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2014

17th Annual High School Mathematical Contest in Modeling (HiMCM)
Summary Sheet

(Please attach a copy of this page to your Solution Paper.)

Team Control Number: 5295
Problem Chosen: B

Please type a summary of your results on this page. Please remember not to include the name of your school, advisor, or team members on this page.

Summary

Ebola has caused the death of 784 individuals since the year 2000. Although there has not yet been a large, global outbreak of this disease, it has devastated many of the communities it has appeared in, before being quarantined and eventually eradicated from said area.. Ebola is a member of the *filoviridae* family of disease. *Filoviridae* are known for causing hemorrhaging of blood went contracted. *Filoviridae*, like all viruses lack an established overreaching cure, or, in other words, there is not a single method for curing viruses like there is for bacterium. In large, establish communities with adequate medical facilities, treatment can be administered such that there is a significant increase in survival rate. An outbreak of Ebola in Africa, for example had a 70% mortality rate despite foreign medical professionals being sent to administer care. Contrarily, in the current outbreak of Ebola in the United States shows a much lower mortality rate of 20%. While Ebola is not as dangerous in large, wealthy countries prepared to care for diseases, it is extremely devastating in smaller less prepared communities.

A case study of a disease showing the same symptoms of the Ebola virus was discovered in a small town in Indonesia. The population of the town when it was discovered the disease was present was 300 people. When the disease was discovered, 150 of those 300 people were shown to have symptoms of the virus. Furthermore, during the time the initial study was conducted 15 of the people showing symptom perished. Because the initial conditions precluded much in the way of preventative action, our primary goals were the containment of the disease and the minimization of its effects on the island's citizens.

In order to effectively combat the disease, not only in the model community, but in other potential communities, a flexible model was created that could be altered to several specific conditions.These conditions are shown by the aggression of the disease, modeled by the chance a person catches the disease on contact, the probability of contact, and the death

rate of the specific strain of the disease. In a second, modified model, these variables and parameters were evaluated for both the children and elderly as well as normal adults. Additionally, the average number of people a person exhibiting symptoms would come into contact with in a week was set as a parameter for the model. Our model can also be used to predict the number of people dying from any disease, and has been applied to the specific case in Indonesia.

In order to best model this problem, we began by modifying a SIR model to return information about five separate categories, which were defined as Susceptible, Infected, Removed, Deceased, and Contagious. This was accomplished by defining a subsection of the Removed category for members of the population that died as a direct result of the disease and a subsection of of the Infected category for members of the population that were capable of spreading the disease. Individuals in both the Infected and Contagious categories were assumed to be carrying the virus, but the individuals in the Infected category were assumed to be in an incubation stage lasting one timestamp (one week).

The first model utilized five difference equations--one for each of the defined categories--to assign each member of the population a certain category. Parameters were introduced for the probability of death given contagious, the probability of infection given susceptibility, and the probability of contact between a healthy person and an infected person. The The model reflected the projected situation supposing a constant probability of death over the entire population on the island and no precautionary or preventative measures taken by the WHO. A modified model was then created to model the same scenario with a set number of doctors sent by the WHO, a more comprehensive understanding of the nature of the disease, and a separate parameter for the probability of death in children and elderly adults. Both models predicted the behavior and spread of the disease over time, with data points separated by one timestamp *n*, where *n* was equal to one week.

Using these models, it was found that the disease ran its course over 6 weeks for both the first and second models. Both models resulted in the infection of the entire population of the island, though the survival rate of the second model was notably higher. It was determined that the introduction of doctors trained to treat such an infectious disease would do fairly little to control the spread but would limit the damage caused by the disease in such a situation.

ARTICLE TITLE

HIMCM 2014 CHALLENGE

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 DATA INDEX

Table 1: Variable Index

Symbol	Explanation	Type of Data
I_0	Initial Infected Population	Discrete/Input Variable
C_0	Initial Contagious Population	Discrete/Input Variable
S_0	Initial Susceptible Population	Discrete/Input Variable
D_0	Initial Deceased Population	Discrete/Input Variable
R_0	Initial Removed Population	Discrete/Input Variable
I_n	Infected Population	Discrete/Output Variable
C_n	Contagious Population	Discrete/Output Variable
S_n	Susceptible Population	Discrete/Output Variable
D_n	Deceased Population	Discrete/Output Variable
R_n	Removed Population	Discrete/Output Variable
n	Timestamp in weeks	Constant
i	Chance Infected	Parameter
β	Probability of Contact	Parameter
μ	Death Probability	Parameter
α	Child and Elderly Probability	Parameter
μ_α	Death Probability for Children and Elderly	Parameter

2 BACKGROUND RESEARCH & PROBLEM STATEMENT

All complex organisms, including humans, faces the problem of disease. While many types of diseases have the potential to be exceptionally dangerous, diseases caused by viruses often have more potential to damage human populations because there is not, as of yet, a method of treatment that prevents all viral infections. A family of viruses that has become especially well-known in recent years is the family Filoviridae, which is associated with large outbreaks of hemorrhagic fever The Ebola virus is a filoviridae that originated in western Africa and has since spread across the world. Since the year 2000, there have been 1,290 confirmed cases of Ebola; 784 of those cases have resulted in death, which amounts to a net mortality rate of 61%. The virus was first identified during a 1976 outbreak in Sub-Saharan Africa. Since its discovery, there have been 26 separate identified outbreaks of the Ebola virus, including the current outbreak in west Africa. All outbreaks prior to the current outbreak have successfully been contained, with a maximum of 425 victims contracting the disease in the Ugandan outbreak of 2000. However, in December of 2013, the latest major outbreak started in western Africa. This outbreak infected approximately 14,000 people thus far, and is becoming a global threat. In areas without well-established medical infrastructure and with relatively poor health standards, the disease is capable of spreading much more rapidly and with greater severity than in countries with the economic and medical capabilities to effectively treat those infected with the disease. In the United States, for example, the mortality rate from the disease is a relatively low 20%, compared to the average mortality rate of 61% for all outbreaks of the virus.

The given data is from an Ebola case study located in Indonesia, where a census of a small village reported that half of its three hundred inhabitants exhibited symptoms similar to those of the Ebola virus. Ten percent of those displaying symptoms have died. As members of the International World Health Organization (WHO), we are tasked to create a model that determines the type and severity of the spread of the disease, and whether the epidemic is contained. Additionally the model determines the best measures to take in order to contain the disease. Using the model created, recommendations can be made to the WHO and to the people of Indonesia with regard to further action.

3 ASSUMPTIONS & RATIONALES

Below are the assumptions made in order to complete the model.

1. The virus in the case study problem is functionally equivalent to those of Ebola.

   Because the problem stated that the symptoms of the disease were similar to those of the Ebola virus, it seemed most logical to model the behavior of the disease faced by the population of the Indonesian village after the behavior of Ebola.

2. Those who are removed or deceased cannot infect healthy individuals.

   Data regarding the Ebola virus has predicted that the virus cannot be passed on after a sick individual recovers from the disease, except under extremely unusual circumstances. It is also assumed that the process of removing the deceased bodies is taken with the utmost care, and no healthy individuals are infected by the deceased. For the purposes of the model, the deceased are removed from the pool of the contagions.

3. The death probability of children (age < 14 years) is the same as the death probability of elderly (age > 65 years).

   Both the elderly and children have a similarly increased chance of death due to illness. It was assumed that these probabilities were identical for the purpose of simplicity. The problem stated that children and elderly adults were both more likely to die in the case of infection. By assuming the death probabilitys are the same, it is possible to avoid the inclusion of two additional raised death probabilitys into our solution, without a clear method for differentiating between the two. In found medical statistics, the children and elderly are typically grouped together.

4. Exactly 3 people travel to and from other villages/islands (for trade)in a period of one day.

   The team was not able to locate data on inter-village trading in the Philippines, necessitating the use of an estimate of traders. Due to the low number of people in the village, we determined that a one percent exchange of people into and out of the village was the most accurate estimate to the number of people traveling.

5. There is nobody in village prepared to provided care for the Ebola patients prior to the WHO professionals.

   The treatment of Ebola requires specific specialized materials such as an IV, medications for blood pressure, and transfusions. Therefore, the only care an unprepared native doctor from the village could feasibly provide would be to provide water for the sick patients.

6. The WHO medical professionals can treat 15 people in a day.

   We assumed that it takes a period of 10 minutes to prepare to treat a victim, 15 minutes to treat the victim, 10 minutes to follow procedure after treating the victim, with 5 minutes of travel time between houses for a total of 40 minutes spent with each victim.

7. The incubation period of the disease is a constant of seven days.

   The time of 7 days was determined based on the mean incubation time for Ebola. The range of incubation times for Ebola was 19 days, with a minimum of two days, and a maximum of twenty one days.

8. The medical professionals travel between households to treat infected individuals.

   In a town with a population of 300, it is unlikely that sophisticated medical facilities would be economically practical or demographically justifiable. It is much more likely that a medical professional would conduct houses visits rather than conduct formal appointments in an established medical facility.

9. 40% of the people treated by the medical professional do not recover.

   In a case study of Ebola in Africa approximately 70% of the people died over the course of a week, even with medical treatment. However, the problem stated that 10% of the people died over the same time span in Indonesia. Because the data given by the problem was not as thorough as would have been preferable, and because of the inherent differences between Africa and Indonesia, an average probability of death was taken.

10. It is assumed that every individual in the village is exactly the same, except for the state of the virus they are in (Susceptible, Infected, Removed, Deceased, Contagious).

Through this, we assume the four following points:

a) Those who do not have Ebola are completely healthy, and those who have contracted Ebola are completely healthy other than having the Ebola virus.

b) The probability of contact from a person with the virus transmitting the disease is the same from person to person.

c) The probability of infection is the same for each person with whom a healthy individual comes into contact.

   Although there are realistically differing probabilitys of infection per person, an assumed average probability of infection was determined. The probability of infection was determined based on the number of people a person in the village comes into contact with who are carriers of the Ebola virus, and whether or not they themselves contracted the virus

d) The number of people in contact with a person who has the Ebola virus is a constant.

4 MODEL DESIGN PROCESS

Table 2: List of Models

Population Part	Model
Suceptable	$S_{n+1} = S_n(1 - i\beta)^{C_n}$
Infected	$I_{n+1} = S_n[1 - (1 - i\beta)^{C_n}] - C_n$
Contagious	$C_{n+1} = I_n$
Deceased	$D_{n+1} = D_n + C_n\mu$
Removed	$R_{n+1} = R_n + C_n(1 - \mu)$

The start of the modeling process began with a basic version of the SIR model.

Table 3: List of Models in SIR model

Population Part	Model
Suceptable	$S_{n+1} = S_n - S_n[1 - (1 - \beta)^{I_n}]$
Infected	$I_{n+1} = I_n + S_n[1 - (1 - \beta)^{I_n}] - I_n h$
Removed	$R_{n+1} = R_n + I_n h$

In the SIR model it is assumed that an individual moves from being susceptible to the disease, to being infected with the disease, and finally to being removed from the population as immune.

In our version of the SIR model, it is assumed that an individual moves from susceptible, to infected, to contagious, and then either, to being removed, where they are healthy and immune from the disease, or the individual dies. It was assumed that when an individual died they were immediately buried in an isolated grave, thus no longer infecting the general population. Our final model was a set of difference equations that took all these factors into account.

Our models seen in Table 2 has five interrelated equations, calculating the amount of people susceptible to the disease, infected with the disease but not contagious, infected and contagious, deceased, and healed or removed from the population. At any point these 5 equations should always add up to the total population in a system.

Firstly we looked at the number of people in the population who are still susceptible to the disease, modeled in this equation:

$$S_{n+1} = S_n(1 - i\beta)^{C_n}$$

This equation takes the previous amount of susceptible people, S_n, and multiplies this by the probability that a person will come into contact with and be infected by a contagious person, $(1 - i\beta)^{C_n}$. This is calculated by taking the probability a person will come into contact with an individual, β, multiplied by the probability of infection, i, reversing the probability by subtracting it from one, creating the probability a person will not come in contact with an individual, $(1 - i\beta)$. This is then raised to the power of the number of contagious infected people, as seen in $(1 - i\beta)^{C_n}$. When this is multiplied by S_n it gives us the number of people who are not infected.

Secondly we looked at the number of people in the population who are infected but not yet contagious. We assume that the period of being infected without being contagious is equivalent to a single timestamp, or a single iteration of n, which in itself is equivalent to a week. This is modeled in the equation:

$$I_{n+1} = S_n[1 - i(1 - \beta)^{C_n}] - C_n$$

This equation is taken by taking the opposite of the equation described in problem one, $(1 - i\beta)^{C_n}$, thus getting $[1 - (1 - i\beta)^{C_n}]$, which gives us the number of people who are infected in a given timestamp. From that, we need to subtract the number of contagious people, which is equal to the infected people from the previous timestamp. So the number of infected people added to the number of susceptible people is equivalent to the number of susceptible people from the previous timestamp.

As mentioned above, the number of contagious people is equivalent to the number of infected people from the previous timestamp, seen in $C_{n+1} = I_n$. The assumption is made that it takes exactly one timestamp for an infected person to move from infected to contagious. Similarly the number of deceased people is equivalent to the previous deceased people added to the number of previously contagious people who have since become deceased. This is calculated by taking the previous contagious people and multiplying that by the probability of death, $C_n\mu$. The equation for D_{n+1} calculated the total deceased in a system up to a point. Similarly, the number of recovered people is calculated as the opposite

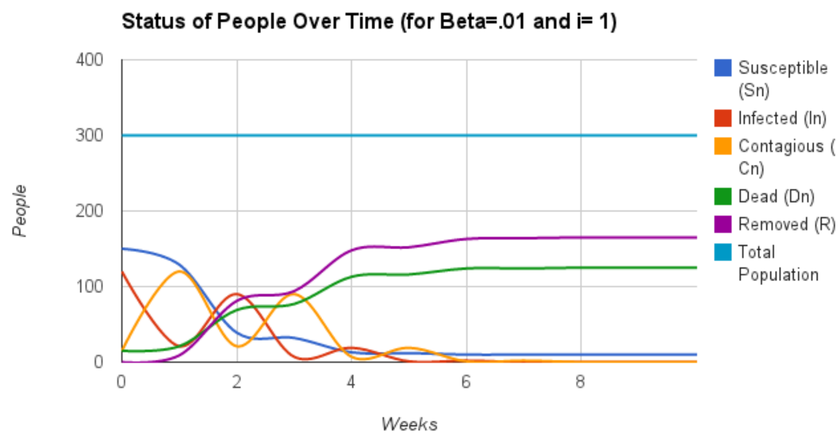

Figure 1: A graph for original assumed values ($\beta = 0.1$ & $i = 1$)

5 CONCLUSION

Table 4: Population Output for Assumed data

n	S_n	I_n	C_n	D_n	R_n
0	150	120	15	15	0
1	69	81	120	21	9
2	0	69	81	69	81
3	0	0	69	101	130
4	0	0	0	129	171

Certain values were assumed for the variables in order to model how the disease spreads throughout the population of our village. The values chosen for the variables and their explanations are listed below:

1. For S_0, the initial Susceptible population, the value 150 was assigned. This value was given in the problem. As we were told, half of the population was showing symptoms. Therefore, half of the population was not showing symptoms and, therefore, susceptible.

2. For I_0, the initial Infected population, the value 85 was assigned.

3. For C_0, the initial Contagious population, the value 50 was assigned.

4. For D_0, the initial Deceased population, the value 15 was assigned. This value was given in the problem. As we were told 15 of the infected had died within the first week, so 15 people are deceased.

5. For R_0, the initial Removed population, the value 0 was assigned. The problem did not specify any people who recovered from the disease so we assumed that the Removed population would be 0.

6. For i, the probability of infection, the value 1 was chosen.
   In other words every time a person comes into contact with an infected person they become infected.

7. For β, the probability of contact, the probability 0.1 was assigned.
   This was calculated by taking 30 people, our estimate of the number of people contacted in a day, and dividing it by 300 the starting population of the village. Even though as people die there are fewer people to contact, the probability of contact is kept the same, because we assume that as people die fear knits the community together.

8. For μ, the probability of death, the probability 0.4 is assigned.
   This value is the average of the death probability taken from the problem, what with 15 people out of a 300 population dying, and the death probability of a well known strain of Ebola, which had a probability of 0.6.

In conclusion, the toll of this virus will be rapid and deadly. Our results show a spike in illness which tapers off, with part of the population living and part of hte population dying. The data listed in Table 5 shows that everyone in our village will be infected with the disease, 171 people recovering (immune to the disease) and 129 dead.

6 CLASSIFICATION OF EPIDEMIC

A disease is classified as an epidemic if the rate at which it spreads in a population is comparatively high . The village in the problem is a trading village in it's area, so 3 people leave and return per day. The disease we modeled has the same level of aggression as the Ebola virus, and therefore is assumed to be highly contagious. If the disease is left untouched and allowed to spread freely such that the entire population of the Earth is infected with the virus; forty percent of Earth's population, approximately 2.8 billion people, would die even with treatment. It is clear that this disease is extremely dangerous. However, because disease is only affecting a small area, it is not yet a full epidemic. If the disease is not contained, it could have to potential to become a major epidemic or even a pandemic, with plague-like consequences for the entire world's population. If the disease is successful quarantined and eradicated, it will not likely become a major global problem.
Displayed in Figure 2 are the results of what would happen if the people in the village ended up spreading their disease to the world, and no action against the disease was taken.

7 ADRESSING ADDITIONAL INFORMATION

1. Appears to spread through contact with bodily fluids of an infected person.

   Considering the disease spreading through bodily contact of fluids the model can be run again with small values for β.

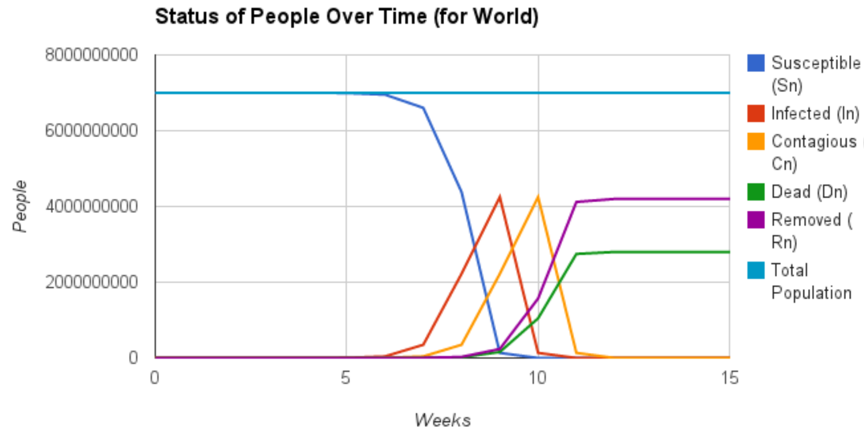

Figure 2: A graph for a world disease outbreak (given the inital village population leaving the village)

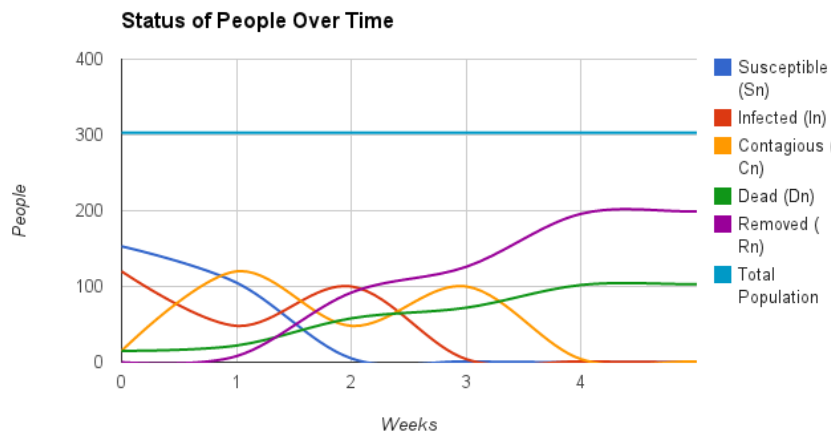

Figure 3: A graph for adjusted models ($\mu = 0.3$ & $\mu_\alpha = 0.8$)

2. The elderly and children are more likely to die if infected.

   Given that children and the elderly have an increased chance of death from infection, and assuming that this increase is the same for each group (Assumption 1)the model needed to be adjusted for multiple death probabilitys. Introduced into the model was the variable μ_α, the α signifying related to children and the elderly.

   The adjusted model takes into account different values for μ, the death probability. It takes the proportion of children and elderly in the population. Before simplification, the model for Death and Removal (the two aspects changed by adjustment) was:

$$D_{n+1} = \alpha(D_n + \mu_\alpha C_n) + (1-\alpha)(D_n + \mu C_n)$$

$$R_{n+1} = \alpha(R_n + (1-\mu_\alpha)C_n) + (1-\alpha)(R_n + (1-\mu)C_n)$$

Table 5: List of Adjusted Models

Population Part	Model
Susceptible	$S_{n+1} = S_n(1 - i\beta)^{C_n}$
Infected	$I_{n+1} = I_n + S_n[1 - (1 - i\beta)^{C_n}] - C_n$
Contagious	$C_{n+1} = C_n + I_n - D_n - R_n$
Deceased	$D_{n+1} = D_n + C_n[\alpha(\mu_\alpha - \mu) + \mu]$
Removed	$R_{n+1} = R_n + C_n[1 - \mu + \alpha(\mu - \mu_\alpha)]$

Here you can directly see how the proportions of the different constants were taken and added to form a whole.
Figure 3 shows a graph of the adjusted models with the values of $\mu = 0.3$ and $\mu_\alpha = 0.8$

3. A nearby island is starting to show similar signs of infection.

   The island should be cut off from the neighboring islands, ending all trade and any other forms of interaction between the islands. The only people that will be allowed to enter and leave the islands should be medical professionals, to diagnose people for the disease. Additional medical professionals will be sent with the equipment and supplies to treat the disease after it is confirmed that the disease is located on the islands. The medical professionals sent for diagnosis will be quarantined for a period of 21 days after visiting the villages in order to rule out the possibility of infection following their time on the island.

4. One of the researchers that returned to your capital appears infected.

   The researcher showing the symptoms must be immediately quarantined, along with every person in his proximity, including but not limited to the other people on the plane, any person he came into contact with at the airport, and any person he came into contact with between his time at the airport and when he reported he was showing symptoms. Furthermore, any location the researcher traveled to after visiting the village in Indonesia must be isolated for a period of 21 days to allow the virus to subside. The period of 21 days was chosen because that is the maximum extreme for the incubation period of the disease. After the 21 days, any person carrying such a viral infection will begin to show symptoms and will be required to come in for testing.

8 SENSITIVITY & ERROR ANALYSIS

Our model was relatively sensitive to change. The set probability of death for the model was 40%, meaning if a person contracted the disease, there was a 40% chance that person would die. The 40% death rate yielded a result of 129 of the 300 people dying over the course of 6 weeks. If the death rate was decreased by 10%, the number of people dead after the same period of time was 101. contrarily, if the death rate was increased by 10%, the number of people dead after 6 weeks was 159. Additionally, a smaller change in death rate was tested. If the death rate was increased by 1%, 131 people were found to not survive the disease, while if the death rate was decreased by 1%, 126 people died. If the model was applied to a larger scale, the change in death rate would cause a very significant change in its prediction of the number of people surviving the disease.

Additionally, if the probability of infection when one comes into contact with a person who is contagious is increased or decreased 10% from a base of 25%, the number of people who die of the disease remains constant. However, the time it takes for the disease to reach every member of the community is greatly altered. At a infection probability of 25%, it takes six weeks for the disease to reach every member of the community. If the probability of infection is decreased by 10% three of the original pool of susceptible victims are never infected. If the probability of infection is increased by 10%, the disease reaches every member of the community in only 3 weeks.

Lastly, if the probability of contact is altered, it affects both the number of people infected, and the death rate. The original probability of contact was 10%. If the probability of contact was decrease by 5%, four of the original pool of susceptible victims never receive the virus, and three fewer people die as a result. Furthermore, if the probability of contact is increased by 5%, the disease reaches every member of the community by the fourth week, but the number of people who die from the disease remains constant.

The majority of the error in our models comes from the many assumptions we made. The constraints in time did not allow us to test for every probability or circumstance. Given more time and unlimited rescources there are a few changes we would like to reasearch and add to our model:

1. Having β, probability of contact, be dependant on the remaining susceptible population.

   Currently β is a parameter, it can be changed per iteration of the model, but it remains constant during the run of the model. In actuality as the number of people in the village dwindles the probability of contact will decrease.

2. The models could be calculated continuosly instead of being discrete, as they are currently.

   Calculating the models continuously would allow for the change of the model over time to be monitored. It would also allow for immediate populations to be calculated rather than only at weekly intervals.

3. With unlimited resources, we would like to be able to go to Indonesia and learn more about their health care system.

   Several times throughout the process of building the models it was noted that the situation described was in a different environment from one we are familiar with. More information on the local level would allow for a mroe accurate model.

4. In more general terms we would like to be able to add more variables to the models.

9 RECOMENDATIONS

1. Instruct citizens to minimize physical contact, even with apparently healthy individuals.

   The spread of any viral infection is facilitated by physical contact, so limiting contact between healthy individuals and potentially infected individuals is a logical means by which to impede the spread of the disease. Certain symptoms of the disease (especially those of the earlier stages of the disease) may not be immediately evident to an observer. The disease, however, is contagious as soon as symptoms appear, so a healthy individual may be at risk even if no symptoms are outwardly visible.

2. Instruct citizens to stop travel (including trade missions) to other towns and villages.

   In the interest of containing the outbreak, citizens of the affected village should immediately halt all travel (including trade missions) with other villages and islands. Villages with which the affected village has traded since three weeks prior to the identification of the outbreak should similarly restrict travel to other villages.

3. Instruct citizens to refrain from attempting to treat sick individuals.

   Infectious diseases are easily spread by close contact between an infected person and a healthy person. Limiting this contact (except in circumstances in which the healthy individual is a medical professional who is trained in proper medical procedures for the handling of infectious diseases) is essential to controlling the spread of the disease in a population. It is especially easy to spread such diseases by attempting to administer treatment without training in the handling of infectious diseases.

4. Instruct citizens to periodically self-test for symptoms of the disease, including fever, fatigue, or muscle pain; if any of these symptoms are present in an individual, he/she should immediately seek out medical treatment.

   In order to maximize the potential for survival, treatment must begin as soon as possible. Many of the early symptoms of this virus can be detected by periodic self-tests, and treating the disease early in its progress can help to minimize its severity and spread.

10 QUESTIONS

1. What is the actual probability of recovery for persons treated by the doctors?

   Knowing the actual chance of a person who was treated by the doctor recovering would make the model more accurate. Without an accurate probability of recovery, it is impossible to know exactly how helpful the doctors on the island.

2. What is the actual average number of people entering/leaving the island a day?

   Knowing this value is important to determining how susceptible the outside world is to being infected with the viral outbreak on the island. A small number of travelers to and from the island would correspond to a low chance of the the Ebola escaping to infect people outside of the affected island, while a high number of travelers would result in a high chance of the virus escaping. To better model the chance of the disease infecting the outside world, this value needs to be accurate.

3. At what stage of sickness were the people showing symptoms on the island when the medical professionals arrived, and how long were they sick?

   Knowing the initial conditions on the island is essential to understanding how the virus develops. The initial conditions can make a better model that accounts for the initial number of infected, contagious, and deceased. If more people are contagious than we estimated, it would result in more people being infected more quickly. If fewer people were contagious, it would take more time for more people to be infected. To have the most accurate model, the stages of sickness when the medical professionals first arrive need to be known.

11 LETTER TO NEWS AGENCY

Dear News Outlet,

A local village in Indonesia has been found to be infected with a dangerous virus. You should inform the general population about methods to avoid getting this illness. Everyone should avoid physical contact with anyone, regardless of if it is known if they have the disease. A person can have the virus before they show symptoms. This virus is transmitted through the body fluids of infected individual, it is key to avoid blood, saliva, and other secretions. This virus can be contracted from any surface that has had contact with these secretions. Early signs of infection are fatigue, headache, muscle soreness, and sore throat. Later on a person may experience diarrhea, rashes, and symptoms showing kidney and liver failure, as well as both internal and external bleeding. Additionally, any town containing infected individuals should be avoided. As inter-town trade continues, the risk of the virus being spread is greater. We understand how difficult it will be for citizens to follow these mandates but it is essential that the spread of this virus is stopped. Citizens should not attempt to treat any victims of this disease by themselves. This virus is highly contagious even if proper medical procedure is not taken. If a non-infected person cares for a patient, it is extremely possible for the person caring for the victim to also become infected, and then further spread the virus. Lastly, it is necessary for individuals to *immediately* seek medical treatment if they have any of the aforementioned symptoms. Those with treatment are less likely to die. If these precautions are taken, it is possible to minimize the damage done by the virus. If the current trend of disease in Indonesia continues, without the interference of medical professions the results will be catastrophic. Our analysts predict that if proper care is not taken and the spread of the virus continues as we have seen over half of the world population could perish. We implore you to help us prevent catastrophe by sharing these recomendations for survival with your viewers.

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