Review Article

Recent advances in the surveillance for measles: when will these be feasible in Africa?

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Abstract: Measles is a highly contagious viral infection with worldwide prevalence. It is transmitted by airborne route and has an incubation period is 8–12 days. Symptoms include fever, coryza, cough, rash, while signs include exudative conjunctivitis, maculopapular rashes. The population at risk for measles are those less than five years of age especially infants, those above 20 years of age, the immuno-suppressed and immune-compromised patients such as those with HIV/AIDS, those on steroids and chemotherapy, those with severe malnutrition. We aim to describe the different surveillance methods for measles including the traditional and modern methods, their evaluation and analysis. The traditional surveillance for measles includes over the counter sales of antipyretics and cough syrups, data from school absenteeism and school nurses, daily physician office visit, hospital ED visits, hospital admission data, nurse hotline data, emergency medical services and ambulance 911 calls and laboratory test requests. Measles surveillance can also be done using modern methods which can be used at the local, state and regional levels for the detection of measles outbreak. These modern methods include the Electronic Surveillance System for the early notification of community-based epidemics (ESSENCE), the real-time outbreak detection system (RODS), early aberration reporting system (EARS), Redbat and the syndrome reporting information system (SYRIS). Telehealth is another modern method for the surveillance of measles which detects outbreak of measles earlier regardless of how far the patient is from the healthcare centers. The various disease surveillance methods above are effective and beneficial in terms of early detection of outbreaks and situation analysis for measles and are hence recommended for use.

Keywords: Measles; surveillance; traditional; modern

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Introduction

Measles as an important public health problem in Nigeria and the need for its surveillance

Measles infection is the leading cause of vaccine preventable death globally (1). It is a highly contagious disease with risk of infection in household contacts as high as 90% (2). It is a major public health burden especially in sub-Saharan Africa. Measles infection has a high morbidity and mortality with a mortality rate of over 10% in the developing countries (3). One in 5 children die from measles complications in Nigeria (4). Measles infection solely accounted for 114,900 deaths in children globally in 2014 with a larger percentage of this death in under-5s (5). It is a respiratory disease with multiple organ involvement and acute complications like diarrhea and pneumonia. On a long term, measles infection can cause blindness, hearing impairment and poor growth (6).

Measles vaccine is safe and efficacious in prevention of the infection. A single dose of vaccine prevents infection in up to 95% of cases and efficacy of almost 100% if given the second dose (7). Despite the efficacy of measles vaccine, countries like Nigeria still falls short of the required coverage and a resultant effect of recurrent outbreaks of measles infection. Twenty-five million Nigerian children are yet to receive measles vaccine. Measles vaccine coverage in 2014 in Nigerian children was 63.1% which declined in the year 2015 to 51% (4). Vaccination rate varies within regions in Nigeria with the lowest coverage in the North-Western part of the country that had a drastic decline from 42.5% in 2014 to 21.5% in the year 2015 (4). In this year 2016, 2 measles outbreaks in Lagos State and Sokoto State killed 20 and 23 children respectively with over 300 cases in the latter state (3,8). Overall, 3.95 cases per 100,000 of total population of measles infection occurred in 2014 in Nigeria (9).

In the Ministerial Conference on Immunization in Africa in 2016, Nigeria was rated poorly due to unsuccessful elimination of measles and failure to implement the measles-containing vaccine (MCV2) recommended by WHO which contains two doses (9).

Factors responsible for the poor achievement in measles vaccination in Nigeria include a poor surveillance, inadequate cold chain especially to the hard to reach regions of the country. The terrorist attack that ravaged Nigeria especially the North-East part of the country would have undoubtedly contributed to the poor immunization coverage in that region. Underestimations of cases occur in Nigeria due to poor surveillance of the disease (9). Measles infection is one of the five major causes of death in under-5s in Nigeria. In addition to acute respiratory infection, diarrhea, malaria and malnutrition, they account for 70% mortality of children less than five years (10).

Nigerian did not achieve the Millennium development goal 4 by the year 2015. To have achieved this, a reduction of under-5 mortalities to 70 was required but currently, under-5 mortality rate is 108.8. Decline in measles vaccine coverage and outbreaks of infection were one of the reasons for this short fall in attaining the goal (11).

Sustainable Development Goal (SDG) aimed to prevent childhood diseases through vaccination and end preventable death in under-5s by 2030 (12). To achieve this in Nigeria, there is need for surveillance, political commitment, enhances immunization especially in hard to reach regions of the country. Surveillance is a pivot to achieving SDGs; there is need to monitor the incidence rate, outbreaks, provide effective tools to increase vaccination coverage and their efficiency and frequently evaluate the progresses made with each intervention.

Traditional measles surveillance methods

Surveillance subjects and data sources

Measles is a highly contagious viral infection with worldwide prevalence. Its mode of transmission is by airborne and portal of entry is through the respiratory tract and through the conjunctiva. Incubation period is 8–12 days. Symptoms of measles include fever, coryza, cough, rash, while signs include exudative conjunctivitis, maculopapular rashes.

The population at risk for measles are those less than five years of age especially infants, those above 20 years of age, the immuno-suppressed and immune-compromised patients such as those with HIV/AIDS, those on steroids and chemotherapy, those with severe malnutrition.

The data needed to perform the surveillance for measles include; over the counter sales of antipyretics and cough syrups, data from school absenteeism and school nurses, daily physician office visit, hospital ED visits, hospital admission data, nurse hotline data, emergency medical services and ambulance 911 calls and laboratory test requests. The primary data sources are from pharmacy sales of over the counter drugs, emergency medical services and ambulance 911 calls and school nurses' data while my secondary data sources will be daily physician office visit, hospital admission data and laboratory tests.

The data obtained from pharmacy stores includes the date of purchase, the type of drugs and its code, the location of the store. This information usually forms a chain which are collected electronically into a database and collated hourly which can readily be used for disease surveillance.

The data from the school nurse can also be assessed the same way from the database after obtaining permission from the relevant authorities. The same followed for the hospital admission database, physician office visits, emergency medical services, ambulance 911 and the laboratory tests.

Collection and provision of data on sales of over the counter is the responsibility of The National Retail Data Monitor (NRDM) which is a public health surveillance tool that collects and analyzes daily sales data for over-the-counter (OTC). National library of medicine also provide data, including health statistics units of various ministry of health.

The aggregate record of data that can be used include, record of age, sex, location presenting symptom, signs,

number of cases with symptoms and signs of measles over time compared with the total number.

The quality of the data collected can be ensured by evaluating the data using data processing and data comparison. Data processing involves filtering each data source and smoothing the data using a 7-day smoothing application. Data processing helps to eliminate the effect of confounders such as day of the week effect, holidays and sale period effect. In doing data source comparison, the minimum date, maximum date and SNR are used.

Algorithm for the surveillance of measles

The indicators that can be chosen to use include pharmacy sales, Pediatrician office visit record, Children emergency visit and hospital admission record, school clinic record, school absenteeism record and daycare center record (13).

Pharmacy sale record is appropriate in the algorithm because it can give information about sales of antipyretics and cough syrup which may be purchased as an immediate remedy by parents of children with measles who has fever or cough. The use of Pediatrician office record is based on the fact that morbidity of measles is commoner in children less than five years of age especially infants hence they are likely to present to Pediatrician. The above reason also explain why they may present in children emergency especially if fever is associated with convulsion which will scare parents and make them present at the children emergency. Measles is commonly associated with fever which is usually high grade, and malaise hence, children with measles are likely to present in the school clinic for first aid treatment, those very ill are also likely to be kept at home by parent or admitted in the hospital which makes school and day care absenteeism record reliable for the algorithm.

Hospital admission record gives information about the presenting complaint which can be grouped into the international classification of diseases (ICD) classification.

The logical process of the algorithm is to collate data from the sources above and calculate the prevalence using the total cases or population as the denominator, this helps to identify actual increase and eliminates the effects of migration and changes in the total number of cases seen which may give an apparent increment in the prevalence of an illness.

The next stage is to filter the data using the syndromic surveillance (13,14). In terms of signs and symptoms at presentation. Symptoms of measles are fever, cough, malaise, coryza. Signs of measles are rashes, convulsion, exudative conjunctivitis. Features of complications are diarrhea, breathlessness and altered consciousness (15). With these, likely cases of measles can be identified from which appropriate laboratory investigations can be done to confirm the diagnosis of measles in suspected cases.

The strength of the algorithm above is the fact that information can easily be obtained about the demographic characteristics of the cases making tracing of the source of outbreak possible.

Limitations include the non-specific nature of some of the data giving opportunity for false alarms. There are confounders in many of the sources of data mentioned above, for example, holiday, day of the week and sales period can affect pharmacy sales, school and daycare absenteeism. Other causes of febrile illness and cough can also cause the increment noticed giving rise to false alarm. Migration of people from one region to another can also cause false alarm. Availability of a new Pediatric center or service can make parent bring children to be seen by Pediatrician which can give a false alarm. Another limitation is the fact that collation of the data above is rather slow hence making timely intervention to be delayed (16).

The mock digital dashboard above has been designed from the algorithm created for measles (*Figure 1*). The charts showed pharmacy sales, pediatrician office visit record, Children emergency visit and hospital admission record, school clinic record, school absenteeism record.

The first chart is a clustered column which enumerate pharmacy sale over a period of four weeks in terms of the sales of cough syrup, antipyretics and oral rehydration salts. There was an upsurge in the sale of these three which may be an indication for an outbreak of a febrile illness and cough as showed by the arrow.

The next chart is a pie chart showing Pediatrician office visit, there was an increase to 20 in the fourth week from an average of 11 per week in the previous weeks. Measles morbidity and mortality is commoner among those less than five years of age, especially infant, an increase in the visit to Pediatrician may be an indication of an outbreak of a disease commoner in children. This same explanation follows for the bie chart which illustrates children emergency visit and hospital record. Period of increase which may indicate an outbreak are highlighted using the blue arrow for the pie chart and the red arrow for the bie chart.

The fourth chart which is a clustered column chart enumerates the school clinic attendance and school absenteeism, there was an increase in school clinic attendance and absenteeism at the fourth week which may

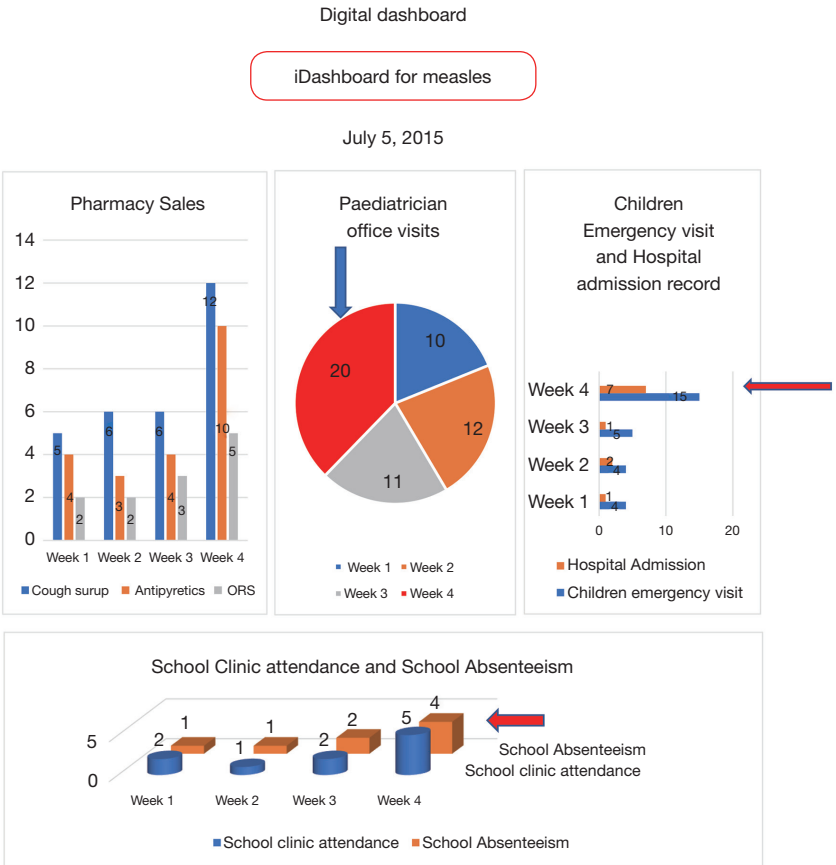

Figure 1 Charts of various traditional surveillance methods for measles.

be an indication of an outbreak in the pupils making them ill while in school and hence presenting at the school clinic leading to an increase in the number of pupils attended to at the school clinic, the illness could have also been responsible for their absenteeism from school either as a result of admission in the hospital or because they are not strong enough to attend school. The red arrow indicates a likely outbreak.

The various data presented in the charts above has various limitations. The pharmacy sales record can be affected by sales period and days of the week sales, presentation at the pediatrician office can be affected by migration or setting up of new pediatric facility.

Children emergency visit and hospital admission record can be affected by other causes of febrile illnesses. These records are more likely to produce reliable information on surveillance on time, due to the stay in the hospital and time taken in collating data on admission and discharge records.

In all, a digital dashboard provides at a glance information on specific records which can be used in creating an algorithm.

Modern measles surveillance system

eHealth

Modern surveillance system which can be used at the local state and regional level for the detection of measles outbreak includes the Electronic Surveillance System for the ESSENCE. It was developed by the John Hopkins University Applied Physics Laboratory (17). Another modern surveillance system which can be used for measles is the RODS which was developed by the University of Pittsburg and the Auton Lab of the School of Computer Science in Carnegie Mellon University (17). Another modern surveillance system that can be used for measles is the EARS which was first developed in New York City

after September 11, 2001 (17). Redbat is another modern Surveillance system that can be used for measles. The SYRIS is another surveillance tool which can be used for measles (17).

ESSENCE is a flexible application that allows imports of data from various sources, hence can be used to obtain surveillance data from the pharmacy stores, pediatrician office visit, emergency room visits and hospital admissions including school clinic record and school absenteeism record. Essence uses a password protected website to view information. It is able to give information as to the specific cause or source of an alert out of all the various sources of data input into it. It has an alert that can identify statistical anomalies, it can be used by epidemiologist to monitor various health issues within the community. It allows easy communications among users (17). RODS is able to record data from various sources including admissions, discharges and transfers. It is able to also capture chief complaints and incorporate into syndromes which are predetermined into the application. It can be used by health department to set the alerting algorithm so that alarm can be generated at various sensitivities. For example, if there is an increase in the number of cases of measles that present is more than the baseline, it automatically sends an email to the health department. EARS is a SAS- based program which can be downloaded. It looks for changes in the frequency of health events using aberration-detection algorithm. Redbat is majorly used for infectious disease outbreaks but can be used for surveillance of chronic diseases also. It can be used by the health system to collect other useful data such as injuries, reportable disease. Data entered into Redbat can be analyzed within the software or exported for analysis in another surveillance system tool. SYRIS is aimed at collecting data entered from various health centers, nurses, emergency departments, microbiologists, environmental health practitioners. Data entered into it can be made available to public health officials who can set parameters for public health alarms. Statistical analysis and mapping can be done with SYRIS by the Public Health Officials.

The government has a lot of responsibilities for monitoring measles at the local, state, region and national level. One of the responsibilities of government is provision of financial support for the employment of manpower, procurement, implementation and maintenance of systems, training and re-training of staff, provision of effective communication systems at the various level and ultimately monitoring of the various political levels for effectiveness. The reporting requirement differs at each political level, at the local level, different health systems are involved which sends data to the local level. The local level collates these data including the ones from pharmacy sales, school clinics and clinic visit. The data at the local level is able to give information about the demographics in terms of location, sex and age. Data from various local data are sent to the state which inurns send data to the region and then the national level.

From the above, the different modern surveillance tools such ESSENCE, Redbat, RODS, EARS and SYRIS has been enumerated. The use of one or more of the above methods in the surveillance for measles is encouraged. Redbat is specifically preferred because it is preferred for infectious disease. The use of either ESSENCE or RODS is also advocated since they are able to generate alert algorithm and send email if measles reaches a level that exceeds the health department limit (17).

Telehealth as a modern surveillance method for measles

According to Laureate Education (18), telehealth uses modern telecommunications and information technology to provide healthcare delivery to patients when there is geographical separation between the patient and the caregiver. It is different from traditional method of healthcare provision where the patient and healthcare giver are present in the same geographical location. It is very useful in many aspects of health including disease surveillance.

The traditional mode of surveillance that I planned to use are pharmacy sales, Pediatrician office visit record, Children emergency visit and hospital admission record, school clinic record, school absenteeism record and daycare center record (13). Telehealth can be incorporated into the above traditional methods by the use of tele-consultation, telemedicine or videoconferencing, internet image transfer, remote monitoring and use of cell phone (18).

The implications of telehealth for the surveillance of measles is a surveillance system which detects outbreak of measles earlier regardless of how far the patient is from the healthcare centers, pharmacy stores and school (18). It also allows for better coverage and allow for specificity in the data thereby removing ambiguities since it uses modern technology. Telehealth also ensures that patient with measles are diagnosed, monitored treated and well taken care of in their natural environment thereby reducing the need to travel with sick children, it reduces the visits to physicians, emergency department and hospital admissions

which ultimately reduce cost and improve the wellbeing of the populace. It also encourages early detection and reduce the risk of spread of measles (18).

The benefit of telemedicine in the surveillance for measles are enormous, with tele-consultation, the parent can interact with the healthcare provider on phone, they are able to relate the symptoms and the Pediatrician is able to give specific advice on care including medications to procure, this will allow for more specific diagnosis of measles without confusing it with other viral illnesses making the data from this more specific and representative. In addition, video can be incorporated into the tele-consultation to form a video conferencing which is a form of telemedicine, this will give the physician the advantage of being able to see the child directly including the rashes and the pattern of the rashes, it also enables the physician to see how sick the child is, moreover, this boost the confidence of the parent who though far away geographically are able to relate with their Pediatrician right in the comfort of their home. Remote monitoring allows patients with measles to be monitored in their natural environment by the nurses, for example thermometer can be used to monitor the temperature of patient with measles with the temperature sent to the healthcare provider who can then modify the care of the patient using this information. Cell phone can be used to take a photograph of the rashes in measles which can then be sent to the healthcare provider, this can help in making a diagnosis, it can also be used for medication reminder for the parent (18). In addition, with the use of cell phone parent can communicate with the healthcare provider through social media like WhatsApp application which is cheap and reliable.

The challenges of incorporating telehealth into surveillance system for measles include its acceptability to the populace, security challenges in terms of maintaining patients' confidentiality and privacy because patient can be afraid that a third party may be able to listen to or hack their information while it is being sent. Another challenge in my environment is irregular supply of electricity which is needed to power all the modern technologies involved and lack of internet services in the rural areas.

Evaluation of measles surveillance methods

Evaluation is important to be able to know if a system works, it is needed to know the cost effectiveness and benefit of a particular system. Evaluation of disease surveillance system is needed to be able to know if the system is effective in detecting the disease entity and if it is cost effective and justify the purpose of setting it up (19).

The disease surveillance systems developed for measles are; the traditional surveillance systems, the modern surveillance systems including eHealth and telehealth.

In evaluating the effectiveness and efficiency of the above surveillance methods for measles, protocols for each will be developed which will describe each type of measles evaluation method, the ability of each method to rapidly detect measles, the assessment of each surveillance method in terms of how rapid it detects outbreak, its ability to give situation analysis and the ease of implementation of the specific measles surveillance method (19). In carrying out the evaluation, the planning will include making a budget for the evaluation, arranging for a venue where the evaluation will be done establishing telephone and computer network access, arranging for security and administrative support. After this, the various healthcare facilities where the various data on measles surveillance using the different methods are used will be contacted and invited for the evaluation (19).

The criteria that can be used for the evaluation include are; the quality of each disease surveillance methods in terms of the quality of information obtained using the system, the ability of the information to rapidly detect measures outbreak and also give situational analysis, the intention to use the specific method at each healthcare facility, the user satisfaction in terms of ease of use, understanding, analysis and interpretation of the data obtained, timeliness of each method in terms of giving specific information on outbreak of measles. The intension of the user to use each method and the net benefit of each of the surveillance method (19).

Sources of data that can be used for the evaluation will include health registers, community registers, laboratory registers, food and water test results, for monitoring and/or evaluation Potential sources of data for routine monitoring and periodic evaluation include weekly, monthly, quarterly, half yearly and annual surveillance reports, self-assessment reports, outbreak or rumors log, surveillance bulletins, case reports, outbreak investigation and response reports, minutes of surveillance coordination meetings (e.g., the IDSR monthly coordination meetings), surveillance plan of action, previous monitoring and evaluation data and reports, surveillance staff and stakeholders. I will use a quantitative method of data collection to obtain the evaluation information (20).

The selection of these evaluation criteria is based on the ease of these data collection, data management, processing

and utilization which will ultimately help to improve the system. The other reasons are based on the costs, reliability of data, required skills, ability to quantify results, richness and adequacy of the information generated and the fact that training required for the staff who will collect and compile these data is just basic (20).

System analysis of measles surveillance system

In analyzing the surveillance systems for measles in terms of cost, functionality, timeframe, social, political, environmental and economic elements. The surveillance system for measles which involve the traditional surveillance methods, algorithm, syndromic surveillance is cheap and cost effective because it involves making use of already established systems for collecting data which are used for surveillance, it does not involve setting up a new organization but making the best use of an already existing organization for measles surveillance for the benefit of the community, it is also functionality and time frame, collection of data from the various sources does not require so much training, in terms of time frame it relatively gives information early on disease surveillance although the response time can be affected by staff motivation (21) and work load since in most of the set up dedicated staff are not employed for collection of data on measles surveillance only but it is an additional task for the staff. The traditional methods are mostly socially acceptable to the populace and is also politically suitable, since the address of the patients are also involved it helps to give information on measles in a particular environment hence making tracing contacts possible. It is also economically viable because it does not require much additional cost (19).

In terms of the modern surveillance methods for measles which were described earlier, it does require more fund for financing compared with the traditional methods, this is because it involves use of modern technologies like computers, telephone, dedicated staff who are trained in health informatics, however it is cost effective because it makes collection of data faster including the analysis, interpretation and transfer of data. The cost is balanced by its effectiveness in giving information on measles surveillance faster making detection of outbreaks and situation analysis of measles to be faster (19). It is also more functional; it poses less stress on the staff collecting the data unlike the traditional approach which may involve gathering information from files and papers. It is more functional because it can also effectively collect and collate data from many centers which can be analyzed to give a more representative information on measles surveillance in the area or region. This also makes this surveillance method to be more applicable and benefiting economically, socially and politically (19).

Measles surveillance in Nigeria

Disease surveillance was introduced in Nigeria after yellow fever outbreak in the year 1988 (22). In the year 2006, individual case reporting form was introduced for reporting measles cases and outbreaks with laboratory support for confirmation of outbreaks. These forms are filled by private and public health care providers and transferred to the local government health department for onward transfer through the state ministry of health epidemiology unit to the Federal Ministry of Health (FMOH) epidemiology unit. FMOH unit is responsible for dissemination of information to the donor agencies (22). Since inception of measles surveillance in Nigeria, laboratory support for confirmation of the disease has been introduced as a tool to curtail spread of infection.

There is paucity of data on availability and reporting of measles cases in Nigeria. Nnebue *et al*. (23) in Anambra state, Nigeria evaluated the availability of Integrated Disease Surveillance and Response form (IDSR). In all, 25% and 16.2% of health care providers reported irregularity and constant out of stock of IDSR forms respectively. There is need for constant evaluation on measles infection notification and introduction of effective measures on how to improve measles surveillance in Nigeria.

In applying the traditional and modern surveillances methods for measles in the west African sub-region, *Tables 1*,*2* summarizes the advantages and challenges.

Conclusions

The data needed to perform the traditional surveillance for measles include over the counter sales of antipyretics and cough syrups, data from school absenteeism and school nurses, daily physician office visit, hospital ED visits, hospital admission data, nurse hotline data, emergency medical services and ambulance 911 calls and laboratory test requests. The above data can be obtained from pharmacy sales of over the counter drugs, emergency medical services and ambulance 911 calls and school nurses data while my secondary data sources will be daily physician office visit, hospital admission data and laboratory tests.

Table 1 Traditional surveillance systems

Types	Pros	Cons	Suitability for Nigeria
Over counter sales of antipyretic and cough syrups	Cost effective	Difficulty in capturing data from registered chemists. Delay in data collation and detection of outbreaks	Suitable. Many individuals' practices purchase of drugs over the counter
School absenteeism and school clinic	Cost effective. Easy accessibility to data. Prevention of large outbreaks	Non-illness absenteeism from school raises false alarm. Poor co-ordination among schools	Suitable. However, school enrolment especially in rural area is poor
Physician daily visit/hospital emergency visits	Appropriate and specific data collection. Can be done manually or electronically	Training and retraining of healthcare personnel required	Suitable. Delay in presentation at the hospital will lead to late curtailment of disease and outbreak. Traditional/orthodox medicine which is still in practice results in incomplete data capturing
Laboratory report	Gold standard	Not cost effective	Inadequate laboratory center and poor accessibility results in delay diagnosis. Out of pocket health care financing system affects efficiency
Ambulance services data collection	Quick	Expensive	Not suitable. Poor road network, inefficient referral system and availability of ambulance services in remote areas

Table 2 Modern surveillance systems

Types	Pros	Cons	Suitability for Nigeria
Early Notification of Community-Based Epidemics (ESSENCE)	Gives early warning of measles outbreak	Uses syndromic information which is expensive	Not suitable in Nigeria, a resource poor country
Real-Time Outbreak Detection System (RODS)	Easy collation and accessibility to data. Early disease curtailment	Expensive	Not suitable. It is computer based. Requires technology which is not readily available
Early Aberration Reporting System (EARS)	Appropriate and specific data collection. Can be done manually or electronically. It is quick	Non-specific symptoms raise false alarm	Suitable. It is cost-effective. However, delay in presentation at the hospital will lead to late curtailment of disease and outbreak. Traditional/orthodox medicine which is still in practice results in incomplete data capturing
Redbat	Early dissemination of information and notification on disease outbreak	Not cost effective	Not suitable: unavailability of required technology
Telehealth	Quick, efficient. Distant barrier in consultation eliminated	Expensive	Not suitable. Cost implication is high. Irregular power supply

Algorithm for measles can be created using the above data however the limitation of this method of surveillance for measles include the non-specific nature of some of the data giving room for false alarms. Another limitation of this method is that data collection is very slow.

Measles surveillance can be done using modern methods which can be used at the local state and regional level for the detection of measles outbreak. These modern methods include the ESSENCE, RODS, EARS, Redbat and the SYRIS.

Telehealth is another modern method for the surveillance of measles. It detects outbreak of measles earlier regardless

of how far the patient is from the healthcare centers, pharmacy stores and school It also allows for better coverage and allow for specificity in the data thereby removing ambiguities since it uses modern technology. It has the advantage of ensuring patient diagnosis, monitoring, and treatment in their natural environment but faces the challenge of acceptability by patient and legal issues such as privacy and confidentiality coupled with the challenge of irregular supply of electricity which is needed to power all the modern technologies involved and lack of internet services in the rural areas especially in developing countries.

The various disease surveillance methods described above are effective and beneficial in terms of early detection of outbreaks and situation analysis for measles and are recommended for use globally, there is a need to overcome all the barriers preventing their usage in Africa.

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Footnote

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://pm.amegroups.com/article/view/10.21037/pm.2019.09.03/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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