Biological Disaster Response

Aaron McConnell

Throughout history, one issue that immediately strikes fear into people is the thought of being infected with a lethal or debilitating disease. The image of blood oozing from a friend's or family's orifices as life leaves their body paralyzes even the most stoic of individuals with fear. As a disease spreads across a community, one cannot help but fear the possibility of being next. Once the disease ravages a community and moves to the next community, it quickly becomes an epidemic or, worst case scenario, a pandemic, and it spreads with impunity.

Technological advances in transportation has exponentially decreased the amount of time a disease needs to spread across continents. A disease trapped in a large cylinder as it travels by plane or boat provides the organism the perfect environment for incubation and transmission. Even societies that do not travel by plane or boat migrate from location to location and this mobility can also be a mechanism by which disease is spread. For example, those who contracted the Ebola virus and fell ill would oftentimes go to the hospital spreading the infection back to hospital workers that then brought the virus home and exposed others who were healthy individuals.[1]

In addition to transmission of diseases between humans, there is the threat of cross-species infection due to importing animals from other locations across the world. Animals and humans have intimate interactions, whether for research, consumptive purposes or as companions. These zoonotic infections are perfect carriers by which to infect a population quickly, regardless if the exposure is accidental or deliberate as in a direct terrorist attack.

However, most zoonotic infections are treatable. Parasites, of course, are pervasive, especially in very poor countries (e.g., those in Africa and Asia). Tapeworms, flatworms, and

[1] Richard Preston, *The Hot Zone: The Terrifying True Story of the Ebola Virus*, (New York: Random House, 1994), p. 44.

other helminths cross-contaminate between animals, yet, if treated, the effects can be mild.[2] Horrifying diseases of the past such as the Bubonic Plague, caused by the microscopic parasite Yersinia pestis that killed 75 million people, and was zoonotic in origin.[3] Despite this, it, and other fatal diseases like malaria or tetanus, are quite manageable with modern medicine.

Even food can be hazardous. Toxoplasmosis and Salmonellosis are the most common infections seen in North America that are transmitted between animals and humans.[4] However, in other parts of the world, protein is a precious commodity. The eating of bushmeat is common and most of those that consume bushmeat are not concerned about what type of animal it came from. Contracting diseases such as Q Fever, Leptospirosis, and even rabies are not unheard of.[5] Even Ebola can be traced back to consumption of bats or monkeys in Africa.[6] But the eating of monkey meat, a fellow primate, has caused tremendous problems with emerging threats from Africa, regarding diseases.

Monkeys possess many of the same diseases as humans, and some diseases specific to monkeys can evolve in to human diseases. The origins of Human Acquired Immune Deficiency Syndrome (AIDS) have been traced back to two simian diseases – Simian Immunodeficiency Virus in chimpanzees (SIVcpz) and Simian Immunodeficiency Virus from sooty mangabeys (SIVsm).[7]

The importing of research animals from around the world expose humans to risk as diseases can be passed between humans and animals, especially primates. "Monkey houses,"

---

[2] "Animal Transmitted Diseases." Washington State Department of Health. Accessed 6 December 2016. http://www.doh.wa.gov/YouandYourFamily/IllnessandDisease/AnimalTransmittedDiseases.
[3] *Ibid.*
[4] *Ibid.*
[5] *Ibid.*
[6] Melissa Hogenboom, "Ebola: Is bushmeat behind the outbreak?" *BBC News,* 19 October 2014, http://www.bbc.com/news/health-29604204.
[7] J.M. Conly and B.L. Johnston, "The infectious diseases consequences of monkey business," *Canadian Journal of Infectious Diseases and Medical Microbiology*, 19 January 2008, p. 12.

used for research have been found to be carriers of Ebola to the United States.[8] With a mortality rate of 50-90 percent, regardless of propensity of infection, if unmanaged, this would destroy a community.[9] This illustrates the ability of zoonotic infections to cross over to the human population.

But these animal based infections only start there. Whether the delivery agent is a flea, a mosquito, or a fellow human, these infections can spread at an alarming rate. In the movie *Contagion*, it depicts how quickly the disease moved from bats, to pigs, to humans, only to become an epidemic.[10] Although a fictional account, the ability for a disease to spread through a population is very real. From the bowl of peanuts on the bar counter, to shaking hands with a cook, it only takes a brief interaction to set forth a dangerous chain of events.[11]

This chain of events occurs through contact, but has a specific formula for the transmission rate. Differential equations are used to calculate the transmission rate of a disease, using three groups within the population: those that are susceptible, those that are infected, and those that have recovered.[12] When an unknown and foreign disease (e.g., Ebola) is introduced to a new population, virtually all are susceptible to being infected. Additionally, since the mortality rate is between 50 and 90 percent, very few recover, allowing the disease to continue spreading, due to lack of immunity.[13] However, the aggressiveness of a disease (e.g., Ebola) is beneficial to controlling the outbreak to a single population, since the average life span of one who contracts

---

[8] Richard Preston, *The Hot Zone: The Terrifying True Story of the Ebola Virus*, (New York: Random House, 1994), p. 359.
[9] *Ibid*, p. 284.
[10] *Contagion*, directed by Steven Souderburgh, performed by Matt Damon and Lawrence Fishbourne, 2011.
[11] *Ibid.*
[12] Matthew Keeling, "The mathematics of diseases," *Plus Magazine,* 1 March 2001, https://plus.maths.org/content/mathematics-diseases.
[13] Richard Preston, *The Hot Zone: The Terrifying True Story of the Ebola Virus*, (New York: Random House, 1994), p. 284.

the disease is approximately a month.[14] This being said, once the symptoms begin, the host only has about 12 days before they are succumb to the disease and likely will die, and during this time they remain communicable.[15] This reduces the R_0, or the number of people one sick person will infect, to 2, whereas the R_0 of measles is 18.[16]

The Hot Zone and *Contagion* movies both do an excellent job of illustrating the ability of a disease to spread through a susceptible population. As mentioned above, the Ebola virus infects fewer people, because it is so lethal. However, *Contagion* shows what a less aggressive, more communicable disease could do, just as the Bubonic Plague did in Medieval Times.

But how could a community react to an epidemic that spreads like these diseases? The first task community leaders should engage in is the establishment of a standard operating procedure (SOP) for disaster response, before it is needed. This SOP should contain specific measures and actions once an incident occurs and address not only biological incidents, but nuclear, chemical, and high-yield explosive attacks, and naturally occurring events like hurricanes and tornados.

Specific SOPs for an epidemic should begin with establishing a command post and then implementing and adhering to the principles of the Incident Command System. The SOP will have already outlined the chain of command, in which the Disaster District Coordinator (DDC) and the Military District Coordinator (MDC) would work in conjunction with one another, the DDC being the authority, but providing the unity of command necessary for a successful operation.[17] Once the command post is operational, an Incident Action Plan (IAP) should be

---

[14] Nathan Wolfe, *The Viral Storm: The Dawn of a New Pandemic Age*, (London: Allen Lane, 2011), p. 107.
[15] Michael T. Osterholm, et al. "Transmission of Ebola Viruses: What We Know and What We Do Not Know." Journal of the American Society for Microbiology. 19 February 2015. http://mbio.asm.org/content/6/2/e00137-15.full
[16] *Ibid.*

developed, and delegation of authority and allocation of resources should begin. The necessary comprehensive resource management, outlined in the ICS, should be adjacent to the command center, in order to provide command and control of all resources.[18] By using mobile resources, such as fuel trucks and Light-Medium Tactical Vehicles (LMTV) to distribute all of the essential items, it prevents unnecessary individuals from being in the secure area and allows the resources to be pushed out to the affected area quickly. Items, specifically medical supplies and water should be staged in a central location along with fuel and rations and the area should be guarded at all times.

A plan for transportation of affected individuals out of the area of operations for medical treatment and evaluation is imperative. Specific LMTVs should be identified for transport of sick individuals, and depending on the severity of the outbreak, aerial resources should be considered. Much like with the Ebola outbreaks in Africa, helicopter landing zones (HLZ) in the area within the cantonment should be established for use, as a last resort.[19]

However, a plan for those who remain in quarantined areas should also be implemented. All the necessary resources will be co-located with the COP. With this, rations and water will be readily available, along with medical equipment, but other incidental items should also be taken into account. Since the COP will likely be at a convention center, or large gymnasium, cots should be set up in order to administer a sleep plan for those working in the operations center, along with plenty of room for displaced persons. Although encouraged to have three days of supplies on hand, many will not. Working with non-governmental organizations to provide basic hygiene items is imperative, such as baby wipes, soap, etc. Otherwise, additional problems due

---

[18] "ICS Features and Principles," FEMA, accessed 4 December 2016, https://training.fema.gov/emiweb/is/is100b/.../03ics100b_visuals_october2013.pdf.

[19] Conrad R. Wilmoski and Meghan C. Muller, "Is the United States Ready for a Deadly Airborne Disease Outbreak?" *Interagency Journal,* Vol. 7, Issue 2, Summer 2016, p. 60.

to hygiene issues will present within the cantonment area. Included in this is additional portable toilets, with the target of 1 toilet per 25 individuals on the scene.

Once this first stage of establishing a cantonment area for resources and personnel is complete, the necessary principles of epidemiology and control should be enforced. Because current protocol is less aggressive in containment, this presents a hazard to the general population. The current standard, as prescribed by the CDC is a thirteen-step approach. The steps are: prepare for field work, establish the existence of an outbreak, verify the diagnosis, construct a working case definition, find cases systematically and record information, perform descriptive epidemiology, develop hypotheses, evaluate hypotheses epidemiologically, as necessary; reconsider, refine, and re-evaluate hypotheses, compare and reconcile with laboratory and/or environmental studies, implement control and prevention measures, initiate or maintain surveillance, and, finally, communicate findings.[20]

This analytical approach dates back to the mid-nineteenth century. In Soho, London a cholera outbreak was affecting people, and Dr. John Snow decided to plot the locations of the affected individuals.[21] After plotting the sites, and examining the data, he found that the common link was to water on Broad Street. By researching the incidence, he found the culprit, and was able to shut down that pump, stopping the outbreak.

Sometimes the culprit is airborne, making the halting of an epidemic infinitely more difficult. Prior to even the thought of a biological attack, the influenza pandemic of 1918 ravaged the United States, Europe and Asia.[22] Because of the movement of soldiers and sailors across the

---

[20] "Principles of Epidemiology in Public Health Practice, Third Edition," *Centers for Disease Control and Prevention,* 15 September 2016, http://www.cdc.gov/ophss/csels/dsepd/ss1978/lesson6/section2.html.
[21] Kenneth J. Rothman, *Epidemiology: An Introduction*, (Oxford: Oxford University Press, 2002), p. 71.
[22] John M. Barry, *The Great Influenza: The Epic Story of the Deadliest Plague in History*, (New York: Penguin Books, 2005), p. 278.

globe, the flu traveled far and wide, and the vessels carrying sailors were also carrying far more nefarious cargo. In the fall of 1918, ships that arrived in Philadelphia brought a number of infected sailors into the harbor, just as had happened in other areas, which added another location to the already long list of cities plagued with influenza.[23] Because no specific instruction was given, ships were bringing infected people from other locations in the U.S. and Europe, adding to the infection rate. Although minimal quarantines were enforced, freighters, such as the "City of Exeter" were allowed to disembark on U.S. soil.[24]

The word quarantine comes from the Italian words *quaranta giorni*, meaning "forty days."[25] It comes from the practice of staging ships off of the coast of Venice for forty days, prior to being allowed to land, and was very effective in controlling the spread of disease from infected ports. After this period of time, a majority of the individuals on board were either dead or immune from any pestilence. This did not occur in Philadelphia, at least not for forty days. However, when the City of Exeter did arrive, it was to an empty port with no one but ambulance personnel wearing surgical masks, taking the ship full of affected individuals to the hospital, effectively sequestering them from others, until they could reach medical treatment. Measures such as this should have been taken everywhere, but since they were not, an estimated 20 to 50 million people died around the world.[26]

With an aggressive infectious and highly contagious disease, a more proactive approach is needed. This presents difficulty in a free and open society, but in extenuating circumstances, it

---

[23] John M. Barry, *The Great Influenza: The Epic Story of the Deadliest Plague in History*, (New York: Penguin Books, 2005), p. 311.
[24] *Ibid*, p. 272.
[25] "Quarantine and Isolation," *Centers for Disease Control and Prevention,* 31 July 2014, http://www.cdc.gov/quarantine/historyquarantine.html.
[26] John M. Barry, *The Great Influenza: The Epic Story of the Deadliest Plague in History*, (New York: Penguin Books, 2005), p. 202.

becomes necessary to execute a plan that is more audacious than the public is comfortable with. Although the conventional methods should be followed, such as forming hypotheses and identifying disease, effective quarantines must be enforced. While the discovery phase is being executed, and the Centers for Disease Control (CDC) and local healthcare practitioners are trying to find out what the disease actually is, the infected population must be sequestered in order to reduce the amount of contact between individuals. If done properly, this can greatly reduce the spread of the disease. In addition, the use of proper personal protective equipment (PPE) by those caring for the infected individuals ultimately protect themselves from contracting the disease. Containment is required for the overall safety and security of the population.

Security and safety for the public is the number one priority for first responders, and an outbreak, whether intentional or not, is a horrifying event to even conceive. Hollywood has illustrated this fact for years with movies such as *Contagion, Outbreak,* and *28 Days Later,* and these interpretations feed on the fear that one may contract a deadly disease that is spreading across the community. This fear has been present for centuries, and due to the fact of being based on reality, this fear is present for many. The Tuberculin outbreak in the 1800s in the United States affected millions, and Tuberculosis continues to plague the globe today.[27] The spread of such diseases between humans; however, has increased in speed exponentially, due to the increased mobility of individuals and hosts, regardless of species. As such, the ability to control an outbreak is inversely correlated with mobility, making control remarkably more difficult. Because of this, it is incumbent for all who are responsible for control of the spread of disease to present increasingly creative solutions for the management of disease, while instituting a decisive plan of action. If the first responders are able to achieve this, once an outbreak occurs,

[27] Raymond Hurt, "Tuberculosis sanatorium regimen in the 1940's: a patient's personal diary," *Journal of the Royal Society of Medicine,* July 2004, p. 350.

the incidence of death related to it will be reduced, which is the goal of any disaster response, regardless of the origin and nature of the disaster.

Bibliography

"Animal Transmitted Diseases." Washington State Department of Health. Accessed 6 December 2016. http://www.doh.wa.gov/YouandYourFamily/IllnessandDisease/AnimalTransmittedDiseases.

Barry, John M. The Great Influenza: The Epic Story of the Deadliest Plague in History. New York: Penguin Books, 2005.

Conly, J.M. and B.L. Johnston, "The infectious diseases consequences of monkey business," Canadian Journal of Infectious Diseases and Medical Microbiology, 19 January 2008, pp. 12-14.

Contagion. Directed by Steven Souderburgh. Performed by Matt Damon and Lawrence Fishbourne. 2011.

Hogenboom, Melissa. "Ebola: Is bushmeat behind the outbreak?" BBC News. 19 October 2014. http://www.bbc.com/news/health-29604204.

Hurt, Raymond. "Tuberculosis sanatorium regimen in the 1940's: a patient's personal diary" Journal of the Royal Society of Medicine. July 2004. pp. 350-353.

"ICS Features and Principles," FEMA, accessed 4 December 2016, https://training.fema.gov/emiweb/is/is100b/.../03ics100b_visuals_october2013.pdf.

Matthew Keeling, "The mathematics of diseases," Plus Magazine, 1 March 2001. https://plus.maths.org/content/mathematics-diseases.

Michael T. Osterholm, et al. "Transmission of Ebola Viruses: What We Know and What We Do Not Know." Journal of the American Society for Microbiology. 19 February 2015. http://mbio.asm.org/content/6/2/e00137-15.full.

Preston, Richard. The Hot Zone: The Terrifying True Story of the Ebola Virus. New York: Random House, 1994.

"Principles of Epidemiology in Public Health Practice, Third Edition." Centers for Disease Control and Prevention, 15 September 2016. http://www.cdc.gov/ophss/csels/dsepd/ss1978/lesson6/section2.html.

"Quarantine and Isolation." Centers for Disease Control and Prevention. 31 July 2014. http://www.cdc.gov/quarantine/historyquarantine.html.

Rothman, Kenneth J. Epidemiology: An Introduction. Oxford: Oxford University Press, 2002.

Wilmoski, Conrad R., and Meghan C. Muller. "Is the United States Ready for a Deadly Airborne Disease Outbreak?" Interagency Journal, Vol. 7, Issue 2. Summer 2016. pp. 56-63.

Wolfe, Nathan. The Viral Storm: The Dawn of a New Pandemic Age. London: Allen Lane, 2011.