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Special Issue

Commentary

Emerging Zoonotic Diseases: An Opportunity to Apply the Concepts of Nidality and One-Medicine

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Abstract

The use of animals as sentinels of human disease revolves around the concept of nidality. That is, an agent of disease occupies a particular ecologic niche and alterations in that niche will change the function of that agent relative to traditional host-agent-environment relationships. Nidality is a derivation of the root word nidus. Nidus is defined as a nest or breeding place, particularly a place where microbes such as bacteria, fungi, viruses, as well as other organisms and larger parasites, are located and multiply. Application of the concept of nidality and development of prevention strategies has most frequently been associated with military campaigns and interruption of tick-borne infections.

Modern usage of the phrase "one-medicine" was popularized in the United States and Europe by Calvin Schwabe and the concept is attributed to Rudolph Virchow. It is applied today to the study of zoonotic disease and interventions in rural agricultural communities that share close living arrangements between people and their families, their pastoral work environment, and the animals for which they care.

Integration of the two concepts of one-medicine and nidality provides an opportunity to apply a systems approach (i.e. general systems theory) to dealing with emerging zoonotic diseases in today's global agricultural and industrial settings.

Key words: zoonoses, bioterrorism, epidemiology, public health

Introduction

The use of animals as sentinels of human disease revolves around the concept of nidality. That is, an agent of disease occupies a particular ecologic niche and alterations in that niche will change the function of that agent relative to traditional host-agent-environment relationships (1). Nidality is a derivation of the root word nidus. Nidus is defined as a nest or breeding place, particularly a place where microbes such as bacteria, fungi, viruses, as well as other organisms and larger parasites, are located and multiply. Application of the concept of nidality and development of prevention strategies has most frequently been associated with military campaigns and the interruption of tick-borne infections (2).

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Modern usage of the phrase "one-medicine" was popularized in the United States and Europe by Calvin Schwabe and the concept is attributed to Rudolph Virchow (3). It is applied today to the study of zoonotic disease and interventions in rural agricultural communities that share close living arrangements between people and their families, their pastoral work environment, and the animals for which they care. A recent movement in the United States, the "Medicine and Public Health" initiative (http://www.sph.uth.tmc.edu/mph/) recognized that human clinical medicine and public health communities had developed parallel but separate enterprises and there was a need to reassess this division. Medicine (focusing primarily on the health of individuals) and Public Health (with a population perspective) needed to find innovative and joint solutions to improve the health of the people of the United States. Similar schisms are evident between veterinary medicine and the agricultural industry in the United States and initiatives are underway to bridge these gaps. Integration of the two concepts of one-medicine and nidality provides an opportunity to apply a systems approach to dealing with emerging zoonotic diseases in today's global agricultural and industrial settings.

Application of the Model

In the late 1990s, our School of Public Health embarked on a series of Bioterrorism Awareness Seminars for health care students and primary care providers, i.e. family practitioners, pediatricians, general internists, nurse clinicians, physician assistants, and others. I struggled with the development of a communications approach that would capture the interest of the audience, especially prior to the events of September 11, 2001. The presentation of information needed to raise a clinician's awareness for the early diagnosis of a bioterrorism incident was considered by many to be esoteric, an unlikely scenario, and not relevant to the daily practice of medicine in the United States.

As a public health veterinarian, I knew that many of the biological organisms identified as potential agents of bioterrorism occur naturally in North America, specifically Texas which is situated on the southern border of the United States of America. Texas has enzootic foci of anthrax, tularemia, and plague. Mosquito-borne encephalitides such as Saint Louis Encephalitis, Eastern Equine Encephalitis, Western Equine Encephalitis, and most recently West Nile Virus occur in our geographic region. We have had cases of hemorrhagic fever (*Ebola alice*) in primate colonies in Texas. Dengue is endemic in countries immediately to our south. Vibrio species infections are identified in association with our seafood and shellfish industry in the Gulf of Mexico. It is not unusual for sporadic human cases of infection with these organisms to be diagnosed by clinicians in Texas. The teaching challenge was to accomplish our goal of "heightened awareness" for agents of bioterrorism and also make the seminars relevant to the daily practice of medicine (4).

There is an overall lack of knowledge regarding the natural history and ecology of these zoonotic organisms (5). There is an abysmal lack of understanding among the general public and media of the natural occurrence of many biological organisms in the agricultural and animal industry setting as well as in free-ranging animal populations. The natural history, normal ecology, and epidemiology of potential agents of bioterrorism provide scenarios for explaining risk to the human population at large. Understanding the natural history of these organisms and their role in agriculture and free-ranging animal populations provides a context for health care providers to make appropriate risk assessment decisions.

When first confronted with the emergent threat of bioterrorism I used a mental paradigm based on the principles of nidality. Instead of considering the biological niche of the organism in nature, however, I chose to define the agent's nidality from an epidemiological perspective. Every organism that causes disease in human populations has an expected epidemiologic presentation. The epidemiologic pattern provides clues as to whether the clinical presentation is "expected" or "un-expected" in that physician's range of practice experience. A corollary to the expected/un-expected clinical paradigm is the potential route of exposure to the organism in a particular geographic and/or occupational setting (6). Routes of exposure can be categorized as "natural" or "un-natural" and may in fact influence the constellation of signs and symptoms observed by the clinician. I now employ these concepts in teaching and instructional activities to prepare health care providers in biodefense preparation and response.

The paradigm that I employ is as follows:

- Expected and natural clinical presentation and epidemiologic circumstances
- Unexpected but natural clinical presentation and epidemiologic circumstances
- Unexpected and unnatural clinical presentation and epidemiologic circumstances

Let me illustrate by providing examples of the three clinical presentations of anthrax in humans: cutaneous; gastrointestinal; and inhalational.

Expected and natural *clinical presentation and epidemiologic circumstances*

Cutaneous Anthrax

In South Texas it would be usual and expected to diagnose a sporadic case of human anthrax. The presentation would normally be a single cutaneous eschar on a visible surface such as the hand or arm. The epidemiologic history would most likely involve contact with a known diseased animal. The latest example was an adult male who cut himself while removing the hide (skinning) from a buffalo (American Bison) that had died at a game ranch. The geographic area had recently experienced a severe die-off of white tailed deer from anthrax. This clinical presentation and epidemiologic history would be usual and normal in South Texas.

Unexpected but natural *clinical presentation and epidemiologic circumstances*

Gastrointestinal Anthrax

It is rare to diagnose gastrointestinal anthrax in humans in Texas. Animal protein is abundant. Cattle raised for human consumption are inspected. The hunting culture is one of harvesting healthy and active game animals, not culling old and/or impaired specimens. When anthrax epizootics occur in free-ranging populations, they are in remote areas with minimal human interaction.

However, one could envision a scenario of ranch workers and/or unwitting hunters harvesting anthrax infected cattle or deer for the meat. Diagnosis of a cluster of gastrointestinal anthrax cases in a family or several acquaintances with a history of hunting their own food would be **unexpected**, but given the epidemiologic evidence, **natural**.

Unexpected and unnatural *clinical presentation and epidemiologic circumstances*

Inhalational Anthrax

It is difficult to develop a scenario for the state of Texas where any occurrence of primary respiratory infection with the anthrax organism would be expected. However, Laredo, Texas is the largest inland port in North America. Ten thousand tractor trailer trucks cross the Mexico–United States border every day. If a trailer contained a cargo of anthrax infected animal hides, it is feasible that the truck driver and or illegal passengers riding

in the trailer could be exposed through the respiratory route. This fictional example would certainly represent **unexpected** and **unnatural** circumstances.

All three of the preceding scenarios for cutaneous, gastrointestinal, and primary respiratory infection with the anthrax organism share several epidemiologic characteristics. *Bacillus anthracis* occupies a natural ecologic niche in the southwestern United States and parts of Mexico. The number of individuals involved in each scenario was small. The clinical presentations followed classical expectations. The epidemiologic picture matched the clinical presentation. Thus, the information presented to my clinical audience was relevant to their practice of medicine today in the state of Texas and hopefully raised their level of knowledge regarding the natural history of one of the potential agents of bioterrorism. I conclude with "clues" to understanding how the epidemiologic picture may differ if the anthrax exposures were man-made and intentional rather than a part of what is expected in our part of the world: the epidemiology would be wrong; there would be large numbers of human cases; there may be concomitant deaths of other animal species; and, there may be unusual strains of the organism.

Conclusion

The concepts of nidality and one-medicine provide the opportunity to explore the natural history of agents of disease; the inter-relatedness of human activity, animal industry, and free-ranging animal populations. Application of the principles espoused by the Medicine and Public Health initiative provides a framework for human medical clinicians, public health practitioners, and the veterinary medicine community to interact and address the threat of bioterrorism in a reasoned and scientific manner based on effective risk assessment.

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