Short communication

EPIDEMIOLOGICAL INVESTIGATION, MONITORING AND SURVELLANCE; STRATEGIES IN PUBLIC HEALTH SUSTENANCE

ABSTRACT

Monitoring, surveillance and investigation of health threats are vital capabilities for an effective health system. The International Health Regulations require countries to maintain an integrated, national system for public health surveillance and response, and set out the core capabilities that countries are required to achieve. Public health laws typically establish a list of "notifiable diseases" and other conditions that health care providers, hospitals and/or laboratories are required to report to the relevant local or national public health authority. Notifiable diseases generally include infectious diseases that can quickly spread throughout communities and regions via water, food, contact with animals, mosquitoes, airborne droplets or through sexual contact and other forms of human interaction. Rare and new events may not be included in regular, clinical and laboratory-based surveillance systems. In addition, outbreaks of serious or contagious diseases require immediate investigation so that appropriate public health measures including isolation and contact tracing can be implemented. A significant degree of stigma may be attached to some diseases. Notifiable disease legislation should require the protection of personal information, and clearly define any exceptions. Concerns about discrimination and breach of privacy may be addressed by requiring certain diseases to be reported on an anonymous or de-identified basis.

Key words: Monitoring, Surveillance, Investigation, Health, Public

INTRODUCTION

From the words of Rudyard Kipling (*1865-1936*), -'I keep six honest serving-men: they taught me all I knew) their names are what and where and when and how and why and who. Epidemiology, according to Rudyard kipling, should; Define *what* will be studied, Find out *where* the problem is, *who* gets it, *when* it is occurring, Try to explain *why* the problem has such a distribution, Do specific studies to find out *how* the problem is occurring. The word epidemiology is coined from '*Ep*i-'which means upon, among; '*demos*-'for people; and '*-ology*' meaning science or study of. One major threat to human existence is the onset and spread of diseases [1]. The prevention of onset and spread of diseases should be prioritized in other to assure sustenance of environmental health [2]. It is of immense importance that the distribution and determinants of human health and disease conditions that define a population is studied and analyzed. Epidemiology should be the main focus of public health. If humans lack the required

tools to determine the-'who', 'when' and 'where', in relation to a given health condition, it will be a difficult task to develop mechanisms against such environmental challenges [3]. According to the World Health Organization (WHO), epidemiology is the study of the distribution and determinants of health-related states or events and the application of this study to the control of diseases and other health problems. It is the use of scientific methods for disease investigation [4]. It combines both biostatistics and medicine [1]. It is the study of how often diseases occur in different groups of people with aim of providing answers to questions like-'why is a disease more frequent amongst certain group of people? [5] From epidemiological investigations, an epidemiological information is derived and this information is used to plan and evaluate possible strategies that will serve as prevention mechanisms against illnesses and as a guide to the management of patients in whom diseases has already developed [1]. Epidemiological investigation includes all the procedures required to determine the relationship in terms of how often and why is a particular disease so common within a given population [5]. The goal of Epidemiological investigation is to control an epidemic and to prevent future epidemics attributable to the same or related causes. The specific objectives of an investigation are to define the parameters of the epidemic (i.e., time of illness onset and conclusion of the epidemic, number of cases, and morbidity and mortality), to identify control or prevention measures, and possibly to identify new data relative to the epidemiology of the health problem. Epidemiological investigation are always performed collaboratively with partners domestically or internationally [6].

OBJECTIVES OF EPIDEMIOLOGICAL INVESTIGATIONS

The main aim of epidemiological investigation is to derive information concerning the distribution and determinants of health [3], diseases and injury in human population and the application of this information to the control of health problems [5]. The objectives of investigation in epidemiology include;

- ✓ To investigate the etiology of disease and modes of transmission
- ✓ To determine the extent of disease problems in the community
- ✓ To study the natural history and prognosis of disease
- ✓ To evaluate both existing and new preventive and therapeutic measures and modes of health care delivery.
- ✓ To provide a foundation for developing public policy and regulatory decisions.

FEATURES OF EPIDEMIOLOGICAL INVESTIGATION

A key feature of epidemiological investigation is that the measurement of the disease outcomes must be in relation to a particular population at risk [6]. The population at risk in this case, is the group of people, healthy or sick, who would be counted as cases if they had the disease

investigated for. For instance, if a public health scientist were to determine or statistically evaluate how many patients visit a particular health center with complaints of gustatory defects, the population at risk would comprise those people on the list, and also, those who have a tendency of seeing him if they had similar problem. John snow (*1813-1858*), an English physician and modern day father of epidemiology, used scientific methods to identify the cause of an epidemic of cholera in London in 1854. He believed that it was the water pump on Board street in London that was responsible for the disease. The removal of the pump handle ended the outbreak of the disease. Another feature of epidemiological investigation is an epidemiological approach. Epidemiological approach, are strategic steps taken to investigate a problem or disease etiology [3]. They include;

- ✓ Perform an initial observation to confirm the outbreak
- ✓ Define the disease
- ✓ Describe the disease by time, place, and person
- ✓ Create a hypothesis as to the possible etiologic factors
- ✓ Conduct analytic studies
- ✓ Summarize the findings
- ✓ Recommend and communicate the interventions or preventative programs

They also include;

Conduct field work which includes

Perform initial observation of suspected condition, Establish the existence of an outbreak

Verify diagnosis of such disease, Collect data.

Define disease;

Establish case definition, Identify all cases, Identify the population at risk, Describe disease by time, place, and person, Plot epidemic curve, Plot spot map, Tabulate data of exposure and other characteristics.

Develop hypothesis;

Hypothesis (Alternative and null): exposure to ***x*** is associated with disease ***y***, Conduct analytic studies.

Use appropriate analytic studies;

Calculate measures of risk

- ✓ Refine hypothesis
- ✓ Conduct additional studies if needed
- ✓ Summarize findings
- ✓ Recommend and communicate interventions or preventative programs

STAGES OF EPIDEMIOLOGICAL INVESTIGATIONS

Epidemiological investigations usually have the basic objective of describing and quantifying disease problems and of examining associations between determinants and disease [6] [7]. With these objectives in mind, epidemiological investigations are normally conducted in a series of stages, which can be broadly classified as follows:

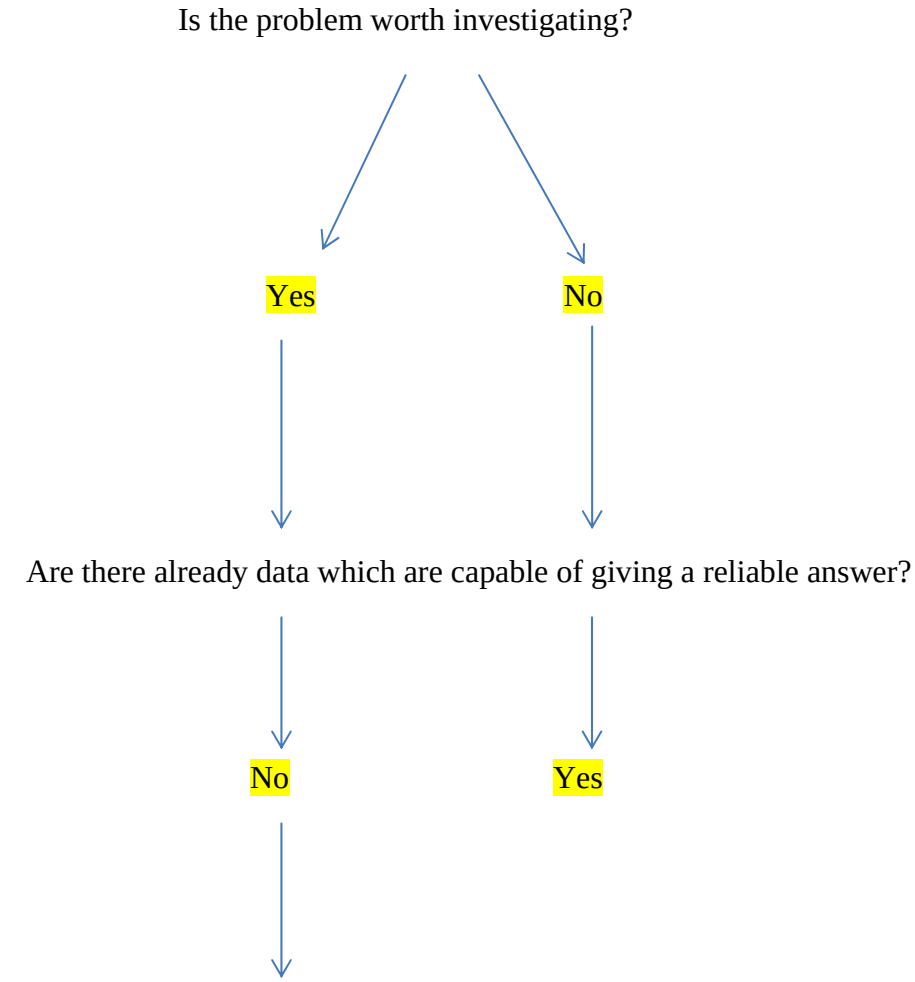
- ✓ A diagnostic phase, in which the presence of the disease is confirmed.
- ✓ A descriptive phase, which describes the populations at risk and the distribution of the disease, both in time and space, within these populations. This may then allow a series of hypotheses to be formed about the likely determinants of the disease and the effects of these on the frequency with which the disease occurs in the populations at risk.
- ✓ An investigative phase, which normally involves the implementation of a series of field studies designed to test these hypotheses.
- ✓ An experimental phase, in which experiments are performed under controlled conditions to test these hypotheses in more detail, should the results of phase 3 prove promising.
- ✓ An analytical phase, in which the results produced by the above investigations are analyzed. This is often combined with attempts to model the epidemiology of the disease using the information generated. Such a process often enables the epidemiologist to determine whether any vital bits of information about the disease process are missing.
- ✓ An intervention phase, in which appropriate methods for the control of the disease are examined either under experimental conditions or in the field. Interventions in the disease process are affected by manipulating existing determinants or introducing new ones.
- ✓ A decision-making phase, in which knowledge of the epidemiology of the disease is used to explore the various options available for its control [8]. This often involves the modeling of the effects that these different options are likely to have on the incidence of the disease. These models can be combined with other models that examine the costs of the various control measures and compare them with the benefits, in terms of increased

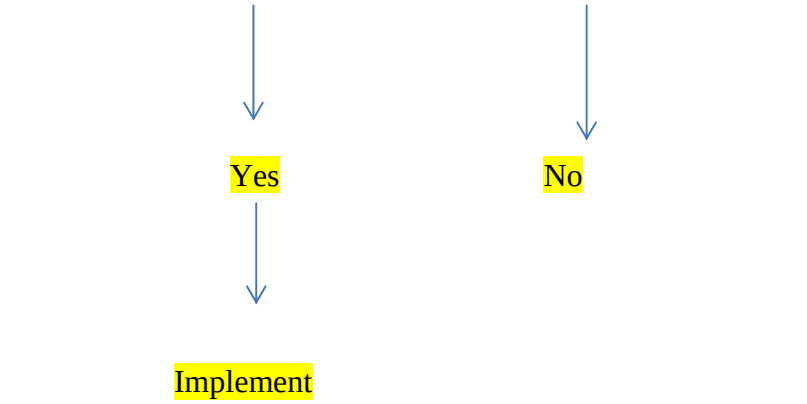
productivity, that these measures are likely to produce. The optimum control strategy can then be selected as a result of the expected decrease in disease incidence in the populations of livestock at risk.

- ✓ A monitoring phase, which takes place during the implementation of the control measures to ensure that these measures are being properly applied, are having the desired effect on reducing disease incidence, and that development that are likely to jeopardize the success of the control programme are quickly detected.

BASIC CONSIDERATIONS IN THE DESIGN OF EPIDEMIOLOGICAL INVESTIGATIONS

A good way to approach the planning of a field study is to take the view that we are, in effect, buying information [9]. We must make sure, therefore, that the study produces the information required at the lowest possible cost. We should also ask ourselves if that information can be obtained from other, cheaper sources. The processes involved in such considerations could be schematized as follows:





The first step is to write out clearly the objectives of the study and the data that will need to be generated in order to attain them [9] [10]. Throughout the entire planning process, constant reference should be made to these objectives in order to ensure that the procedures being planned are of relevance. If it is found that the resources available may not permit the achievement of the original objectives, the objectives may have to be redefined or additional resources found.

Objectives can often be defined by constructing a hypothesis [11] [12]. An epidemiological hypothesis should:

Specify the population to which it refers i. e. the population about which one wishes to make inferences and therefore sample from. This is referred to as the target population. Sometimes, for practical reasons, the population actually sampled may be smaller than the target population. In such cases the findings of the study will relate to the sampled population, and care must be exercised in extrapolating inferences from the sampled population to the target population.

Frequently, inferences may be required about different groups within the target population. For example, one may want to estimate not only the overall prevalence of a specific disease, but also the prevalence's or incidences of the disease in various groups or subsets of the population. To obtain estimates with the precision required, the samples taken from these groups must be large enough, and this will obviously affect the design of the study [13] [14].

A further problem may occur when defining the actual units to be sampled within a population. If, for example, the sample unit was a calf, at what age exactly does a calf cease being a calf? Alternatively, suppose the sample unit is a herd. What exactly is meant by the term "herd"? If a livestock owner has only one animal, does that constitute a herd? Obviously, the sample unit must be precisely defined and appropriate procedures designed to take care of borderline cases.

Specify the determinant or determinants being considered can such disease determinants as "stress", "climate" and management" be defined accurately? How are these determinants to be quantified and what measurements would be used in their quantification? What are the advantages and disadvantages of these methods of measurement? How accurate are they?

Specify the disease or diseases being considered. The criteria by which an animal is regarded as suffering from a particular disease must be carefully defined. Will the disease be diagnosed on clinical symptoms alone? If so, what clinical symptoms? Are there likely to be problems with differential diagnoses? Will laboratory confirmation be needed? If so, are there adequate laboratory facilities available? Will they be able to process all the samples submitted? Will diagnostic tests be used? How accurate are these tests? Remember that studies based solely on diagnostic tests may provide data about the rates of infection present in the population being sampled, but they may not indicate whether the infected animals are showing signs of disease or not. Additional data on mortalities and morbidities may have to be generated.

What rates are to be calculated? Remember that incidence and attack rates cannot normally be obtained by a cross-sectional study. If estimates on economic losses due to particular diseases are required, various production parameters may have to be recorded. How are these to be measured? How good and how accurate will these measurements be?

Specify the expected response induced by a determinant on the frequency of occurrence of a disease. In other words, what effect would an increase or decrease in the frequency of occurrence of the determinant have on the frequency of occurrence of the disease? Remember that the determinant must occur prior to the disease. This may be difficult to demonstrate in a retrospective study.

Make biological sense. In epidemiological studies we are interested in exploring relationships between the frequency of occurrence of determinants and the frequency of occurrence of disease. We are particularly interested in determining whether the relationship is a causal one i.e. whether the frequency of occurrence of the particular variable being studied determines the frequency of occurrence of the disease. We analyze such relationships by the use of statistical tests which tell us the probability of occurring by chance of the relative distributions of the determinant and the disease in the studied populations. If there is a good probability that the distributions occur by chance, the result is not significant and the distributions of the variable and the disease are independently related. If there is a strong probability that the distributions did not occur by chance, the result is significant and the distributions of the variable and the disease are related in some way.

Note that a statistically significant result does not necessarily imply a causal relationship.

EPIDEMIOLOGICAL MONITORING AND SURVEILLANCE

One of the most important activities in epidemiology is the continuous observation of the behavior of disease in populations [14]. This is commonly known as monitoring or surveillance [16] [17]. The term *surveillance* refers to the continuous observation of disease in general in a number of different livestock populations, while *monitoring* normally refers to the continuous observation of a specific disease in a particular livestock population.

Epidemiological monitoring

This is the repeated standardized evaluation of the health status of a population for the purpose of protecting this population from environmental health hazards [18] [19]. It is compared with environmental monitoring and epidemiologic studies. This approach is relatively cost effective. Systematic monitoring of serious infectious diseases and other conditions is typically achieved through notifiable diseases legislation based on clinical observation and laboratory confirmation.

Clinical and laboratory-based surveillance also provides the basis for systematic collection of vital statistics (births, deaths, causes of death), and may extend to the reporting and analysis of risk factors for non-communicable diseases and injuries [20] [21]. Systematic collection of these data informs the allocation of resources and facilitates evaluation of community-based and population-level prevention strategies.

Epidemiological surveillance

Surveillance activities involve the systematic collection of data from a number of different sources [21]. These may include already existing data sources as well as new ones that have been created for specific surveillance purposes. The data are then analyzed in order to:

- ✓ Provide a means of detecting significant developments in existing disease situations, with particular reference to the introduction of new diseases, changes in the prevalence or incidence of existing diseases, and the detection of causes likely to jeopardize existing disease control activities, such as the introduction of new strains of disease agents, chancres in systems of livestock management, changes in the extent and pattern of livestock movements, the importation of livestock and their products, and the introduction of new drugs, treatment regimens etc.
- ✓ Trace the course of disease outbreaks with the objective of identifying their sources and the populations of livestock likely to be at risk.
- ✓ Provide a comprehensive and readily accessible data base on disease in livestock populations for research and planning purposes.

The prime objective of such activities is, however, to provide up-to-date information to disease control authorities to assist them in formulating policy decisions and in the planning and

implementation of disease control programmes. Although a detailed discussion on the design and implementation of surveillance systems is beyond the scope of this review, it may be useful to review briefly some of the considerations involved.

The success of any surveillance or monitoring system depends largely on the speed and efficiency with which the data gathered can be collated and analyzed, so that up-to-date information can be rapidly disseminated to interested parties [21]. As a result of recent advances in data processing techniques, particularly in the field of computing, the development of comprehensive and efficient surveillance and monitoring systems at a reasonable cost is now within the reach of most veterinary services.

The capacity of epidemiological units to employ these modern techniques means that such units may be able to offer data-processing services to institutions and organizations in return for the use of their data. This has removed one of the main constraints on the development of such systems in the past [22], which was the reluctance of various data-generating sources to make their data available to those responsible for surveillance. Such cooperation depends on a clear identification of the information needs of reporting organizations and fulfilling these rapidly and efficiently.

Modern computerized data processing allows complicated analytical procedures to be carried out on large volumes of data quickly and easily. However, they must be used with a great deal of caution and only on data which justify them. If used on incomplete or inaccurate data whose limitations are not understood, they may produce results which are at best confusing or misleading. For this reason, the analysis of surveillance or monitoring data should be kept simple and the limitations of information produced should be clearly stated [23].

A further consideration is that of confidentiality. Any surveillance or monitoring system will contain a certain amount of confidential data. If such data get into the wrong hands and are used indiscriminately without due regard to their probable limitations, serious problems may result [24]. Appropriate safeguards need to be designed, therefore, to ensure that information is distributed to interested parties on a confidential and need-to-know basis.

In countries like Nigeria, the incidence management system (IMS) model is used for outbreak coordination [25]. Cases and deaths are identified through routine epidemiological surveillance system using standard definitions for suspected and confirmed cases and deaths respectively [25] [26]. Blood specimens collected from suspect cases are sent for confirmation at a WHO accredited laboratories. Active case search are intensified, and identified contacts of confirmed cases are followed up for the maximum incubation period of the disease. Other public health responses include infection prevention and control, communication and advocacy as well as case management [27].

Evolutionary changes have improved epidemiological investigation, monitoring and surveillance, in Nigeria [27] [28], they include;

- ✓ Improve tools in science, technology, and communication;
- ✓ Broader scope both in terms of geography and the nature of the public health problems under investigation;
- ✓ A better trained and equipped workforce that includes not only epidemiologists, public health advisors, microbiologists, and statisticians, but also behavioral and social scientists, economists, informaticians, toxicologists, and chemists; and
- ✓ New or changed roles for public health partners (e.g., Environmental Protection Agency, Department of Justice, Department of Housing and Urban Development, Department of Homeland Security and local law enforcement) and enhanced collaborations with the World Health Organization; the U.S. Department of Agriculture; the Food and Drug Administration; the National Institutes of Health; the World Health Organization; and the private sector, including the business community, academia, community-based organizations, health plans, professional societies, volunteer agencies, and international organizations.

CONCLUSION

Epidemiological investigation, surveillance and monitoring are critical components of a well-functioning public health system. Public health professionals use these approaches to assist them in performing many of their key functions. These include monitoring, vector control, responding to outbreaks of infectious disease, identifying the source of foodborne illnesses, ensuring the safety of drinking water and national blood supplies, and tracking modifiable risk factors for non-communicable diseases in order to develop and evaluate preventive policies. The investigation, surveillance and monitoring of noncommunicable diseases and their risk factors tends to occur through community-based or voluntary clinical reporting systems, rather than through formal, legislative notification systems. In appropriate circumstances, however, the mandatory reporting of risk factors for noncommunicable diseases may assist in identifying cases and ensuring that affected individuals are offered treatment to prevent the progression of disease, also, the identity of concerned individuals should be treated with confidentiality to encourage early report by the public. It is further advised that anonymity be maintained and there should be no attempt to breach the privacy of anyone involved in the process of epidemiological investigation, monitoring and surveillance.

REFERENCES

1 Arita I, Nakane M, Kojima K, Yoshihara N, Nakano T, El-Gohary A. (2004) Role of a sentinel surveillance system in the context of glob2016al surveillance of infectious disease. Lancet Infectious Diseases.;4:171–7.

2 Fredrick, C., David, T., (2017) Programme on Maternal and Child Health and Family Planning, Division of Family Health.; 1-60.

3 Mulk, T., Christen, A., (2017) A clinico-anatomical study on the etiological factors pertaining toprimary infertility in females using some common investigative procedures. J AnatSocIndia; 56:14–7.

4 Dowdle WR, Mayer LW, Steinberg KK, Ghiya ND, Popovic T. Laboratory contributions to public health. In: Public health then and now: celebrating 50 years of *MMWR* at CDC. MMWR 2011;60.

5 Bola E.O., Adebola A.A., and Taiwo A.B., (2017). A review of female infertility: important etiological factors and management. *Journal of Microbiolology Biotechnology Review*. 2(3): 379-385.

6 Esse Kampoola (2016). Ageing investigation: Socio demographic characteristic and dropouts of Ageing women at Family Guidance Association of Ethiopia (FAGE). *Ethiopan Journal of Health*. 14(2): 127-134.

7 International Health Regulations (2008). 2nd ed. Geneva: World Health Organization; (http://www.who.int/ihr/publications/9789241596664/en).

8 International Institute for Population Sciences and ORC Macro, Report of theNational Family Health Survey (NFHS-III) (2016;) Mumbai: IIPS.

9 Hacker SB, Stroup DF, Sencer DJ. (2014) Epidemic assistance by the Centers for Disease Control and Prevention: role of the Epidemic Intelligence Service. *American Journal of Epidemiology*.

10 Rao M and Rao D. (2017). Cytogenetic studies in autoimmune diseases. 28:209.

11 International Health Regulations (2008). 2nd ed. Geneva: World Health Organization: Annex 1 (http://www.who.int/ihr/publications/9789241596664/en).

12 Wilson K, McDougall C, Fidler D, Lazar H. (2008) Strategies for implementing the new International Health Regulations in federal countries. Bulletin of the World Health Organization.;86:215–20.

13 pajobi SO, Kandakai OYT, Mawak JD, Olukemi MA, Bello CSS. Vibrio cholerae Vibrio cholerae 01 infections in Jos, Nigeria. African J Clin Exp Biol. 2016;5(3):260–264.

14 Tanje, T.A., (2014). Epidemiological investigation: Socio demographic characteristic and dropouts of malnourished mothers from primary health care centers. *Ethiopian Journal of Health*. 14(2): 127-134.

15 Sandars, A. O., (2018). A preliminary study on the prevalence of hypertension and obesity.Fitoterapia **70**: 15–20.

16 Aviruppola, K. A.J.M., Rajapakshe, R.P.V.J., Rajakaruna (Amarakoon), R.S., (2016) Coprological survey of gastrointestinal parasites of mammals in Dehiwala National Zoological Gardens, Sri Lanka. Ceylon Journal of Science 45(1), 83-96.

17 Kiani, H., Haghighi, A., Salehi, R., and Azargashb, E. (2017) Distribution and risk factors associated with intestinal parasite infections among children with gastrointestinal disorders. Gastroenterol Hepatol Bed Bench *9*, S80-S87.

18 International Health Regulations (2015). Toolkit for implementation in national legislation. Questions and answers, legislative reference and assessment tool and examples of national legislation. Geneva: World Health Organization; 2009:11 (http://www.who.int/ihr/publications/WHO_HSE_IHR_2009.3/en/).

19 Nham, T., Poznanski, S.M., Fan, I.Y., Shenouda, M.M., Chew, M.V., Lee, A.J., Vahedi, F., Karimi, Y., Butcher, M., Lee, D.A., Hirte, H., and Ashkar, A.A. (2014) Ex vivo-expanded NK cells from blood and ascites of ovarian cancer patients are cytotoxic against autologous primary ovarian cancer cells. Cancer Immunol Immunotherapy.

20. Vuso, D. A. and Alcolado, A. C., (2015). Humans against diabetes mellitus. Diabetic Medicine. 22:359-370.

21 International Health Regulations (2016). 2nd ed. Geneva: World Health Organization; 2008, Articles 19–46.

22International Health Regulations (2009). Toolkit for implementation in national legislation. Questions and answers, legislative reference and assessment tool and examples of national legislation. Geneva: World Health Organization:25–115.

23 Liu, E.W., Chastain, H.M., Shin, S.H., Wiegand, R.E., Kruszon-Moran, D., Handali, S., and Jones, J.L. (2011-2014); Seroprevalence of Antibodies to Toxocara Species in the United States and Associated Risk Factors, Clin Infect Dis *66*, 206-212.

24López-Gigosos RM, Plaza E, Díez-Díaz RM, Calvo MJ. Vaccination strategies to combat an infectious globe: Oral cholera vaccines. J Glob Infect Dis. 2011 Jan;3(1):56–62. [PMC free article] [PubMed]

403 25Gunther S, Emmerich P, Laue T, Kuhle O, Asper M, Jung A, et al. Imported Lassa fever in
404 Germany: molecular characterization of a new Lassa virus strain. Emerg. Infect. Dis. 2000;
405 6:466–76.

406 26 Tobin EA, Asogun DA, Isah EC, Ugege OG , Ebhodaghe P. Assessment of knowledge and
407 attitude towards Lassa fever among Primary care providers in an endemic suburban community
408 of Edo state: implications for control. J Med Med Sci 2013; 4(8): 311-8.

409 27 Enria D.A., Mills J.N., Bausch D., Shieh W., Peters C.J., Arenavirus infections. Guerrant
410 R.L., Walker D.H., Weller P.F., (2011) Trop Infect Dis: Principles, Pathogens, and Practice, 3rd
411 ed. Philadelphia, PA: Churchill Livingstone; 449–61.

412 28 Kouadio K, Okeibunor J, Nsubuga P , Mihigo R, Mkanda P. (2016) Polio infrastructure
413 strengthened disease outbreak preparedness and response in the WHO African Region. Vaccine,
414 34: 5175-80.

415

416