected infants in populations with predominantly non-B HIV subtype: a collaborative analysis of data from cohorts in Thailand, South Afr. IAS Conference, Rome, 2011. Oral Abstract Session-TUAB0203.
- [46] Levison J, Williams LT, Moore A, McFarlane J, and Davila JA. Increasing use of rapid HIV testing in labor and delivery among women with no prenatal care: a local initiative. *Matern Child Health J*. 2011, Aug; 15(6): 822-6. doi: 10.1007/S10995-010-0636-1.
- [47] Rea MF, DosSantos RG, and Sanchez-Moreno CC. Quality of infant feeding counselling for HIV+ mothers in Brazil: challenges and achievements. *Acta Paediatr*. 2007 Jan; 96(1): 94-9.
- [48] Chopra M, Doherty T, Jackson D, and Ashworth A. Preventing HIV transmission to children: quality of counseling of mothers in South Africa. *Acta Paediatr*. 2005 Mar; 94(3): 357-63.