The Ebola Crisis and Public Fear Networks
A System Dynamics Approach

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Abstract

One of the most important problems during a period of crisis in any country is how to respond to the public's fear. There has been a lot of research investigating epidemic diseases and the corresponding fear. However, a mere paucity of these have employed a system dynamics (SD) approach to demonstrate the relationships between pandemics and the public response to fear, the public perception of epidemic, and related organization's response to the issue. In this study, an SD model has been developed to study the hidden relations of some irrational behaviors and the spread of fear that accompanies the spread of disease. More specifically, our focus is on fear among the population due to the Ebola crisis. This model can also be used for the other outbreaks, and unfortunately, Ebola is not the last pandemic, and in the near future we will confront with less and more severe situations again. By learning from the past and using more systematic approaches, we will be able to stop the spread of disease faster. We conclude that we should use fear as a leverage point to confront the disease, and try to increase public attention in order to decrease the infectious rate.

Keyword

Ebola Virus Disease, Fear, Tweet, Irrational behavior, WHO, and Calibration.

Introduction

Changing people's habits is always difficult, but analyzing fear patterns can make this process easier for policy makers. It can be a strategy for regulators to implement their plan on changing population's habits. These kinds of strategies are called "Just As Well" strategies (Rowell, 2014). For instance, we can use people's fear to teach them to wash their hand, stay home when they are sick, and start taking the flu shot. These actions help people to take control over their fear. The author mentions three reasons why these strategies are useful; they give people the opportunity to overcome their fear by taking their fear seriously, they attract people's attention towards actions that can be useful for them, and they give motivation to groups to defeat risks. Therefore, it's a useless policy to remove fear which is raised by a fatal and frightening disease. Rather, the best way to produce positive changes is to show people what they can do to prevent getting infected, and try to increase public knowledge about the disease.

Overall, there are some factors that lead to the growth of fear from a specific disease. These include the probability of being infected by some products or contact with people, the possibility of fatality from the disease, the absence of control over the disease, the speed of

disease spread and a high number of mortalities, the low degree of knowledge and high degree of uncertainty about symptoms, and the mode of transmission of the disease.

Data analysis and current trends

In Figure 1, you are provided with the total cumulative number of death from Ebola Virus Disease in three main countries, Guinea, Liberia, and Sierra-Leone. The time period of death toll study is from March 2014 to March 2015.

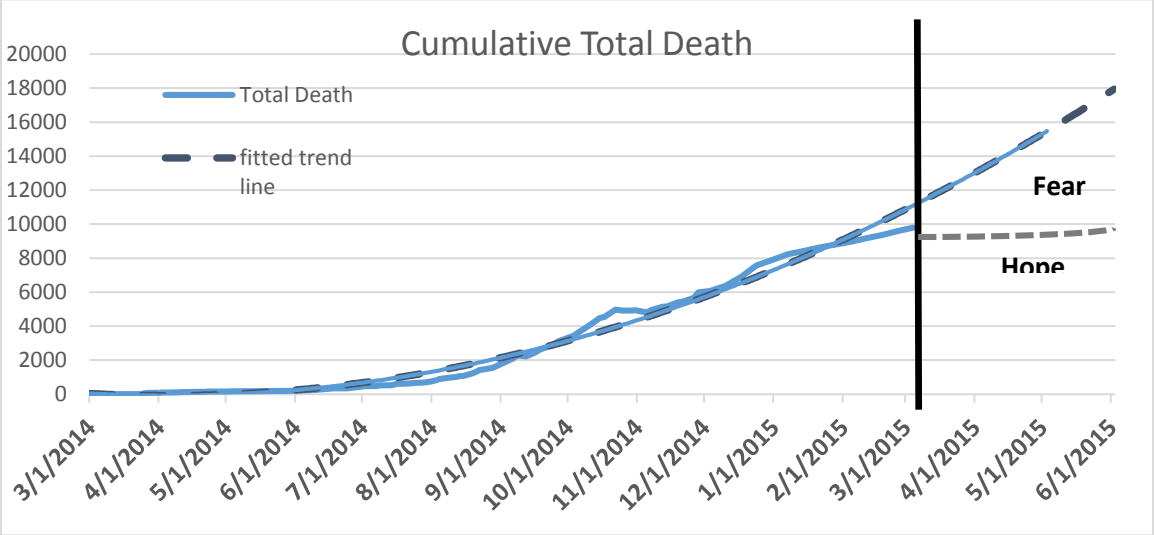

Figure 1 - Cumulative total death of Ebola

As can be seen, the total death had an exponential growth, which can be seen by the dark dotted line. Our hope is that total deaths from Ebola stops, but our fear is that total deaths continue to grow.

System Dynamics Model

We have developed a system dynamics model to understand the causal mechanism underlying the changes in fear and how this impacts the spread of Ebola. We will describe some of the interesting insights we have captured within the model shown in Figure 3.

In the case of Ebola Virus Disease, the people in United States started to experience a lot of fear due to the first and second infected nurse (Lyon *et al.*, 2014), who were treating the first Ebola infected patient in a U.S. hospital. After spreading fear through the population, a massive amount of news was broadcasted and everyone was talking about Ebola, its symptoms, and strategies to avoid getting infected. However, healthcare organizations like WHO and CDC, were trying to cover the issue, and as a result, media was releasing news with uncertainty to make these organizations reveal further information about the disease spread. This whole process reinforced the increase of fear among population, which is captured by feedback loop (R2 in Figure 3**Error! Reference source not found.**).

Meanwhile, healthcare practitioners started to release useful data from their own experience, and from reliable, credible sources such as CDC website(CDC, 2014) and New

England Journal of Medicine (NEJM, 2014). This helped people to learn about the facts and disease, and consequently decrease fear among the population (Lee, 2014). This is demonstrated by loop B7. Furthermore, as Symplur (2015) has demonstrated through analyzing doctors' tweet activity, the more they tweeted and released useful information, the less tweets from the public were made, and so the less fear there was among people (Figure 2). Tweets about Ebola represent fear or awareness.

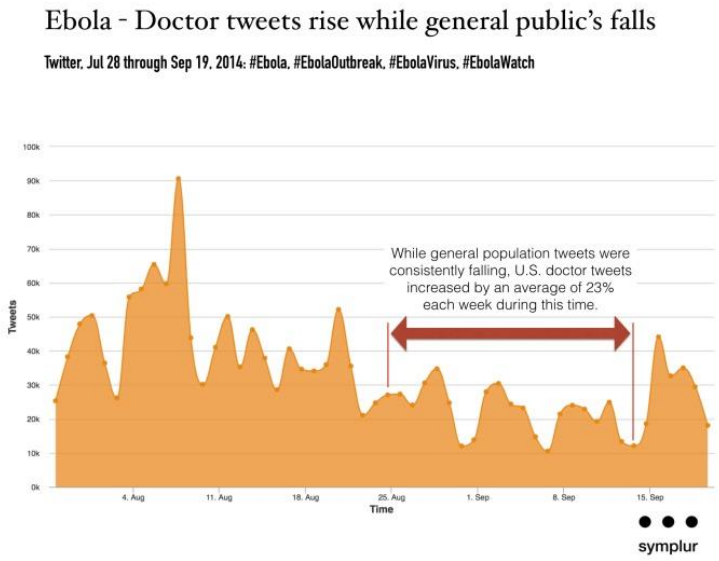

Figure 2 - Doctor Tweets about Ebola facts

Reference: Symplur

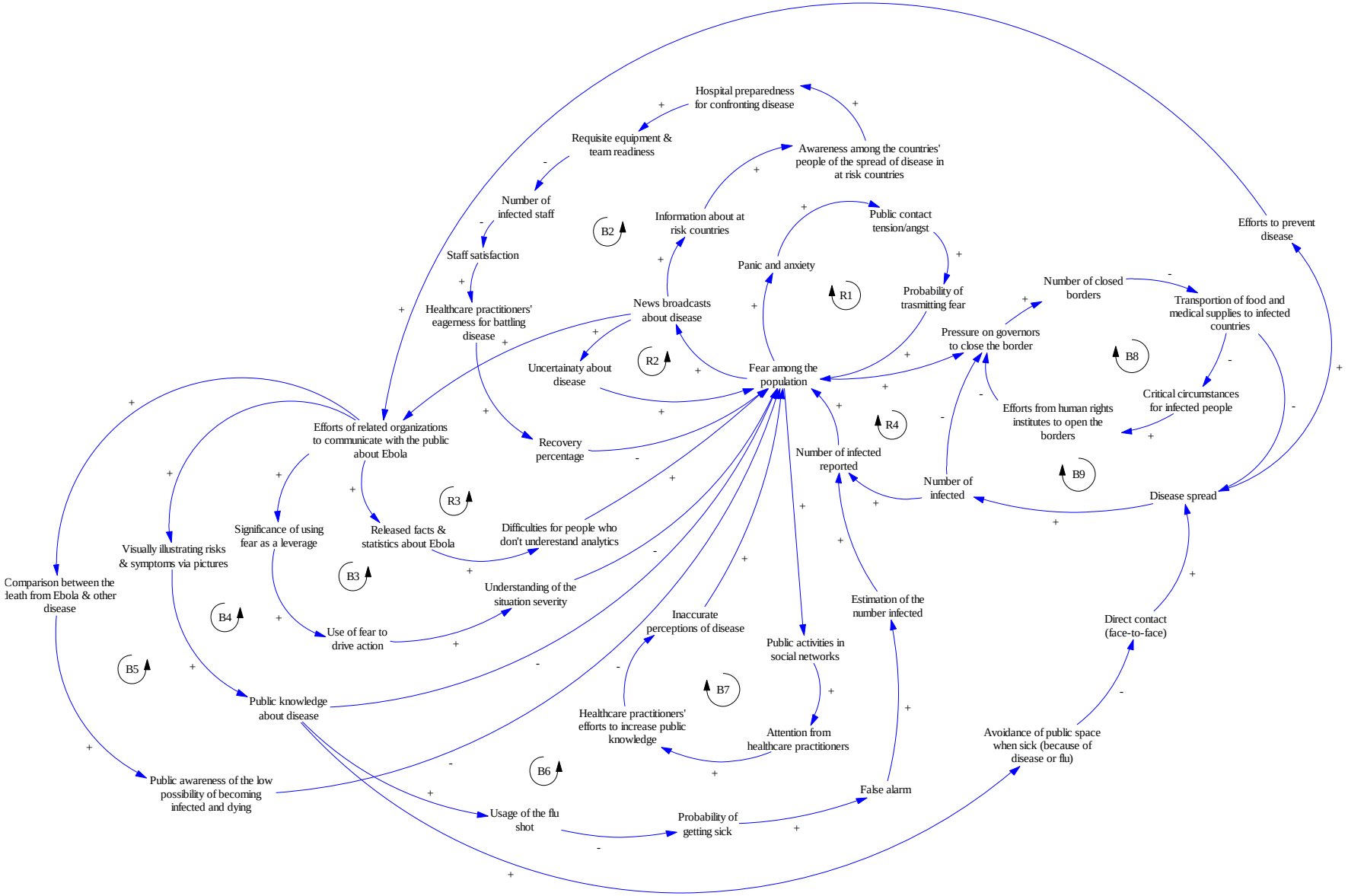

Figure 3 - Causal Loop Diagram

Simulation

We have developed simulation models, starting from the basic SIR model. Our objective is to capture the underlying social and behavioral mechanisms by calibrating our model to historical number of deaths and cases from WHO.

In each step, we calibrated some variables and did sensitivity analysis on variables to see which of them had the most significant influence on the output of model.

Conclusion

Overall, the aim of this paper is to establish that public perception and risk management are two critical points in the case of pandemics. Further, it is vital to consider the whole system and unintended consequences before implementing our policies because disease spread can affect all parts of society. Also in the case of the spread of a fatal disease, such as Ebola, it is not practical to attempt to eliminate fear in the public. On the contrary, we should use fear as a leverage point to confront the disease, and try to increase public attention in order to decrease the possibility of getting infected.

We plan to use our refined simulation model calibrated with the WHO data, to test different policy scenarios in leveraging public fear and awareness to deal with the spread of fatal diseases such as Ebola.

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