The Fourth Horseman's Armored Cavalry: The Technology of Bioterrorism in the Early 21st Century

Anil J. Misir, B.Sc. (0T4)

Background

Our outlook on the world has drastically changed in the months following the al-Qaeda terrorist attack on the Pentagon and World Trade Center. It has been a long time since we last had our sense of safety so radically undermined. In the days and weeks following September 11, a new danger reared its head – the threat of bioterrorism. With weapons-grade anthrax circulating in the US postal system, many people got their first glimpse of a threat that seemed to be a new and shocking development.

However, the use of bioweapons has a long history in human warfare. Perhaps the earliest form entailed dipping arrows or spears in excrement to encourage wounds to fester. But biological weapons have been systematically used for a long time as well. During the 14th century siege of Kaffa (now Feodossia, Ukraine), the Tatars turned a plague in their camp into an instrument of conquest by hurling cadavers over the walls of the fortress. Smallpox led to the decimation of aboriginals in the Americas and was often introduced deliberately by trade in infected blankets and goods.[1]

The coalescence of the science of microbiology at the turn of the twentieth century allowed for more systematic results to be obtained. To that end, the Imperial Japanese experimented on Manchurian civilians during their occupation between 1932 and 1945.[1] The Soviet Union maintained what would become the world's largest biological weapons program in history with its operation of the Biopreparat military complex in Sverdlovsk. Indeed, a small scale accidental release of experimental weapons-grade anthrax led to up to 900 deaths in 1979 and to significant morbidity for many others.[2]

What is new in the early 21st century, however, is the spread of such weapons to sub-state actors. In the same way that increasingly cheap computing power has diffused information power to smaller groups and to individuals, increasingly cheap biological technology promises to do the same for biological warfare. The US State Department defines terrorism as "premeditated, politically motivated violence perpetrated against a non-combatant target by sub-national or clandestine state agents, usually intended to influence an audience."[3] Whereas nuclear and, to a large extent, chemical weapons will likely remain the prerogative of nation-states, the rapid increase in knowledge and the rapid decrease in cost of basic microbiological technology now put bioweapons in the hands of the sub-national terrorists – and even the disgruntled individual.

While the overall topic of terrorism is a complex and fascinating one, this article will restrict itself to the technology of bioterrorism. As it shall be shown, this technology is cheap (and becoming more so) with its various components almost all commercially available for legitimate reasons.

The Power of Bioweapons

A useful weapon must have four main attributes. First of all, it must be affordable to the user. Nuclear bombs may have tremendous explosive potential, but are useless to a terrorist organization if that organization cannot pay for them. Next, the weapon must be capable of reaching its target: a gun that does not fire is an expensive doorstop. Thirdly, it must limit "friendly" damage. A weapon that kills as many of your side as the other is useless in all but the most cold calculations for attrition of a numerically inferior opposing force. Lastly, the weapon must result in the desired outcome, most often death.[4]

No weapon currently known can come close to matching a carefully chosen biological weapon in any of these categories. Bioweapons do not require an extensive uranium enrichment physical plant, or a large-scale chemical works. Given access to source materials, the appropriate science can be performed using basic high school or undergraduate university equipment with material easily and inexpensively purchased from medical supply companies.[4]

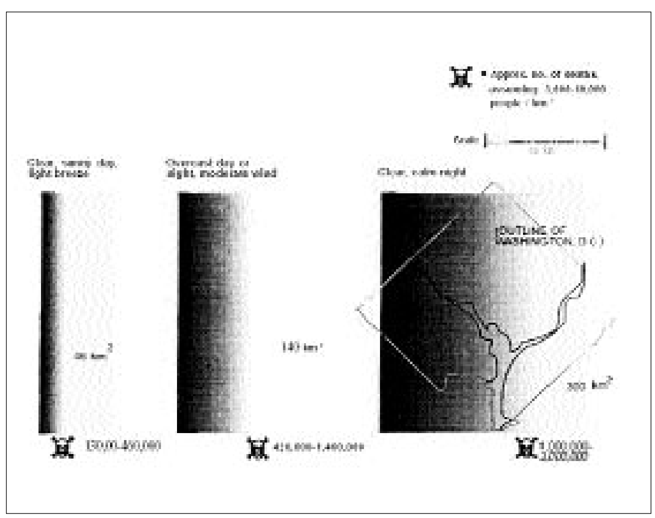

Figure 1. Lethal areas for a single airplane-load of 100 kg of anthrax spores. Diagram shows how fatalities could vary greatly under three different weather scenarios.

Chemical weapons such as sarin and VX may be incredibly cheap compared to nuclear weapons, but biological agents are cheaper still. An oft quoted UN report in 1969 estimated the cost (in 1969 American dollars) of a large-scale military attack on civilians: "casualties might cost $2,000 per square kilometer with conventional weapons, $800 with nuclear weapons, $600 with nerve gas weapons, and $1 with biological weapons."[5] Though there has been much inflation since 1969, the price of the necessary technology has also fallen precipitously.

Beyond the sheer deadliness of biological agents, three additional features unique to biological weapons make them particularly amenable to terrorist use. First is the necessary size of the agent released, or "footprint". Chemical and non-nuclear bombs do not come close to matching the potential footprint of the biological weapon. Secondly, there is the ability of contagious agents to be spread person-to-person after the initial attack, vastly increasing the scope and time of damage. Lastly, the incubation period between introduction and onset of disease (which can last from days to months) compounds psychological factors such as fear and panic.[4]

The deadliness of a properly implemented terrorist biological attack cannot be underestimated. A 1993 study by the Office of Technology Assessment, a body which reports to the US Congress, reached a staggering conclusion: a small airplane dispersing only 100kg of anthrax spores would be more lethal than a Scud-like missile carrying a hydrogen bomb. If the hypothetical airplane dispersed its cargo on a clear calm night in order to minimize destruction by sunlight and maximize efficient distribution, 1 to 3 million people would die in the 300 square mile area surrounding Washington DC (Figure 1). The hydrogen bomb, on the other hand, would kill 'only' 570,000 to 1.9 million people.[6]

Using an airplane to spray a metropolitan area is only one way to disseminate a biological agent. An attack on a more compact scale using small spray devices could also deliver high concentrations of selected agents within a smaller footprint of public buildings or subways, and with devastating effects. Given the daily traffic in and through large buildings such as airports, office towers and shopping malls, the number of people exposed could equal the population of a big city.[4]

The Technology of Bioterrorism

When it comes to the technology of producing bioweapons, a would-be terrorist needs two things: the agents themselves and a means to disperse them. Although sophisticated attack mechanisms (e.g. using missiles) are difficult to set up and would invite massive retaliation once the source was discovered, primitive attacks using commercially available "off-the-shelf" technologies would be relatively easy for a small-scale terrorist group.

Obtaining the necessary agents and preparing them present no difficulty to the determined terrorist. As of 1998, there were 10,000 scientists inside of Russia's ex-Soviet Biopreparat biowarfare research system, of whom 1,500 are considered top researchers.[2] This number is substantially decreased from the 60,000 who worked there before the political implosion of 1991.[7] The breakup of the former Soviet Union, and the following social and financial chaos, have very likely provided the incentive for at least some of these skilled scientists, tired of being paid months late or working in menial jobs, to leave the country with vials of deadly agents to parts unknown.[8] Even in the United States, until very recently, there were very few effective controls on the distribution of dangerous biological agents. 1995 alone saw at least three major reported incidents involving bubonic plague and the toxin ricin.[3]

Dispersing biowarfare agents can be as simple as using aerosol sprays via crop dusters or spray trucks, of the kind used to aerosolize mosquito insecticide in urban settings.[4] It is this "dual-use" nature of terrorist biowarfare technology that is perhaps its most difficult aspect. Critics often point to this "aerosolization" as the main bottleneck in the use of biological weapons. However, this is not as great a constraint as it may seem. Aerosolization technology, spurred on by the needs of agriculture, industry and research, has greatly increased in sophistication in recent years to the point where it is quite easy to produce dry and liquid aerosols of many kinds. Almost all of this knowledge is in the public domain and freely accessible to anyone.[4]

A cursory search of the Internet reveals scores of websites that offer information on crop-dusting planes and equipment that can be fitted to any plane or truck. Most of this equipment produces a highly controlled wet-spray, with nozzles that can set the droplet size precisely. Commercial farmers prefer wet aerosol sprays to equipment that disperses dry powder, because this technology offers the user greater control over the placement of the spray. Powders tend to drift, spreading pesticide to nearby fields and increasing environmental risk. Even so, powder dispersal systems are available for legitimate uses – perfect for agents such as anthrax. All of these technologies are easily purchased directly from the Internet or on Internet auction sites.

And it is not just crop-dusting equipment companies that have mastered aerosolization. Industries ranging from health care to photocopying have mastered the technology of delivering particles of precise size and quality. The technology is both easy to find and portable: a total delivery system could weigh as little as five pounds. A would-be terrorist need only walk to the local pharmacy to purchase a medical aerosolizer (used for producing "mists" of prescribed medications) or an inhaler if a dry powder is needed.[4]

Potential Agents

Frighteningly, there are quite a large number of potential agents that a would-be terrorist could use against a civilian population. The Atlanta-based Centers for Disease Control (CDC) has categorized agents that can be used according to a three-tiered ranking (Table 1). Category A consists of agents considered to have the greatest threat, in terms of producing casualties and in terms of the need for stockpiling antibiotics and vaccines. Category B agents have potential for illness and transmission, but have fewer public health action requirements. Category C agents are those that are possible emerging public health threats that could be engineered for possible future use.

Table 1
Categorization of Potential Biowarfare Agents

Category	Biowarfare Agents
A	Bacillus anthracis (anthrax), Clostridium botulinum toxin (botulism), Yersinia pestis (plague), variola major (smallpox), Francisella tularensis (tularemia), Viral hemorrhagic fever (e.g., Ebola)
B	Coxiella burnetti (Q fever), Brucella species (brucellosis), Burkholderia mallei (glanders), ricin toxin from Ricinus communis (castor beans), epsilon toxin of Clostridium perfringens, Staphylococcus enterotoxin B
C	Nipah virus, hantaviruses, tickborne hemorrhagic fever viruses, tickborne encephalitis viruses, yellow fever, multidrug-resistant tuberculosis

Perhaps the most ominous disease of all on this list is smallpox. The eradication of smallpox in 1979 stands as perhaps one of the greatest achievements in public health. The consequences of its release upon a non-immunized population would be catastrophic. Perhaps most frightening is the international dimension that this could play. Advanced industrialized nations such as Canada with good transportation, communication and health infrastructure could relatively easily immunize its entire population to either protect against or halt a terrorist attack. The same cannot necessarily be said for "failed states" where government is weak, unstable or non-existent. Places such as The Democratic Republic of Congo, Pakistan, the interior of Columbia, Somalia and parts of the former Soviet Union could be badly hit if smallpox were to spread from the initial site of attack via an intercontinental flight taken by an asymptomatic person. Indeed the impact of a reintroduction of smallpox on an unprotected region could rival the impact of AIDS on sub-Saharan Africa – without the 10 year latency period.

Natural Advantages and Anti-Bioterror Technology

Fortunately, nature has also given us at least a couple of in-built advantages – few of the major potential bioterrorist agents are food transmissible. Thus, barring future genetic engineering, the worst we can likely expect in the way of a terrorist attack via our food supply would be hemolytic anemia secondary to Escherichia coli poisoning. Additionally, unlike nuclear weapons, biological agents must be dispersed according to weather conditions. Sunlight can destroy certain agents and wind can affect dispersal patterns.[6] A terrorist would have to wait for just the right weather conditions.

The dual-use nature of much of the technology of bioterrorism also works in our favour and may be the key to successful cost-effective countermeasures. Microbe detectors used in meat inspection can be used for monitoring intentional releases of agents. Heating and ventilation advances used to counteract "sick building syndrome" can also be taken advantage of. Future technologies, such as bio-sensors, as well as new uses of current technologies, for example international anti-terrorist computer databases, would also be valuable.[10]

But the most important new "technologies" in combating bioterrorism are likely to be administrative and political. Joint military-civilian development of antibiotics and vaccines would speed up the development of new treatments. More co-operation between police, military and health units would speed up recognition and treatment.[10] Even something as simple as pre-emptively hiring ex-Soviet bioweapons researchers to do civilian research, and buying and destroying the old arsenals would reduce the supply of expertise and materiel to would-be terrorists. All of these are currently being implemented, but preparation is still in its infancy, and is not without problems. The far-sighted attempt begun a decade ago by the American government to purchase the nuclear, chemical and biological weapons of the ex-Soviet Union, for example, is finding that some of the stocks remain mysteriously "unaccounted for".[8]

Here Comes the Cavalry!

What, therefore, lies in the future? Bioterrorism is now within the capability of any reasonably well-financed sub-national group. The information needed to make bioweapons is in the public domain, freely accessible and indeed necessary for a whole host of perfectly legitimate and necessary medical, industrial, agricultural and public health purposes. Unfortunately, there can be no technological magic bullet to fix this threat. Even the much-vaunted anti-anthrax drug ciprofloxacin can be rendered useless if a terrorist creates resistant anthrax through deliberate natural selection. Instead, a series of technologies combined with increased co-operation and vigilance is the necessary solution. Political and economic development efforts that endeavor to reduce the threat of terrorism itself are also vital. Like it or not, the threat of bioterrorism is here to stay.

References

1. Christopher GW and Pavlin JA. (1997). Biological Warfare: A Historical Perspective. *JAMA*, 278(5): 412-417.
2. Mangold T and Goldberg J. (1999). Plague Wars: A True Story of Biological Warfare. Macmillan: London.
3. Levine RM. (2000). Chemical and Biological Weapons in Our Times. Franklin Watts: Toronto.
4. Osterholm MT and Schwartz J. (2000). Living Terrors: What America Needs to Know to Survive the Coming Bioterrorist Catastrophe. *Delacorte Press*: New York.
5. Pringle L. (1993). Chemical and Biological Warfare. Issues in Focus. Enslow Publishers, Inc.: Hillside, New Jersey.
6. Proliferation of Weapons of Mass Destruction: Assessing the Risks, OTA-ISC-559. (1993). US Congress, Office of Technology Assessment: Washington, D.C.
7. Anderson K. (2001). A new national security policy. BBC News. Retrieved January 6, 2001, from the World Wide Web: http://news.bbc.co.uk/hi/english/world/americas/newsid_1457000/1457616.stm.
8. Housden T. (2001). Analysis: Threat from weapon stockpiles. BBC News. Retrieved January 5, 2002, from the World Wide Web: http://news.bbc.co.uk/hi/english/world/europe/newsid_1628000/1628486.st.
9. Public Health Emergency Preparedness & Response: Agents/Diseases. (2001). Centers for Disease Control, US Department of Health and Human Services. Retrieved January 6, 2002, from the World Wide Web: http://www.bt.cdc.gov/Agent/Agentlist.asp.
10. Seigrist DW and Graham JM. (1999). Countering Biological Terrorism in the U.S.: An Understanding of Issues and Status. In: *Terrorism: Documents of International and Local Control, 2nd ed, Vol.4*. Alexander Y and Musch DJ (eds). Second ed. Oceana Publications, Inc.: Dobbs Ferry, New York.