Understanding the Cholera Epidemic in Haiti: Comparing Disease focused, with a Complex Adaptive Systems [CAS] Approach

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Summary

Vibrio cholerae, has managed to easily weave its way through the country of Haiti resulting in the deaths of thousands of people. This is in part due to instabilities in a number of infrastructural components needed to secure the health of the Haitian people. Political strife influenced by both international and local entities continues to plague Haiti resulting in poor management and allocation of local and international funds. Water and sanitation infrastructure is non-existent, leading to the spread of lethal diarrheal diseases. The healthcare system is inadequately funded, resulting in poor access to essential healthcare. Social support networks are faltering as violence washes through the streets. And these are just a few examples of instability in critical systems required to ensure the health and safety of the Haitian people. What adds to the complexity are the many hands that are involved in “fixing” the problems of Haiti. Thousands of Non-Governmental Organizations (NGOs) are currently operating in Haiti, many focusing on the recent cholera epidemic. The pervasive strategy addressing the cholera epidemic in Haiti has been a disease-focused approach that measures its success based on a number of health indicators. Where health indicators are helpful, if they are not used appropriately it can lead to a deficient strategy that neglects the larger picture. This paper will explore and compare the disease focused and complex adaptive system (CAS) approaches. The purpose is to demonstrate how CAS holistically evaluates a system identifying critical interactions that effect long term stability. Through the understanding of these interactions appropriate strategies targeting a number of systems (political, water and sanitation, healthcare, economic, social, etc.) can be developed, thereby moving away from the traditional only intervention/outcome approach to embrace a comprehensive, holistic one.

Introduction

The cholera epidemic in Haiti resulted in data collection agencies struggling to amass accurate data, NGOs scrambling to provide life saving services, public health workers launching numerous education campaigns, and water and sanitation workers attempting to distribute the needed supplies to contain the epidemic; all the while political strife plagued the infrastructure

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building efforts by the Ministry of Health and the country’s economic system continued its downward spiral. The pervasive strategy addressing the cholera epidemic in Haiti is a disease-focused approach that measures its success based on a number of health indicators. Where health indicators are helpful, if they are not used appropriately it can lead to a deficient strategy that neglects the larger picture. This paper will explore and compare the disease focused and complex adaptive system (CAS) approaches. The purpose is to demonstrate how CAS holistically evaluates a system identifying critical interactions that effect long term stability. Through the understanding of these interactions appropriate strategies targeting a number of systems (political, economic, social, etc.) can be developed, thereby moving away from the traditional only intervention/outcome approach to embrace a comprehensive, holistic one.

When applying the disease-focused approach, specific health indicators of concern are identified, and interventions designed to adjust the health indicators in the appropriate directions are implemented. In the case of cholera, the number of deaths and number of cases caused by cholera are the two primary health indicators. During the implementation phase of health interventions the interdependence between sub-systems (political, economic, social, etc.) may be acknowledged, however, the effects the intervention has on the dependent sub-systems may not be identified because only the specified health indicators are being evaluated. For this reason, the disease focused approach and CAS approach are competing frameworks. In emergency situations the default approach is disease-focused, which primarily addresses short-term stability. However, the application of this approach may in fact drastically hinder long-term stability by adversely effecting critical dependent sub-systems. By using the CAS approach the effects of both short and long term actions can be evaluated in the context of the entire system.

Identifying a system as a CAS has certain implications. The first is that the system is considered non-linear and must be evaluated as a number of interdependent sub-systems (e.g. they cannot be analyzed independently). Secondly, a CAS is probabilistic; therefore, a level of uncertain behavior should be expected from the sub-systems. Uncertainty should be differentiated from unpredictability, the former suggests that the exact future state cannot be determined from a number of possible known states; however, the latter suggests that the system acquires a state that was not identified as a possible state (i.e. cholera in Haiti). Lastly, a CAS can result in chaos induced by only small changes in the overall system’s state. Through the use of the CAS framework it becomes possible to understand the interdependence of the sub-
systems, prepare for uncertainty, promote resilience to unpredictable states through sound infrastructure building, and identify states that may lead to chaos. For example, the early promotion of a water and sanitation system in Haiti could have provided resilience to the cholera epidemic (an unpredictable state).

**Background to the Ongoing Protracted Emergency Situation**

The cholera outbreak in Haiti was first detected on October 21, 2010; the first outbreak witnessed in at least a century. As of December 3rd, 2010 the Ministry of Health (MSPP) has reported 91,770 cases, and approximately 2,071 deaths. (MMSP 1586) What’s even more alarming is that some epidemiologists warn that the country could face more than a half a million cases over the next year. (Butler) Assuming the current case-fatality ratio of 2.3% (Figure 1) over the next year, the country will experience an estimated 11,500 deaths. Figure 1 does however present promising data, the case-fatality ratio has halved over the course of a month, presumably from the efforts of the MMSP, Pan American Health Organization (PAHO), and the many NGOs providing logistical support.

That being said, Dr. James Wilson, a founding member of the Biosurveillance Indication and Warning Analysis Community and founder of the Haiti Epidemic Advisory System (HEAS), which represents over 215 NGOs and individual responders in Haiti, reports that the figures stated by the MSPP are “gross underestimates” of the true caseload. HEAS states “The greatest discrepancies in reporting are observed in the difficult to reach mountainous, rural areas. There are currently no credible statistics to account for these communities, which are thought to represent nearly 2/3 of Haiti by land area.” (HEAS HEAS SiteRep) It is unclear what the true
statistics are, but what appears to be clear is that even using conservative estimates the current efforts are not sufficient to contain the rapidly moving disease blanketing the country of Haiti. The U.N. Secretary-General Ban Ki-moon’s remarks during the General Assembly’s informal meeting on Haiti (took place in New York on December 3rd, 2010), clearly emphasizes this position.

And yet one thing is clear: admirable as they may be, these collective efforts are simply not sufficient. Without a massive and immediate international response, we will be overwhelmed. The lives of hundreds of thousands of people are at risk. And it is up to us to act, with maximum speed and full resources. (Ki-moon)

**Disease-focused Approach**

The current strategy employed is mainly a disease focused approach that concentrates on treatment, containment, and prevention. Where there is some convergence in the goals established using both the disease focused and complex adaptive systems approach, there is a stark difference in the underlying methodology. Interventions that subscribe to the disease focused approach aim to affect health indicators directly associated with cholera, e.g. number of cases and case-fatality ratio.

**Treatment**

Treatment in the context of the disease focused approach is Oral Rehydration Therapy (ORT) and antibiotics, which serve to lower the case-fatality ratio. Severe cholera can quickly lead to death, in the most severe cases, the rapid loss of large amounts of fluids and electrolytes can lead to death within 2-3 hours, and in less extreme cases 18 hours to several days. (Mayo) Therefore, successful treatment is contingent upon immediate detection and application of ORT. The potentially rapid onset of cholera poses several logistical problems for Haiti. Firstly, areas that are known to have cholera cases must have a sufficient number of treatment centers. Secondly, the people experiencing severe diarrhea must be aware of the severity of the condition, know the location of cholera treatment centers, and have the ability to get to a cholera treatment center in a timely fashion. Lastly, nationwide surveillance systems must be able to quickly detect newly exposed areas, and rapidly deploy treatment centers to those areas. As shown in Figure 1 the case-fatality ratio has gradually dropped indicating these processes have been effective. However, using the case-fatality statistic as an indicator of nationwide treatment success could be problematic if the HEAS is correct in stating the current figures are “gross
underestimates”. At this point it is too early to generalize the data to the entire Haitian population; the only substantiated assessment now is that treatment appears to be effective in the areas surrounding data collection points.

**Containment**

Containment is primarily achieved through clean water distribution and proper hygiene and sanitation, and serves to lower the total number of cases. Transmission typically occurs through the contamination of water and food sources by fecal matter infested with the Vibrio cholerae bacteria. Contamination occurs mainly through two mechanisms: improper sewage disposal and the lack of or improper hygiene. The current containment strategy focuses on the distribution of clean drinking water, chlorine tablets used to disinfect water originating from questionable sources and soap. Where these measures have certainly helped slow the spread of cholera, they do not address the fundamental issue of waste disposal. There is currently no sewage treatment facility in Haiti, and experts believe that the threat of cholera and other waterborne diseases will continue to be pervasive until this void has been filled. (Schmall) Since January of 2010, humanitarian organizations have installed approximately 13,000 latrines, most of which are concentrated in the tent camps that average 50 people to every toilet. (Schmall) Henry Gray, a water and sanitation emergency coordinator for the Paris-based nonprofit Medecins Sans Frontiere (MSF), states “It’s not the camps where we are seeing a disproportionate number of cases. It’s the slums. The number of toilets in the slums is a worry. There are very few.” (Schmall) In Canaan, and estimated 12,000 family camp city spread over three miles share 50 latrines. (Schmall) And where toilets do consolidate and control the spread of fecal matter, they do not solve the problem of waste disposal. “Critical decisions have to be taken now, open new sites special for cholera waste and treat waste disposal correctly to avoid a new epidemic coming from all that waste,” Dr. Michael Janssens, an MSF press officer said. (Schmall)

**Prevention**

In times when cholera is not present, containment methods act to prevent isolated cases of cholera from manifesting into an epidemic. Therefore, it can be argued that there is a great deal of overlap in containment and prevention strategies. However, one preventative method that cannot be used in the containment phase, is the use of vaccines. The use of vaccines has been discouraged by PAHO in areas where the cholera outbreak has reached. (Knox) Generally,
vaccines are most effective when given to people who have not yet been infected. However, because cholera is asymptomatic in many cases, it is not apparent who has been infected. It is thought that in infected regions 80% of the people are carrying it without any symptoms.(Knox) Dr. Jon Andrus, deputy director of PAHO and vaccination specialist, says, “The horse is out of the barn, so you can’t determine with any accuracy where that bacterium is circulating…You already have transmission outside your ring,” referring to the “ring vaccination” strategy that was critical in eradicating smallpox.(Knox) Another issue is one of logistics. To properly be vaccinated two doses are required for adults and three in young children. “Keeping track of who’s been vaccinated and getting them back for a second and third dose presents enormous logistical problems and a lot of personnel. And even with all that effort, it still takes three weeks at the least for immunity to build in the body,” Andrus says.(Knox) That being said, the use of vaccines is a viable strategy that is being considered in areas where the outbreak has not spread. A main concern however, is the availability of the vaccine; there are only 200,000 doses of Durkoral, the only vaccine that has been approved by the World Health Organization (WHO) as safe. Another vaccine Shanchol is available in larger quantities, but has yet to be approved by the WHO.(Knox; WHO)

An Alternative Approach – Complex Adaptive Systems

In contrast to the disease-focused approach, the complex adaptive systems approach attempts to predict the emergence of a particular outcome by observing the complex interrelationship of the multiple sub-systems involved. John H. Hollland, a computer scientist with joint appointments at the University of Michigan and the Santa Fe Institute is a co-founder and significant contributor in developing the characteristics that define complex adaptive systems, states:

Many of our most troubling long-range problems-trade balances, sustainability, AIDS, genetic defects, mental health, computer viruses - center on certain systems of extraordinary complexity. The systems that host these problems - economies, ecologies, immune systems, embryos, nervous systems, computer networks - appear to be as diverse as the problems. Despite appearances, however, the systems do share significant characteristics, so much so that we group them under a single classification at the Santa Fe Institute, calling them complex adaptive systems [CAS]. This is more than terminology. It signals our intuition that there are general principles that govern all CAS behavior, principles that point to ways of solving the attendant problems.(Horgan 104-109)
The theory attempts to construct a unified structure that can be used to simulate/evaluate seemingly very different problems that have similar underlying characteristics or principles governing their behavior. It is important to note that where the unifying nature of complex adaptive systems is novel, the nature of complex adaptive systems is not foreign to those who are holistic experts. If you were to ask Dr. Paul Farmer, an anthropologist and physician who is the Presley Professor of Medical Anthropology in the Department of Social Medicine at Harvard University and an attending physician at Brigham and Women’s Hospital in Boston, about the reasons for the lack of access to clean water and sanitation in Haiti, he would be able to describe the complex interactions associated with Haiti’s history, current politics, economy, social systems, international community, etc… The complex interactions between systems in Haiti will be highlighted by providing a brief historical context, followed by news surrounding the cholera outbreak.

**Historical Context**
A significant factor affecting Haiti’s expenditure on public health is its external debt.(Chatterjee 615-618) Haiti’s history of debt can be traced back to their independence from France in 1804; the Haitians say that in 1825, France, with warships ready to be deployed, demanded that the Haitian government compensate them for their loss of a slave colony. (Chatterjee 615-618) The French demanded 150 million Francs (approximately $21 billion today), in exchange for French recognition of Haiti as a sovereign republic and to lift the trade embargo.(Chatterjee 615-618) The colony at the time was designed primarily to provide agricultural exports such as coffee and sugar, however, with the Europeans and the United States following the French-led embargo on Haiti, it was unlikely they would be able to find other customers.(Farmer 305-325) These pressures resulted in a large debt taken on by the nation. Jean Price-Mars, a Haitian anthropologist, states, “From a country whose expenditures and receipts were, until then, balanced, the incompetence and frivolity of the men in power had made a nation burdened with debts and entangled in a web of impossible financial obligations.”(Farmer 305-325) The United States refused to recognize Haitian independence until 1862, however, the isolation was largely diplomatic and rhetorical.(Farmer 305-325) Throughout this time the United States was increasingly present acting as a trading partner and policeman. Eventually, their continued naval presence led to their occupation of Haiti.(Farmer 305-325) This resulted in a number of military and paramilitary governments ruling from 1957 to the Duvalier regime, which accrued millions
of dollars in debt. (Farmer 305-325) Fast-forwarding to post 2000 elections, Jean-Bertrand Aristide became the first democratically elected president. However, because he was highly unpopular with the United States government the claim was made that the elections were corrupt, which led to the subsequent use of the United States’ influence with international lending institutions to freeze already approved loans earmarked for development and improving health, education, and water quality in Haiti. (Farmer 305-325) Furthermore, direct aid from the U.S. government bypasses the formal national structures, such as the Ministry of Health and Education, and is solely distributed to nongovernmental agencies (NGOs). (Farmer 305-325)

This history clearly outlines a series of events that led to political and civil unrest, international interference, failure to establish a thriving economy or build health, education, and water and sanitation infrastructure. Additionally, the current policy to bypass the Ministry of Health and Education only serves to weaken the Haitian government’s ability to control the development of their infrastructure. “Since NGOs are basically accountable to the constituencies that sponsor them, and Haitian government officials and politicians rely heavily upon them to access the resources (financial or otherwise) necessary to gain internal political consensus, the power of NGOs to steer and influence local politics is likely to be much stronger than the local electorate’s.” (Zanotti 755-771)

Recent News
In January 2010, a devastating earthquake hit the Haitian people, leaving over 1.5 million people displaced from their homes. (Sontag) October 2010’s cholera outbreak has led to large scale protests and riots as Nepalese United Nations troops are blamed for carrying a foreign (Asian) strain of cholera into Haiti. (Associated) In the town of St. Marc, a group of local residents demonstrated violently against a cholera treatment center established by MSF. The facility was being built on a soccer field near a school, and the 300 protesters feared the clinic would bring more disease to the town and infect the children. Francoise Otero, an MSF representative said "They didn't understood well what was the purpose of this camp and how are we going to treat the patients there." (Mulholland) Currently, there is speculation that the recent election results are fraught with corruption leading protestors to take to the streets. President Rene Preval, said “people are suffering because of protests that have spread throughout the capital since the results were announced late Tuesday (Dec, 7th, 2010).” (Associated) What is ironic is that twelve of the eighteen candidates wanted to cancel the elections due the lack of
preparation and chaos at the polls; however, the international community pushed hard for Haiti to launch the November 28th, 2010 election. (Beaubien; Mozingo) With $6 billion in aid pledged for the country, the international community claims to want a stable, legitimate government for the reconstruction effort. (Mozingo) Amidst this chaos cholera is spreading and people are suffering. The experts know that an effective water and sanitation system is the answer to their problems, "Critical decisions have to be taken now, open new sites special for cholera waste and treat waste disposal correctly to avoid a new epidemic coming from all that waste," says Dr. Michel Janssens, an MSF press officer. (Schmall) However, the inability of the international community to comprehend the realities in Haiti, leads to disconnected policy and the withholding and misallocation of critical funds.

**Complexity and Emergence**

The historical context and recent news outlines the complexity of the situation. And those who are holistic experts in the area will have an intimate understanding of the interactions that have led to the chaos that currently plagues Haiti. Adding to the complexity are those (non-experts) that attempt to perform a number of functions in Haiti without having the contextual knowledge that has shaped political, economic, social, education, health, and water and sanitation systems, among many others. Currently there are “non-experts” who staff the thousands of NGOs now operating in Haiti, as well as powerful international agencies that force an agenda with possible outcomes that are not well understood. (Zanotti 755-771) Therefore, it is imperative to put these complexities within a framework that will allow local and international agencies to better understand the nature of the outcomes that may result from their actions. Utilizing the CAS approach, models can be created that describe/detail the interactions between political, economic, education, social, health, and water and sanitation systems. It may be found that attempting to establish a water and sanitation system with the current levels of political and civil unrest may not be feasible or lead to an ill planned inefficient system that could be detrimental to the people of Haiti. This however does not abandon the idea of establishing a water and sanitation system, it simply means that other systems must first be strengthened before the development of a water and sanitation system becomes viable.

John H. Hollland and many others at the Santa Fe Institute have been working on CAS computer models that can be used to simulate potential system interactions associated with actions taken by an entity such as an NGO.
If we are to make parallel simulations of complex adaptive systems accessible, two criteria must be satisfied. First, the parallel simulation must directly mimic the ongoing parallel interactions of the complex adaptive system. Second, there must be a visual, game-like user interface that provides natural controls for experts not used to exploring systems via computers. For example, a policy maker should be able to try out an economic model in much the way that a pilot tries out a flight simulator. (Holland 17-30)

By having a flexible computer model, “non-experts” can adjust parameters associated with political, economic, social, information and communication, healthcare, educational, transportation, legal, protective, food and nutrition, and energy systems. Through this investigative process, it may become evident that strengthening several of these systems may be required before the emergence of an effective water and sanitation system becomes viable. The power of the collective use of this framework, is that “non-experts” will converge on a set of systems, which will effectively concentrate resources where they are needed most. The convergence will occur in a distributive fashion, where the players involved are not being guided by a central agency, rather through the use of this framework they are individually coming to this conclusion. This is a powerful feature because creating a central agency to coordinate thousands of NGOs would be a logistical nightmare and an unrealistic task. Once the players have converged on the systems that require building, they have essentially established a common set of rules by committing to the strengthening of specific set of infrastructural components. “Assuming that individual or local units want what’s best for themselves (common set of rules) spontaneous cooperativity will emerge from chaotic events.” (Rihani) This implies that once a common set of rules has been established, a pattern of cooperation will evolve between thousands of NGOs without the need for a central organizing agency. Currently there is no common set of rules between the individual and local units involved in Haiti, and for the most part there has not been the cooperative emergence of stable structures. “How on earth could one rebuild such a broken place? Haiti has no roads to speak of and poor telecommunications. Agriculture has faltered, perhaps irreparably, and no industry promises to replace it. There are of course great polemics regarding the methods of “grassroots” development and production for export and equally high sentiment regarding foreign aid.” (Farmer 305-325)

The CAS models being developed at the Santa Fe Institute are in the development phase and may not be available for several years. However, there are local and international holistic
experts such as Paul Farmer, and interdisciplinary teams who can in the intern serve this function. It is incumbent upon “non-experts” to involve holistic experts and/or interdisciplinary teams in their decision making process before committing time and resources to an intervention that could possibly support destabilization processes.

An example demonstrating the power of the CAS approach was highlighted in a case study performed within Bosnia between 2004 and 2005. It was found that the introduction of a primary health care system required the intimate and coordinated involvement of political, social, and economic systems. (Atun et al. 28-39) They identified the need for a simultaneous and holistic analysis of the context, the innovation, the adopters and the interactions between them over time. (Atun et al. 28-39) Within a few years, multifaceted reforms in Bosnia led to over 25% of the country having access to primary health care services. This case study is especially compelling because the primary care infrastructure was developed in spite of considerable resource constraints and a challenging post-war context. (Atun et al. 28-39)

**Conclusion**

There is a stark difference between the disease focused and complex adaptive systems approaches. The disease focused approach identifies specific health indicators, and using a number of approaches aims to drive those indicators in the desired directions. Infrastructure building may be a strategy employed, however it is not implied. Therefore, it cannot be assumed that positive trends in the health indicators are associated with long-term stability. Furthermore, because only health indicators are used to monitor the effects of the interventions, other sub-systems may be adversely affected and not identified in the process. In contrast the CAS approach aims to establish long term stability by understanding the nature of the interdependence between the subsystems (political, economic, social, education, health, etc…). Through the understanding of these processes resources can be used more efficiently as beneficial and harmful interactions are highlighted. Furthermore, CAS focuses on sub-systems and infrastructure building, which inherently promotes long-term stability.
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