BIOLOGICAL SECURITY AND BIOTERRORISM: INFECTIOUS DISEASE-RELATED RISK, THEORY, PRACTICE, AND EDUCATION

O'SULLIVAN, TERRENCE M., University of New Hampshire
terrence.osullivan@unh.edu

ABSTRACT

The catastrophic COVID-19 pandemic drove home the need to change homeland security/emergency management (HLS/EM) higher education curricula. They failed to adequately assess the probability and consequences of potentially disastrous emerging infectious disease outbreaks—particularly at the complex systems level. Pandemic disease and antimicrobial drug resistance are now more significant risks than before COVID-19. Historic bioweapons and significant advances in biotechnology will make bio-warfare a growing international security risk. Because of these unique, complex, and unfamiliar public health security risk variables, HLS/EM and national security education must better familiarize future professionals with this "wicked" problem set. The University of New Hampshire Homeland Security course *Biosecurity and Bioterrorism* addresses infectious disease's history and contextual future, including relevant scientific, medical, sociological, and biological security-related practices, theories, and methods.

Keywords*: global public health, epidemic emergency management, infectious disease risk, homeland security education, biological weapons*

INTRODUCTION

COVID-19 infected at least 110 million and killed approximately 1.2 million Americans (worldwide, 700 million infected and 7 million deaths). The worst acute global pandemic in 100 years demonstrated how little most people—even much of the medical and scientific community—knew about infectious disease (ID) epidemics. In wealthy post-industrial nations, most deaths before COVID were from chronic diseases—cardiac, respiratory, and cancer. However, pandemic disease is notable as an emergency management and homeland security (EM/HLS) risk because there is no one individual—or even institution—that grasps the totality of the scientific, medical, social, psychological/behavioral, economic, and political variables, nor the universe of complex systems involved. The same holds for biological terrorism or warfare, which has its own unique set of risk factors.

One could say that EM/HLS were late to public health (PH) just as PH was late to EM/HLS, as Feldmann-Jensen (2022) observed. ID disasters pose highly unique interdisciplinary challenges. For traditional EM/HLS, few practitioners need to understand the causes of tropical cyclones or earthquakes. Practitioners must understand the dynamics, threats, surveillance, response, and risk management inherent to ID prevention, mitigation, and response.

The newly revised University of New Hampshire Homeland Security course, *Biosecurity and Bioterrorism* (HLS 665), analyzes modern microbial PH risk and rising future threats in the context of historic ID disasters. It introduces students to facts, methods, terms, and theories that are usually not found in traditional EM/HLS curricula, including the following:

- Basic epidemiology and the germ theory of disease;
- Disease causes, from the survivability and virulence of the microbes/pathogens to the host and environmental factors that may make the host more vulnerable;
- Public health vs. private health similarities and divergences;
- Basic vaccine science (including that of the miraculous MRNA vaccine tech for COVID-19 and its cousins);
- Antibiotic, antiviral, and other ID drug development history, economics, and politics;
- Biological natural selection and mutation, and the expanding severe problem of antimicrobial resistance and superbug pathogens;
- Non-pharmaceutical countermeasures (quarantine, isolation) and their implications for both the historic 1918 Great Influenza (Beach et al., 2022; Morens et al., 2010) and contemporary PH disaster response—especially given U.S. political polarization;
- Essentials of biotechnology advances, some of which will enable not just miraculous medical breakthroughs but enhance the potential for readily reproducing pathogens and designing Frankenstein's monster bioweapons in a laboratory;
- Environmental and economic macro system variables such as globalization and the role of the climate crisis as infectious disease risk magnifiers;
- Psychological theories about public infectious disease risk perception and disaster compliance, the role cognitive bias plays in science skepticism;
- The socio-economic and social justice determinants of (public) health and disease vulnerability and inequality
- PH law, crisis standards of care, and related legal and policy issues during pandemics

UNIVERSITY AND PROGRAM BACKGROUND

The University of New Hampshire (UNH) has a student body of approximately 15,000 students, including 2,500 graduate students. The New England Commission of Higher Education accredits UNH. The Department of Security Studies, Bachelor of Science in Homeland Security (HLS) Program hosts approximately 250 HLS students. HLS 665 is housed in the Department of Security Studies.

COURSE DESCRIPTION

The UNH HLS program takes pride in teaching science and methods not typically found in most HLS/EM programs. HLS 665 learning objectives focus on helping students understand historical, current, and evolving global PH risk mitigation and management, including natural ID outbreaks and deliberate biowarfare.

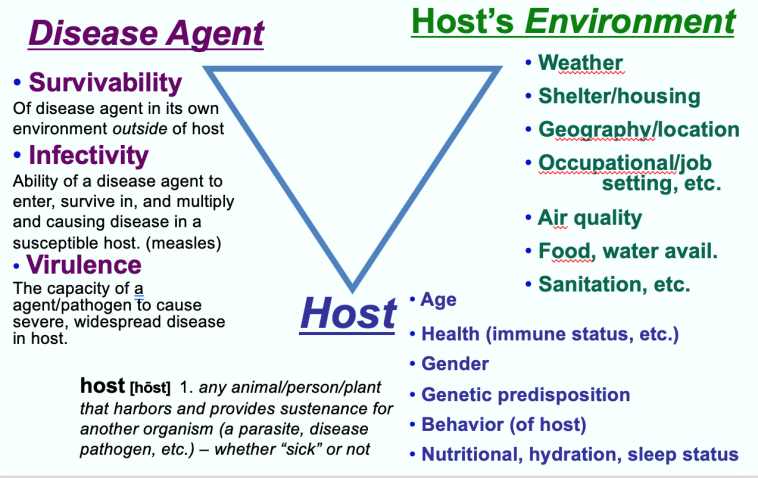
Although global PH and EM have always responded to ID crises, integrated public health emergency management (PHEM) emerged recently as a sub-discipline before COVID-19 (Rose et al., 2017). Future professionals (as well as current ones) need at least a consumption-level literacy in global PH security, surveillance, preparedness, and PHEM response among complex adaptive systems.

HLS 665 introduces basic disease biology, the taxonomy of ID pathogens, and the theory and practice of global PH disease epidemiology (e.g., Frérot et al., 2018). Given that COVID-19 is so close to home for students as an EM/HLS disaster case study, I include frequent class discussions of students' experiences and observations of the pandemic. Course text texts include Preston's (2012) *The Hot Zone* about Ebola and other viral hemorrhagic fevers and Quammen's (2023) COVID-19 book, *Breathless*.

The Disease Triangle (Figure 1) concept used throughout the course helps illustrate the varying evolutionary personalities of each pathogen or disease agent—survivability in specific environments and not others (including susceptibility to antimicrobial drugs or vaccine-induced immunity), infectivity (how transmissible), and virulence (disease-causing abilities); human or other host factors such as demographics (like age, gender, genetics), overall immune and nutrition status, behavior (essential for diseases like HIV/AIDS), and hosts' environment—weather, food/water availability, air quality, geography, and sanitation.

HLS 665 then presents emerging (Ebola, Nipah, COVID) versus reemerging (preexisting, but growing in range or potency) IDs; the climate crisis as a growing public health risk magnifier; and globalization's ID risk *externalities*—a term used in social sciences to mean unintended consequences. Modern trade, travel, migration, urbanization, and increasing consumption patterns significantly raise international disease vulnerability since pathogens can catch a ride to almost anywhere in the world in 24 hours. These phenomena shrink reaction time and confound disease surveillance and public health response systems.

Figure 1. The Disease Triangle: Variables for Infectious Disease Risk



HLS 665 includes analyses of contextualized PH case studies that illustrate various social and epidemiological variables, including:

- Meso-American (c. 1500s) epidemics, where Spanish conquistadors imported smallpox, enslaved and starved the population, and made fertile ground for an indigenous virus, Cocolitzli, that over a century wiped out 90 percent of the indigenous population (Acuña-Soto et al., 2002).
- The 1793 Philadelphia yellow fever epidemic that threatened the then-capital of the fledgling United States (Foster et al., 1998) killed 10 percent of its population and led the U.S. government to flee to the countryside.
- Typhoid Mary Malone, a single Irish immigrant and cook quarantined/imprisoned for life in the early 1900s because she was a poor, unmarried immigrant and asymptomatic disease carrier who unwittingly caused 122 typhoid deaths.
- Deadly Nipah virus and tick-borne Lyme disease, illustrating infectious diseases' environmental and human behavioral variables and the importance of emerging zoonotic pathogens that leap the "species barrier." Nipah, a 40- to 75-percent fatal pandemic candidate carried by fruit bats (over 200 novel coronaviruses have been identified in various bat species), emerged in 1998 in Malaysia and then India on pig farms (Epstein et al., 2006); all worsened by human encroachment into wild areas, and displacement of animals like the bats (Banerjee et al., 2019).
- Other IDs, including the bubonic plague (which depopulated much of Europe in the Middle Ages); smallpox (eradicated in the 1970s, but now a potential biowarfare agent); pandemic/epidemic 19th-century cholera—the first disease of globalization, so disruptive to growing global trade it led to the first international PH cooperation (roots of the World Health Organization); HIV/AIDS (40 million deaths since its 1980s identification); pandemic influenza—a threat still just as dangerous as new "virus X" pandemics like COVID-19; malaria and various mosquito vector-borne diseases (West Nile, Chikungunya, dengue fever, etc.); and antimicrobial resistant pathogens such as the deadly E. coli 0157:H7 superbug (Shlaes & Bradford, 2018).

EM/HLS response to PH ID disasters risk follows, and students complete Texas A&M's (2023) online course, *Basic EMS Concepts for CBRNE Events*, and analyze

- The COVID-19 pandemic in depth, with a guided exercise imagining the origins and implications of a worse, deadly future pandemic.
- Rising biological terrorism threats—exacerbated by dual-use biotechnologies such as genomics and related CRISPR gene editing, rapid PCR replication of genetic material, nanotechnology, and other genetic engineering (see Berger, 2021).
- CDC's Category A (able to cause the biggest societal, medical, and EM challenges), B, and C list of potential bioweapon pathogens, and U.S. biosecurity programs that have emerged—including Biowatch (urban bioterrorism detection), the U.S. Strategic Stockpile, the BARDA pharmaceutical countermeasure development program, the CDC's Cities' Readiness Initiative that prepares major U.S. urban areas for PH disasters, and other infrastructure.

COURSE ASSESSMENT

Course assessment is diverse, including a policy memo project (on the threat of biological attack), multiple quizzes, in-class reflection papers, and analytical essays written out of class after watching critical subject-related films/documentaries. The quality of these student assessments of various subtopics thus measures course outcomes.

PLANS

HLS 665 was seldom taught before I arrived at UNH, but I had taught a similar course for almost 15 years. It is now an elective in our Emergency Management and Terrorism Studies minor. However, when faculty staffing allows, I hope to integrate it into the core B.S. degree curriculum, even as I have already been integrating the material into other courses.

CONCLUSION

Infectious disease science and public health security need a more robust, front-burner role in EM/HLS competency-based education standards (Ramsay & Renda-Tanali, 2018), given the unique growing risks from "naturally occurring" and manmade biological disasters. *Biosecurity and Bioterrorism* focuses on a consumption-level understanding of these increasingly critical interdisciplinary infectious disease risk management challenges.

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