ESSAI

Volume 10 Article 24

4-1-2012

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(Chemistry 1551)

"In 1832, Mozart's librettist Lorenzo da Ponte arranged for the visit of an Italian opera troupe to cholera-stricken Manhattan. They arrived to find the streets empty and silent except for the ringing of church bells and the rattle of carts taking corpses to graveyards. Every resident who could had fled…" (Karlen, 1995). The cholera outbreak across many countries in the 19th century was the last of the great pandemics in which the miasma theory about the origin of disease was considered. New practices were developed to reduce the spread of the disease and a new picture of disease transmission emerged. The efficacy of these measures inspired other countries to follow suit, and soon encouraged some of the most groundbreaking biomedical research in history. Miasma Theory of disease contagion was popular for centuries in Western cultures. It held that diseases were spread through the stench of decay. This theory likely came about from several beliefs. Since the majority of people find the same odors to be offensive, there must be something offensive or dangerous about the source of the odor. The other is that greater exposure to such a stench would increase the likelihood of contracting a disease. Perhaps the most well-known example of this theory in practice was the sniffing of nosegays, small bouquets of fresh flowers, by Londoners as they walked through the city streets during the mid-17th century Black Plague (*All Info About London, website).* The popular playground song "Ring Around the Rosy" rhapsodizes about the attempts to keep the Black Plague's miasma at bay by carrying posies.

Indeed, upon closer inspection, Miasma Theory does have some common sense to it. If an individual were to exist who did not instinctively find certain smells offensive, such as those of rotting flesh or feces, he or she would not go to great lengths to avoid contact with these things and so would not only come into contact with more bacteria, viruses, and other microbes, but would also contact the more dangerous sort. Finding certain odors distasteful can be seen simply as good adaptation. Disease almost always carries with it a smell; even the relatively innocuous common cold can result in bad breath or stale sweats. Additionally, if we consider the source of the odor to be a diseased person, the greater proximity one has to the person would in fact increase the likelihood of disease contraction.

During the Victorian Era, Miasma Theory was extended somewhat. The miasmas that seemed so prevalent among the poor slums were seen as God's punishment for immoral lifestyles. Due to recent technological innovations and associated economic changes, cities had become quite densely populated in a short period of time. There was little to no infrastructure in place to dispose of the wastes created by industry and individuals; all wastes were simply routed to the nearest water source, providing a re-entry point for microbes. The more densely populated cities and those nearest to water, including Paris and Stockholm, suffered the greatest casualties. Hospitals, places of bloodletting and suffering and without effective drugs or treatments, were where people went to die, not to be healed (Karlen, 1995).

Riots broke out across the major European capitals, with everyone from foreigners to bureaucrats to doctors themselves being blamed for the disease and often physically attacked in public (Karlen, 1995; Tierno, 2001). Finally, some individuals, repulsed by the filth of the London slums and the rest of the overcrowded city, began campaigning for sanitary reform. William Farr and Edwin Chadwick led this movement, advocating that the lethal miasmas were born from dirt, sewers, and cesspools all around the city (Karlen, 1995). Though "even basic hygiene measures

were seen as assaults on individual liberty," fear eventually won out: cholera simply killed too quickly, and too dreadfully, to not take a chance on the new theory (Karlen, 1995). Edwin Chadwick became commissioner of the Board of Health, a new position that allowed him to make changes on a national scale.

Chadwick soon took measures to build proper sewers, collect trash, filter and clean water to the greatest degree possible at the time, and destroy slums. Cholera, a water-borne disease of the type vibrios, did not respond to these measures until the next outbreak, about 30 years later. This time, the disease did not spread nearly as quickly, and fewer people died (Karlen, 1995). Additionally, other diseases (which also happen to be water-borne), such as typhoid, dysentery, and shigellosis, were greatly reduced. When cholera hit North America at about the same time, New York quickly adapted the "English model" to deal with the crisis, and soon after that the United States government enacted it across the country (Karlen, 1995). As other technologies developed in the hygiene/sanitation field, including water chlorination and vaccination, both countries implemented the advances rapidly and felt declining impacts from disease epidemics (Karlen, 1995; Tierno, 2001; Tomes, 1998).

The advances of the public sanitation movement had even more effects than diminishing the effects of disease pandemics. It paved the way for germ theory to replace Miasma Theory through a consolidation of findings of many European studies.

The major pieces of the puzzle already existed long before the cholera outbreak. In 1546, Girolamo Fracastoro, an Italian doctor, tracked the progression of a disease now known as syphilis, and theorized about its method of transmission; in 1676, Antoni van Leeuwenhoek described tiny "animalcules" in a series of letters to the Royal Society of London; in 1796, Edward Jenner helped pioneer the modern vaccine after noting that milkmaids exposed to cowpox seemed immune to the human version, smallpox (Tierno, 2001; Karlen, 1995). Ignaz Semmelweis temporarily enacted an informal policy in his German hospital that made handwashing between morgue and delivery room mandatory. Unfortunately, despite immediate and undeniable success, the hospital administration balked at his audacity and "ordered all hand-washing to stop" (Tierno, 2001).

Perhaps the greatest evidence of the day in support of a germ theory was the 1854 work of John Snow, who famously tracked the sources of cholera outbreaks to communal water wells in London; when the pump handles were replaced, often the disease disappeared (Tierno, 2001). Within a few decades, the findings of Louis Pasteur and Edward Koch expanded biomedical knowledge by leaps and bounds. The two men's laboratories, working concurrently but independently in different cities, found tuberculosis, anthrax, cholera, pneumonia, diphtheria, gonorrhea, and typhoid microbes, formulated rabies antitoxin from the spittle of a rabid dog, developed postulates to put the Germ Theory to test, and "established the principles of microbiology and laid the foundations for all subsequent medical research" (Tierno, 2001).

Some measure of scientific progress is made by disproving an existing theory, but substantially more progress can be made by replacing the old way of thinking with a new theory. In the famous words of evolutionary biologist Stephen Jay Gould, the new theory must not only replace the old one, but smash the pedestal upon which it had been placed in our minds. Today, most Western adults would find the prospect of disease as punishment from an angry God, communicable by the mere wafting of malodorous vapors from the wrong side of town, as laughable or just plain wrong. The thought that tiny creatures cause all manner of disease, from influenzas to food poisoning, does not surprise us. Perhaps the indication of the proverbial pedestal having been smashed is that modern people are not offended by large-scale efforts at improving hygiene, as 19th century Europeans were. Signs reminding us to wash our hands abound in public bathrooms; indeed it is rare to find a washroom without one. Doctors, dentists, commercial food preparers and others are actually required to wash their hands by law. Antibacterial hand gels are commonplace and even flaunted among self-proclaimed germophobes. In this case, the panic and desperation of a people

under siege by an epidemic paved the way for a wholly new approach. The first advocates of sanitation in England did not have scientific evidence to back their claims, but they recognized the visual differences of good hygiene and believed that somehow a cleaner city would lead to a healthier community. While some of their efforts may have been misguided, the ultimate result supported their claims and encouraged more research into this area.

Through scientific understanding of natural phenomena, human crises can be averted or at least mitigated. Fear of the unknown can cause mass evacuations like the deserted Manhattan that greeted Mozart's troupe in 1832. Many Japanese have been internally displaced after a nuclear scare following a natural disaster. Without clear facts presented by an objective scientific party, many Japanese on the east coast are taking the approach of "better safe than sorry" and relocating, often splitting up the mother and children from the father (whose job may not be transferrable). True or not, the perception abounds that not much is known about nuclear energy. More research in this area and greater public education will likely reduce panic. When the next natural disaster strikes, whether it be in the form of an epidemic or a destructive event, society should be prepared to entertain new theories and pursue new avenues of research, or face the consequences of its own ignorance.

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