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POLIOMYELITIS, VACCINES AND POSSIBLE COMPLETE ERADICATION

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ABSTRACT

Poliomyelitis commonly known as polio is one of the early 18th to 20th centuries most feared, most deadly and wide spread epidemic disease. Studies have shown that it results from infection by 3 serotypes of poliovirus leading to spectrum of clinical manifestation imprecise infection, non-specific febrile illness, meningitis, paralysis and even death. For over a century, combating efforts were made by researchers to develop a vaccine to contain spread of the viral causing disease which lead to the development of an inactivated (or "killed") polio vaccine (IPV) and oral (or "live") PV vaccine (OPV) as far back between the early 1950 to mid-1960. These 2 vaccines were developed towards preventing poliomyelitis and so far, have been officially recorded with singular dropping leading to eradication of this condition in most part of the world. Yet this disease condition remains endemic in countries like: Afghanistan, India, Nigeria and Pakistan. It has been reported in 2014 that as of 2012, more than 50% of the world's present cases occurred in Nigeria. This posted a belief that the key to complete eradication of poliomyelitis is in Nigeria. This might be due to high refusal by controversies claims based on *"unfounded rumours"* probable due to lack of in-depth knowledge of the disease and vaccine. Nigeria might be holding the key into total elimination, huge amount of money invested to identify most of the set back. Drawing a final entry strategy by findings base on a case study, issues that need to be tackled and recommendations for a complete eradication in Nigeria and the globe at large. This should include enlightenment of history behind the disease and a study into the *"unfounded rumours".*

Keywords: Poliomyelitis, Vaccine, Eradication, Controversies, Nigeria

INTRODUCTION

Poliomyelitis is a highly contagious disease commonly known as polio. It is reported to be one of the earliest 18th to the early half of 20th century most feared, most deadly and wide spread epidemic with more than 20 million recorded cases as at 1992 (Ren 1992, Ren and Racaniello, 1996, Blondel *at el*, 2005). Polio was first clinically described in 1789 by Michael Underwood, a British physician, which was later known to be caused by single strand non-capsulated enterovirus known as Poliovirus (Robertson, 1993). The virus enters its host orally and enters the cells through the process known as adsorptive endocytosis, which alters the cell surface then proceeds to the cell cytoplasm to release its viral RNA targeted cells (Ren 1992, Blondel *et al.*, 2005). The released RNA gets remodels, translates and then

replicates itself, ultimately inhibits transcription of host cell. The virus enters its host orally and has a range of symptoms with its signature traits being paralysis of one or more limbs due to viral attack of the anterior horn of the spinal cord while in extreme cases leads to death due to respiratory paralysis (Robertson, 1993, Jesus, 2007).

Combating efforts were put made by researchers in the 19th centaury to develop a vaccine in order to halt the spread of the viral causing disease which was evident in all age group at that time, although it was known to predominately affect infants in earlier years (Miller, 2004, Animal Research Success, 2012). By the early 1950, inactivated (or "killed") polio virus vaccine (IPV) was developed and immediately administrated to people. In the mid-1960, a second vaccine; an oral (or "live") PV vaccine (OPV) was developed. These two vaccines were developed to prevent the occurrence of poliomyelitis and so far have reduced the prevalence have so far been officially recorded accredited with singularly dropping (Miller, 2004 and Jesus, 2007). Effective usages of the vaccines have extremely lead to the eradication of this condition in most part of the world with the United State reported its last case was in 1979 due to infection with wild type (wt) virus (Jesus, 2007). Although the vaccine has effectively solved the problem, the question of its safety still questionable as evident with report on the virus spread from the oral vaccines.

The reported success in the effective management of the disease condition was due to extensive modern research into the molecular biology of polio virus and pathogenesis of poliomyelitis (Jesus, 2007). Not until recently, the effectiveness of the polio vaccine and vaccination schedule was successful worldwide with just few countries not declared polio free. This as reported is believed to be associated with accusation from some religions' scholars and it is one of the major reasons of its prevalence some countries. In addition to these accusations, the global polio eradication team fear of vaccine-derived polioviruses spreading especially from the laboratory and needs to be eliminated **(**The Global Polio Eradication Initiative, 2010**).**

The work of the global polio eradication team's does not end with polio eradication; but rather is presently working on post-Eradication Initiative of a multi-prolonged programme consisting of research, new product development, strategy formulation and policy development all aimed at lessen poliovirus re-introduction risk **(**The Global Polio Eradication Initiative, 2010**).**

Nigeria, being one of the reported countries with so many challenges and issues surrounding polio vaccine vaccination needs to deliberate on these issues to find lasting solution. This will serve as its own contribution towards the possible virus re-introduction prevention initiative by the Global Polio Eradication team.

This article attempts to provide a brief history of the deadly virus especially in west, its infesting and spreading mechanism, combating contributing efforts towards its global eradication with Nigeria being the key

to attaining it. As such giving a general perception to the community about polio vaccination campaigns.

POLIO VIRUS

Poliovirus is a member of the enterovirus subgroup picornaviridae family alone side agents of the common cold, foot-and-mouth disease virus, hepatitis A virus and human rhinoviruses (Blondel *et al.,* 2005, Mehndiratta *et al.,* 2014). Enteroviruses are small ether-insensitive viruses with a short RNA genome. They are temporary and stable occupants of the acid pH gastrointestinal tract (Robertson, 1993, Blondel *at el,* 2005, CDC, 2009 and Tagbo, 2013). Hogle et al. 1985 (as cited by Robertson, 1993), described poliovirus, as a small virion with 27 to 30 nm diameter containing a RNA with thin 20-sided shell surrounding the RNA composing of four virion proteins (VP1, VP2, VP3, VP4). There are three poliovirus serotypes; P1, P2 and P3 or type 1, 2 and 3, although type 2 was last detected globally in 1999 (Tagbo, 2013, Mehndiratta *et al.,* 2014). He further reported the ability of the virus to survive for weeks at room temperature and its resistance to laboratory disinfectants (ether, 70 % alcohol) (Robertson, 1993). However Minor & Bell in 1990 reported how the virus can be rapidly inactivated by heat, 0.3 % formaldehyde, chlorine, and ultraviolet light (50°C or higher) as in the case of preparing inactivated polio vaccine- IPV (Robertson, 1993 and CDC, 2009).

Polio virus is known to be one of the most understood viruses of eukaryotic cells today due its world epidemic rate which lead to intensive studies on the molecular biology, structure, and genetics of the virus (Ren 1992, Ren and Racaniello, 1996). Even though, the virus has been well-known structurally and behaviourally, it has a short fall in the area of its pathogenesis as its progressive understanding is limited due to absence of a convenient animal model of human being, which are the only animal reservoir of the virus (Ren 1992, Robertson, 1993, and CDC, 2009) and the closet to them being the African rhesus monkey kidneys serving as cultivation medium.

Polio or infantile paralysis is a contagious disease which enters its host as polio virus through the mouth and attaches itself to epithelial receptors in the throat, then migrates down to the intestine where it incubates and replicates. Gradually finds its way into the bloodstream to produce polio antibodies (Maigari *et al.,* 2014). The virus invades local lymphoid tissue and in the absence of sufficient levels of neutralizing antibodies, it might infect cells of the central nervous system (Robertson, 1993, CDC, 2009). Consequently, the affected individual might develop a permanent immunity against the disease. Infected cells shed poliovirus and thus it can be cultured from the pharynx or mouth in the first week after onset of paralysis and from feces for several weeks (Robertson, 1993, CDC, 2009). The virus spreads along nerve fibres within the nervous system and in the process of its intracellular multiplication it destroys motor neurons, resulting in flaccid paralysis even though less than 1 % of all reported cases developed paralysis (Robertson, 1993).

Polio is known to spread through contact with contaminated faeces in airborne droplets, food, or water especially in situations of poor hygiene and sanitation. It is also reported that flies can passively transfer poliovirus from faeces to food (Miller, 2004**,** the global polio eradication initiative, 2010**)** and possibly from person to person (Robertson, 1993 and Tagbo, 2013) mostly in areas of poor personal and environmental hygiene (Ren, 1992).

Signature characteristics of poliomyelitis is its interference with neurological structures (nerve cells of the brain and spinal cord and thus motor function) causing paralysis of one or more limbs with an early symptoms of meningitis. Intramuscular injection might increase the susceptibility of the motor paralysis to the virus which could lead to respiratory associated problems due to paralysis of the muscular diagram in life-threatening cases (Miller, 2004). Replication of poliovirus in the motor neurons of the anterior horn of the spinal cord and that of the brain stem results in cell destruction and causes the typical manifestations of poliomyelitis (CDC, 2009). Other symptoms include fever, headache, sore throat, stiff neck and vomiting. The global polio eradication initiative 2010 reported, about 90 to 95 % of everyone who is vulnerable to the natural polio virus does not show up with any symptoms (thus asymptomatic) even under epidemic conditions (Miller, 2004, Animal Research Success, 2012, The Global Polio Eradication Initiative, 2010 and Routh et al., 2014). Around 4–8 % of persons affected with polio virus have an abortive poliomyelitis which is characterized by a minor, non-specific illness presented without any clinical or laboratory evidence of central nervous system invasion. This category of affected person undergoes a complete recovery in less than a week under treatment. Non-paralytic aseptic meningitis occurs in 1–2 % cases while less than 1% of all polio infections result in flaccid paralysis (Robertson, 1993 and CDC, 2009). Poliovirus is one virus with a very short manifestation period presenting it most infectious form within 7 to 10 days before and after the onset of symptoms while present in the stool from 3 to 6 weeks (CDC, 2009).

Paralytic result is not reversible as there is still no cure thus strategy to eradicate polio is therefore based on preventing infection by immunizing every child until transmission stops. While early detected cases could be reversed or managed properly **(**the global polio eradication initiative, 2010**).**

Studies conducted by Siegel and Greenberg (1956) between the years 1949 to 1953 in New York City and that of Finland in 1985 by Harjulehto et al. (1989), recorded no increase in congenital defect prevalence in the subsequent follow-up of infants born to mothers infected with poliovirus during their pregnancies although Poliovirus is reported to cross the placenta (Robertson, 1993). Although there are have not been any reports of congenital defects due to administration of Vaccine a molecular based approach studies are recommended.

POLIO VACCINE

Jonas Salk (1952) developed the first successful polio vaccine known as the

inactive polio vaccine (IPV) and shortly afterwards Albert Sabin in 1957 produced another polio vaccine using a weaken virus known as the oral polio vaccine (OPV) (Robertson, 1993 and Miller, 2004). These 2 vaccines have so far been able to eliminate about 99 % of the world epidemic as of 2015 (Tagbo, 2013). Although, with the introduction and widespread use of OPV (containing live attenuated poliovirus strains) lead to vaccine-associated paralytic poliomyelitis (VAPP) (18). The oral polio vaccine strains are genetically unstable in vaccines, and chronic infected patients can excrete neurovirulent vaccine-derived PV (VDPV) mutants for up to 22 years (Blondel *et al.*, 2005)

IPV contains all three serotypes of polio vaccine virus which are grown and inactivated with formaldehyde in a monkey's kidney tissue culture (Vero cell line). The vaccine contains 2-phenoxyethanol as a preservative, and trace amounts of neomycin, streptomycin, and polymyxin B. It is supplied in a single-dose prefilled syringe and should be administered by either subcutaneous or intramuscular injection. While the OPV is also known as "trivalent oral polio vaccine" or "Sabin vaccine" and like the IPV, it also contains all three poliovirus serotypes but in live weakened strains of ratio 10:1:3 which are also grown in Vero cell line like IPV. Unlike the IPV, OPV is supplied as a single 0.5 ml dose in a plastic dispenser. The vaccine contains trace amounts of neomycin and streptomycin with no preservative (CDC, 2009 and Maigari *et al.*, 2014).

The human dosage of IPV is: first dose is given at 2 months of age, second dose at 4 months of age, the third dose is be given between at 6 to the 18 months of age and the final dose of the IPV series should be administered at 4years of age or older. The normal recommended dosage for the IPV intervals is 2 months but 4 weeks in emergency protection (CDC, 2009).

The live but weaken polioviruses in OPV replicate in the intestinal mucosa and intestinal lymphoid cells thus having effectiveness in producing gastrointestinal immunity, this was one out of the two characteristics of OPV that propelled for its selection by the world health organisation (WHO) as the instrument of choice in the global polio eradication initiative. The second characteristic is the fact that no special instrumentation (i.e., needles) was required for its administration. In the vaccine treatment, viruses are excreted in the stool for up to 6 weeks after a dose with a maximum viral shedding presented in the first 1–2 weeks post-vaccination, predominantly after the first dose leading to a disadvantage of possible spread from the recipient to persons coming in contact with faecal material of a vaccinated person, yet still archived the present success of eradication rate (Jesus, 2007 and CDC, 2009).

RECOMMENDED SUCCESS STRATEGY

Following the United States polio vaccine trend in archiving its success in combating the polio virus, the country used IVP extensively from 1955 when it was first

licensed, until the early 1960s when type 1 and 2 monovalent oral poliovirus vaccine (MOPV) were licensed. Shortly afterward type 3 MOPV became licensed in 1962; IVP was largely replaced in 1963 with the licensed trivalent OPV in United States and in most part of the world. However with the development of an enhanced-potency IPV in 1987, the United States based on the recommendations of the Advisory Committee on Immunization Practices (ACIP) adopted a sequential polio immunization schedule that included 2 doses of IPV, followed by 2 doses of OPV. They discontinued the use of OPV in 2000 to reduce the costs as well as prevent re-introduction of vaccine-derived and its possible elimination (**the global polio eradication initiative, 2010**, CDC, 2009, and Routh *et al.,* 2014). Nigeria as of 2016 adopted the steps of replacing the use of the OPV with IPV on her way to eradicate this virus and prevents the possibilities of VAPP re-introduction *"Only the complete discontinuation of use of OPV would lead to complete elimination of VAPP"* (CDC, 2009 and Routh *et al.,* 2014). The fact that IPV are administered via injection poses a major challenge as it has been reported to increase susceptibility to polio (Animal Research Success, 2012). This remains a challenge too if Nigeria decide to adopt IPV and needs to adequately prepared.

Clean environment is key as it was reported that improved sanitation in the immediate prevaccine era, allowed less frequent exposure. A study conducted by Ndiaye *et al.,* 2014 in Senegal, reported a wide variety of enteroviruses belonging to the four human enterovirus species found in the collected samples, with an isolation rate (79.7 %) consistently described by other authors in different countries which included Abidjan, Finland and Iran.

In the early vaccine era, after the introduction of the polio vaccine, its incidence dramatically decreased to total of 2,525 paralytic cases were reported in 1961 to just 61 in 1965 and the last case was reported in 1979. Though America had re-introduction of the virus between 1980 through 1999 (about 152 confirmed cases). Out of these, few cases were imported but 95% of cases were vaccine-associated paralytic polio (VAPP) caused by live oral polio vaccine (CDC, 2009, 18).

The last case of VAPP acquired in the United States was reported in 1999. In the year 2000, the United States recommended that IPV be used exclusively In order to eliminate VAPP from the United States. Between the years 2005 to 2009, a few cases were reported of unvaccinated individuals thus led to initiation of efforts to combat re-introduction of the virus as the world is yet to be declared polio free (CDC, 2009). Between year 2009 and 2010, 22 other counties which were previously polio-free were reported to be re-infected with polio virus from importations (Tagbo, 2013).

The international community primarily led by the world health organization (WHO), the rotary international, the United States centre for disease control and prevention (CDC), and the United Nations children's fund (UNICEF) launched a global polio eradication initiative in 1988 which was able

to drastically reduced polio cases by more than 99 % from an estimated 350,000 in 1988 to 1,874 in 2006 and 1,352 reported cases in 2010 from 125 endemic countries in 1988 to 3 in 2012 (Jesus, 2007and Tagbo, 2013).
Though termed as safe and effective, polio vaccine is reported to have some side effects which include the unclear reason behind increased polio risk (paralysis) by injections to polio vaccine immunized children as reported by researchers in the early 1900 (Miller, 2004).

THE NIGERIAN STATUS

In Nigeria, polio vaccination is overseen by the Nigeria's presidential task force on polio eradication (PTFoPE), is in charge of the implementation of the national polio eradication emergency plan with a goal of achieving interruption of polio transmission by December 2014. In 2008, Nigeria was reported to have the highest number of reported cases 0f 801 and closely followed by India with 559 reported cases (Ghosh, 2009). In the year 2013, Nigeria recorded great attainments with at least 58 % reduction in the number of WPV1 cases compared to 2012. In 2013, Borno, Yobe, Kano and Bauchi states from the Northern part of the country recorded an overall drop in 50 of infected local government areas as compared to that recorded in 2012. These 4 states accounts for 84 % of the total cases reported in 2013, with Borno and Yobe states accounting for 54 % of the 84 % cases recorded. This could be to inaccessibility of significant number of LGAs to the vaccines due to insecurity challenges, the major setback in realization of goal (National Primary Health Care Development Agency, 2013).

A study by Tegegne *et al.,* 2018 reported that Ethiopia had five WPV importations between 2004 and 2008 was genetically linked to the virus that originated from Nigeria through Chad and Sudan. They also reported that there were zero cases in Africa by the end of 2015 but in August 2016, Nigeria reported four WPV cases after almost 2 years of polio-free status (Tegegne *et al.,* 2018). This shows that Nigeria surely needs eliminates this virus to declare Africa polio-free continent.

CONTRADICTION

Polio remains endemic in Afghanistan, India, Nigeria and Pakistan (CDC, 2009, 18). This is believed to be due to plagued by controversies worldwide which health officials claims to be based on *"unfounded rumors"* about alleged adverse health effects, vaccine safety, contaminated with anti-infertility agents (estradiol hormone), HIV and cancerous agents (Nwozor, 2013 and Jegede, 2007), "more vaccinated than unvaccinated people get sick" (Maigari *et al.*, 2014). These accusations led to some countries such as Nigeria, boycotting immunization with polio vaccine leading to a noticeable decline in vaccine acceptance. The security challenge in the northern part of the country has put the polio eradication at risk. The federal, state governments and other stakeholders should regard the eradication of polio as a national public health emergency. Misconceptions about polio vaccine have remained a strong barrier in eliminating the disease globally (Maigari *et al.,* 2014).

Immunization treatment schedule in Nigeria is 2 to 3 drops of oral polio vaccines administered orally at certain intervals to children within the range of 0-5 years (Maigari. *et al*, 2014). The standard dosage is not understood by the people as such more suspicions towards the authenticity of the vaccine. Odoh Diego Okenyodo a pharmacy student as well as a journalist on Daily trust newspaper of 2nd March 2013 voiced his pseudo-science observations of the dosages of OPV compared to other disease conditions vaccine (Okenyodo, 2013).

It was reported that 10-30 % IPV and OPV produced and used between the year 1954 to 1963 had traces of simian virus 40, SV-40 (a monkey virus) and where administered to millions of people world wide. SV-40 was found in contaminated Sabin's oral sugar cube vaccine as well as in the kill virus vaccine as SV-40 is said to survive the heat and formaldehyde. SV-40 is known to have oncogenic (cancer-causing) properties and it's also reported to alter the genetic material which could not be neutralized. SV-40 is a catalyst for many types of cancer which has been found in many brain tumors, leukemia and recently in bone cancer and some mesothelioma cancers, a deadly type of lung cancer (Horwin, 2003, Miller, 2004, Nwozor, 2013 Mehndiratta *et al.,* 2014).

It has been suggested that the virus and SV-40 can be spread sexually and from mother to child in the womb, this could explain why some cancers rate are on the rise. A study showed that children of mothers who received salk vaccine between 1959 and 1965 have 13 times higher susceptible to cancer than mothers who did not receive such treatment (Horwin,2003; Miller, 2004 and Mehndiratta *et al.,* 2014).

Ronald Desrosier, a Harvard Medical School professor, stated the possibility that SIV was possible a precursor to HIV and that polio vaccine was the means of transmission from monkey to human. Japanese researchers stated that the African green monkey should not be used to produce polio vaccines as they have antibodies agent SIV (Miller, 2004).

CONCLUSION

Mangal *et al*, 2014 highlighted issues needed to tackled for a complete eradication of the virus which include; vaccine efficacy which seems to be lower in northern states, secondly coverage and population immunity remain too low to interrupt wild poliovirus transmission; and thirdly and most importantly refusals and unawareness of vaccine availability or importance as they belief to be reasons which dominate failure to immunize children who develop poliomyelitis. Nigeria might be able to have a total elimination of the virus if these problems are being addressed. Nigeria recently launched of IPV which is hopefully to eliminate the threat of cVDPVs and VAPP. This might also face some challenges due to its administration medium and thus need more awareness as suggested by Tago, 2013. There have been several tactical management structures by the Nigerian government in collaboration with the global polio eradication initiative (GPEI) which it strengthens could lead to total elimination of the virus.

FUTURE PERSPECTIVE

Polio has no cure but can be prevented through immunization, hygiene, and sanitation, thus environmental surveillance of polio virus is critical for maintaining polio-free areas and toward attaining global eradication of polio (Nakamura *et al.,* 2015). The idea for a standard vaccine is for it to be effective, safe, inexpensive, long-lasting, and easily administered as recommended by Ghosh (2009) this should be optimized for the elimination and eradication of polio virus. Therefore should be continuing studies into the immunogenicity, epidemiological and monitoring trends to develop area-specific strategies. Small pox and renderpest were deadly infectious epidemics just like polio have been able be biologically eradicated and therefore polio is could also be eradicated. The global eradication effort has already achieved over 99 % success and elimination certificate has been issued countries. Also re-infections have been successfully and radically eliminated in previously certified countries.

Pakistan being relatively similar with Nigeria on argued geopolitical occurrences such as war and insecurity, alone side the loss of confidence in the vaccination in certain parts, conducted a study with an objective to find out opinion and response of the people in such communities towards anti-polio campaigns which was able to guide them on direction of sensitization campaign (Akhunzada *et a.l,* 2015). Furthermore in developing area-specific strategies, there is the need to also conduct a study into some of the stated claims especially in the number of off springs to have evident by sound scientific advice from experts. The results of such study might change the perspective of Nigerians, especially the Northern part of the country towards the vaccine and thus the country contributing its quarter towards achieving the global polio eradication team.

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