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Using Sird Mathematical Model Track the Spread of Lassa fever on a Multicity Network of Nigeria

Abdulganiyu Abdulrahman, Rabiu Idris, Amit Mishra
Department of Maths/Computer Science, Ibrahim Badamasi Babangida University, Lapai,
Niger State, Nigeria

Abstract:

This paper develops a mathematical model for the dynamics of Lassa fever disease using a set of four differential equations for the susceptible human, infected human, recovered human and dead human. The model is mathematically and epidemiologically well posed and then investigate the model for equilibrium and stability. Core to the research analysis is the computation of a threshold value; the basic spread of disease from different state in Nigeria which is the number of secondary infections due to introduction of an infective individual into a susceptible population. This research analysis shows that the disease will spread faster in Nigeria when started from Lagos and Kano state of Nigeria.

Keywords: susceptible, infected, recovery, death, Lassa fever

I. INTRODUCTION

The rate at which strange fever spread in developing countries like Nigeria Lassa fever outbreak have killed many people. Nigeria Centre for Disease (NCDC) statistics show that reported cases of the hemorrhagic disease — both confirmed and suspected — stood at 175 with a total of 101 deaths since August 2015. [4]

The disease coursed endemic in Liberia, Sierra Leone and other West African countries. In some parts of Sierra Leone and Liberia, 10% to 16% of all patients admitted to hospitals have Lassa fever. In Sierra Leone it is estimated that 6% of all residents in the initial endemic area have antibodies to Lassa fever, even though only 0.2% were recognized as clinically ill. About 2/3 of all reported cases are women, but this might be as a result of exposure, rather than a tendency toward greater susceptibility in women to the disease. Some Lassa fever cases have been "imported" into the U.S. and U.K. through travellers who acquired the disease elsewhere, ***[12].***

Lassa fever is in the same group as Ebola and Marburg, these are deadly infections that lead to vomiting and, haemorrhagic bleeding. The name of Lassa originated from the town in northern Nigeria where it was first identified in 1969. Endemic to the region, Lassa fever is asymptomatic in 80 percent of cases but for others it can cause internal bleeding, especially if diagnosed late.

The virus is spread through contact with food or household items contaminated with rats' urine or faeces or after coming in direct contact with the bodily fluids of an infected person. The symptoms of Lassa fever develop about 21 days after the infection with acute illness involving multi organs. Specific symptoms include fever, facial swelling, muscle fatigue, vomiting, cough, meningitis, hypertension, and sensor neural hearing loss often permanent.

II. LITEREATURE REVIEW

The earliest account of the mathematical modeling of the spread of a disease was carried out in 1966 by ***Daniel Bernoulli***. Trained as a physician, Bernoulli created a mathematical model to defend the practice of inoculating against smallpox ***[10].*** The calculations from this model showed that universal inoculation against smallpox would increase the life expectancy from 26 years 7 months to 29 years 9 months ***[3].***

Following Bernoulli, other physicians contributed to modern mathematical epidemiology. Among the most acclaimed of these was ***A. G. McKendrick and W. O. Kermack***, whose paper *a contribution to the Mathematical Theory of Epidemics* was published in 1927. A simple deterministic (compartmental) model was formulated in this paper and was successful in predicting [2].

Developed a Lassa fever model using the sex structure approach. Their model represented the transmission dynamics of the Lassa fever disease using a set of ordinary differential equations. The total human population at time t denoted by $N(t)\ H$ was subdivided into four (4) mutually exclusive sub-populations of Susceptible Male, Infected Male , Susceptible Female, Infected Female, Similarly, the total Natural Reservoir/host population at time t , denoted by $N(t)\ R$ was sub-divided into dormant Reservoir host , active Reservoir and host . Their model had the following assumptions.

Susceptible individuals, male/female can be infected via sex intercourse with the active Reservoir (Mastomys Natelensis), and via sexual intercourse with opposite sex. Two major controls were considered, the use of condom to reduce contract via sexual interaction and the use of pesticide/Rat poison to kill the natural Reservoir (Mastomys Natelensis). And finally, horizontal transmission for human and vertical transmission for the Reservoir.

This book mainly serves as a proper introduction to mathematical modeling with Microsoft Excel. Introducing basic modeling techniques such as dynamic modeling and graphing, this book explains the rates of change in the relations between the three compartments, S' (t), I' (t) and R' (t). Namely, as the infected population increases, the rate at which the susceptible population decreases can be calculated, and vice versa.

Using this knowledge, we are thus able to create our own SIR model. Based on statistics we gather, we can utilize similar equations as described in the book to create our own estimations of how the Susceptible, Infected and Recovered populations will change according to the characteristics of the respective vector-borne diseases at hand.

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III. METHODOLOGY

This paper will modify the existing SIR model by introducing death population. We will now have four population group i.e. Susceptible, Infected and Recovered, Dead.

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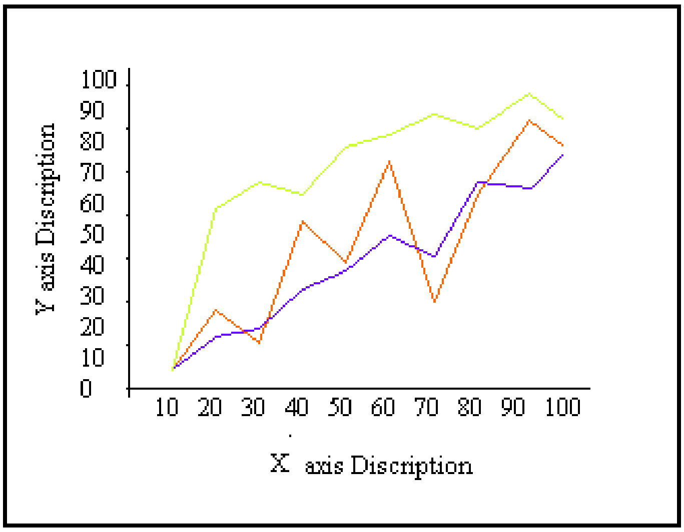

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ACKNOWLEDGMENT

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