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BIOLOGICAL WARFARE AND THE "BUFFY PARADIGM"

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Types of Attack: Determining Future Methods of Attack and the Needed Response

The most important single message that anyone can communicate in regard to biological weapons is that we face a very uncertain mix of existing threats politics, commercial development, and technology will change constantly as far into the future as we can look. The issue is not what we know, but how little we know and how little we can predict.

No one who has looked at our response to this issue to date can ignore just how difficult it is to put biological warfare into perspective

- We have experts who feel that massive future attacks are inevitable and experts who feel the spectre of biological attacks is grossly exaggerated.

- We have experts that see biological weapons as a state-driven threat and others that see it as a new form of terrorism.

- We have experts who claim they can characterize weapons effects and how they will impact on scenarios and experts who feel the situation is dominated by uncertainty.

- We have advocates who favor focusing on overseas defense, homeland defense, and response,

- We have advocates who believe that arms control is the answer and others who believe it is impossible.

- We have technologists and program advocates who claim there are solutions to characterizing foreign threats and facilities, new ways of detecting and inspecting the flow of goods into the US homeland, ways of detecting and characterizing attacks as they occur, and effective treatments that range from stockpiling old cures to developing nearly universal vaccines.

- We have experts who feel that the rule of law and human rights must be given priority and others that talk about security measures based on expediency. We have debates over quarantines and triage.

- We have a focus on physical and psychological casualties, but little focus on economic impacts and actuarial calculations and risk.

- We still think largely in national terms, but our battles may well be international or focus on allies.

- We focus today on the threat that emerged on September 11th, and the related problems of the Middle East and Islamic world, but we have no guarantee that totally different threats may emerge in the future and even the Anthrax attacks that followed September 11th may be largely domestic.

The fact is that we are entering – or have entered – a world we do not yet understand and cannot predict and we are struggling desperately to come to grips with it. In the process, we often seek to deny much of the uncertainty involved. We want a clear course to follow, and a clear plan of action. The fact is, however, that the recent Anthrax attacks, and British experience with hoof and mouth disease, has shown us that old science is old science, while the events of September 11th have shown us that even when we think we know a threat, we can get all of the essentials wrong.

- The US intelligence community will issue its new NIE of terrorism in the next few weeks without ever having performed a net technical assessment of biological weapons and the trends in the ability to produce more lethal agents and more effective defenses.

- At the same time, some 44 federal departments and agencies are rushing into the field, along with 50 states, and an uncountable number of regions, communities, and counties – and this ignore the international dimension.

- We are developing programs and making major investments based on very uncertain and outdated information. In many cases, we are developing technologies without asking whether they can ever been used in reliable and cost-effective systems. We often have no year future year program. We do not fully analyze cost to deploy and sustain, cost to defeat, and cost to improve. We are doing what we can do quickly and consciously or unconsciously paying the price.

Finding a New Paradigm: The "Buffy Syndrome"

The US must plan its Homeland defense policies and programs for a future in which there is no way to predict the weapon that will be used or the method chosen to deliver a weapon which can range from a small suicide attack by an American citizen to the covert delivery of a nuclear weapon by a foreign state. There is no reason the US should assume that some convenient Gaussian curve or standard deviation, will make small or medium level attacks a higher priority over time than more lethal forms.

Any structured intellectual approach to describing this situation – and planning for it -- is so uncertain that a valid structure can only be developed as an exercise in complexity or "chaos" theory. I, however, would like you to think about the biological threat in more mundane terms. I am going to suggest that you think about biological warfare in terms of a TV show called "Buffy the Vampire Slayer," that you think about the world of biological weapons in terms of the "Buffy Paradigm," and that you think about many of the problems in the proposed solutions as part of the "Buffy Syndrome."

I realize that those of you who are workaholics or who are simply mature and without children or younger relatives may never have seen this show. It is, however, about a teenage vampire slayer who lives in a world of unpredictable threats where each series of crises only becomes predictable when it is over and is followed by a new and unfamiliar one.

While uncertainty is the dominating motif, the "Buffy paradigm" has the following additional characteristics:

- What expertise there is consists largely of bad or uncertain advice and old, flawed, and confusing technical data.
- The importance of any given threat changes constantly, past threat behavior does not predict future behavior, and methods of delivery keep changing.
- Arcane knowledge is always inadequate and fails to predict, detect, and properly characterize the threat.
- The more certain and deterministic an expert is at the start, the more wrong they turn out to be in practice.
- The scenarios are unpredictable and have very unclear motivation. Any effort to predict threat motivation and behavior in detail before the event does at least as much
- Risk taking is not rationale or subject to predictable constraints and the motivation behind escalation is erratic at best.
- It is never clear whether the threat is internal, from an individual, or from an outside organisation.
- The attackers have no firm or predictable alliances, cooperate in nearly random ways, and can suddenly change method of attack and willingness to take risks.
- All efforts at planning a coherent strategy collapse in the face of tactical necessity and the need to deal with unexpected facts on the ground.
- The balance between external defense, homeland defense, and response changes constantly.
- No success, not matter how important at the time, ever eliminates the risk of future

problems,

If this is the “Buffy paradigm, the “Buffy syndrome” is different. The characters in Buffy constantly try to create unrealistic plans and models, and live in a world where they never really face the level of uncertainty they must deal with. They do not live in a world of total denial, but they do seek predictability and certainty to a degree that never corresponds to the problems they face. In short, they behave as if they could create and live with the kind of strategy and doctrine that is typically developed by the US joint chiefs, could develop and implement an NSC decision memorandum, or solve their problems with the equivalent of a Quadrennial Defense Review,

Now, if this use of a TV series to describe biological threats and biological warfare seems somewhat unusual, I invite you to consider the more conventional alternatives. We can speculate on scenarios, delivery methods, and lethality, we can conduct studies and exercises, and we can write doctrine until hell freezes over, but our chances of really being much better than Buffy are simply not that great – at least until we have a much clear picture of what kind of biological attacks actually materialize, how effective they really are, and how biotechnology evolves over the coming decades.

Illustrative Attack Scenarios

One way of illustrating the validity of the “Buffy paradigm” is to examine the range of possible scenarios and the obvious uncertainties they create. The federal, state, and local governments are almost certainly correct in assuming that the *current* threat of conventional attack is notably higher than the risk of CBRN attack, and that the use of relatively low levels of CBRN attack is currently higher than the risk of high levels of CBRN attack. However, there are many scenarios where different types of CBRN weapons could have lethalities and costs up to several orders of magnitude higher than those that occurred as a result of the World Trade Center, Oklahoma City, and Aum Shinrikyo attacks.

Consider the following scenarios:

- A radiological powder is introduced into the air conditioning systems of several high-rise office buildings, hostels, etc, possibly in several cities over a matter of weeks. Symptoms are only detected over days or weeks and public warning is given several weeks later. The authorities now detect the presence of such a powder, but cannot estimate its long-term lethality and have no precedents for decontamination. Local tourism collapses, no one will enter the building area, and the buildings eventually have to be torn down and rebuilt.

- A Country X or a Country X-backed terrorist group smuggles in parts for a crude gun-type nuclear device. The device is built in a medium sized commercial truck. The group uses a US Department of Defense weapons effects manual, maps a US city to maximize fallout effects in an area filled with buildings with heavy metals, and waits for a wind maximizing the fallout impact. The group also searches the US literature response measures to pick wind patterns that complicate the response effort and affect a maximum number of first responders. The bomb explodes with a yield of only a few kilotons, but with high levels of radiation. Immediate casualties are serious and the long-term death rate mounts steadily with time.

- Several workers move drums labeled as cleaning agents into a large shopping mall, large public facility, subway, train station, or airport. They dress as cleaners and are wearing what appear to be commercial dust filters or have taken the antidote for the agent they will use. They mix the feedstocks for a persistent chemical agent at the site during a peak traffic period.

- Immunized terrorists carry Anthrax powder into a building or urban area in containers designed to make them look like shopping bags, brief cases, suitcases, etc. They pick sites where their study of federal, state, and local governments indicate that detection is unlikely, and local response capabilities are limited. They slowly scatter the powder as they walk through the areas. The US does not detect the attacks until days or weeks after they occur. It then finds it has no experience with decontaminating a number of large buildings or areas where Anthrax has entered the air system and is scattered throughout closed areas. After long debates over methods and safety levels, the facilities and areas are temporarily abandoned. (A variation on this scenario is the use of a form of inhaled Anthrax modified to prevent effective immunization and use of normal medical treatment.

- A Country X or a Country X-backed terrorist group seeking to "cleanse" the US introduces a modified type culture of Ebola or a similar virus into urban areas. It scatters infectious cultures for which there is no effective immunization and only limited treatment, capitalizing on years of strategic warning regarding what vaccines the US is developing and stockpiling, and the open literature on the limits to US detection and response capabilities. By the time the attack(s) are detected, they have reached epidemic proportions, causing the collapse of medical facilities and emergency response capabilities. Other nations and regions have no alternative other than to isolate the part of the US under attack, letting the disease take its course.

- A Country X or a Country X-backed terrorist group modifies the valves on a Japanese remote-controlled crop spraying helicopter that has been imported legally for agricultural purposes. It uses this system at night or near dawn to spray a chemical or biological agent at altitudes below radar coverage in a line-source configuration. Alternatively, it uses a large home-built RPV with simple GPS guidance. The device eventually crashes undetected into the sea or in the desert. Delivery of a chemical agent achieves far higher casualties than a conventional military warhead. A biological agent would be equally effective and the first symptoms might appear days after the actual attack – by which time the cause would be impossible to determine and treatment could be difficult or impossible.

- A truck filled with what appears to be light gravel is driven through the streets of a city during rush hour or another heavy traffic period. A visible powder does come out through the tarpaulin covering the truck, but the spread of the power is so light that no attention is paid to it. The driver and his assistant are immunized against the modified form of Anthrax carried in the truck, which is being released from behind the gravel or sand in the truck. The truck slowly quarters key areas of the city. Unsuspected passersby and commuters not only are infected, but carry dry spores home and into other areas. By the time the first major symptoms of the attack occur some 3-5 days later, Anthrax pneumonia is epidemic and some septicemic Anthrax has appeared. Some 40-65% of the exposed population dies and medical facilities collapse causing serious, lingering secondary effects.

- A Country X or a Country X-backed terrorist group scatters high concentrations of a radiological, chemical, or biological agent in various areas in a city, and trace elements into the processing intakes to the local water supply. When the symptoms appear, the terrorist group makes its attack known, but claims that it has contaminated the local water supply. The authorities are forced to confirm that water is contaminated and mass panic ensues.

- Immunized terrorists carry small amounts of Anthrax or a similar biological agent onto a passenger aircraft like a B-747, quietly scatter the powder, and deplane at a regular scheduled stop. No airport detection system or search detects the agent on the plane. Some 70-80% of those who fly on the aircraft die as a result of symptoms that only appear days later. It takes weeks to detect the fact that the aircraft remains contaminated.

- Several identical nuclear devices are smuggled out of the FSU. One of the devices is disassembled to determine the precise technology and coding system used in the weapon's PAL. This allows users to activate the remaining weapons. The weapon is then disassembled to minimize detection with the fissile core shipped covered in lead. The weapon is successfully smuggled into the periphery of an urban area outside any formal security perimeter. A 10+ kiloton ground burst destroys a critical area and blankets the region in fallout.

- The same device is shipped to a US port area in a modified standard shipping container equipped with considerable shielding and detection and triggering devices that set it off either when the container is opened at any point near or in the US or using information from a GPS system that sets it off automatically when it reaches the proper coordinates. The direct explosive effect is significant, and even if it detonates at Customs, the damage and "rain out" contaminate a massive local area.

- A Country X or a Country X-backed develops a radiation fallout model using local weather data that it confirms by sending out scouts with simple commercial wind measurement equipment and cellular phones. It waits for the ideal wind pattern and detonates a nuclear device for maximum contamination of a city or critical economic areas. Alternatively, the same group uses a similar weather model, waits for the proper wind pattern and allows the wind to carry a biological agent over a city.

- Simultaneous release takes place of Anthrax spores at 10-20 scattered subway platforms during rush hour, and at commuter rail stations as well. No notice is given of the attack. Incubation takes 1-7 days, and the attack is only detected when massive numbers of cases in the acute phase exhibit flu-like symptoms and then enter the breathing difficulty and shock phase (1-2 days after incubation.) Several million commuters are potential exposed, but the locations of the attack are unknown, and effective triage is now impossible. Prompt treatment is no longer possible. Local and regional medical facilities collapse.

- An illegal smallpox culture is used or stolen. The agent is planted in the air duct of aircraft flying to an airport in the target country. The first cases occur two weeks after the flight(s). Widespread infection presents major problems because of a lack of the ability to trace passengers and secondary infections. Mass panic affects national medical facilities and some 10-30% of those infected die.

- A freighter carrying fertilizer enters a port and docks. In fact, the freighter has mixed the fertilizer with a catalyst to create a massive explosion that also disseminates a large amount of a radiological, and/or biological agent. Response focuses on the damage done by the resulting explosion. The scattering of a radiological or biological weapon over the area is only detected days later.

- A large terrorist device goes off in a populated, critical economic, or military assembly area – scattering mustard or nerve gas. Emergency teams react quickly and deal with the chemical threat and the residents are evacuated. Only later does it become clear that the device also included a biological agent and that the response to this "cocktail" killed most emergency response personnel and the evacuation rushed the biological agent to a much wider area.

- Country X or a proxy group attacks US agriculture with a foreign pest or disease that could be transmitted by normal commerce and which is genetically enhanced. The US suffers major economic damage and never knows it is under attack. Alternatively, it uses a mix of normal plant diseases plus an add on weaponized agent. The US fails to react to the added agent until it discovered the true scale of the problem weeks later, it then finds it has only limited near to mid-term countermeasures. It never conclusively identifies its attacker.

- Country X, a terrorist or proxy group attacks the US with a biological agent in very small amounts in many areas in the US. The US is forced to mount a massive nation-wide preemptive effort at vast expense, even though it is only under limited attack. The attack is tailored to counter the highly detailed open literature on US federal, state, and local detection and response capabilities.

- A local terrorist group produces Ricin from castor beans and either distributes the toxin through the air intake of a government building or sprays it from a truck moving down a street. The first symptoms do not appear until three hours later and there is no know treatment. Significant deaths occur within 36-72 hours.

This is scarcely a comprehensive list of scenarios – as we have learned to our cost in recent months – but it does illustrate four points. First, this list of possible attack scenarios illustrates the fact that a wide range of highly lethal CBRN attacks are practical, although most would *now* require an attacker to at least have access to the level of technology available only to governments. Second, it shows how dangerous it is to assume that attacks have to follow any rules or be carried out in a predictable way. Third, it shows that many attacks can defeat "first response" as well as avoid early US efforts at detection or containment, and/or can be tailored to bypass or counter many of the measures the US is currently exploring for Homeland defense. Fourth, it illustrates the fact that attackers can use more than one means of attack at the same time. Finally, it illustrates the dangers of leaving any gap in Homeland defense between responding to overt warfare like missile attacks and to relatively limited attacks by terrorists.

Biological Weapons as Means of Attack

Biological weapons have never been used successfully in large-scale combat, or in effective covert and terrorist attacks. Japan was the only nation in World War II that made confirmed use of biological weapons, and it used relatively crude means. While Japan used biological weapons against some 12 Chinese cites, the total number of deaths does not seem to have exceed 10,000 – many of which were caused under controlled conditions by experiments using human beings as live subjects.[1] Other nations confined their efforts to experimentation or to developing such weapons for retaliatory purposes. For example, Britain produced over five million seed cakes of animal Anthrax to be dropped by bombers during World War II.

The past, however, is unlikely to be a representative prologue of the future, and once again the constant flow of unpredictable and somewhat irrational scenarios on Buffy may be more realistic than a great deal of the deterministic planning going on in and for the US government. A wide range of powers developed far effective biological weapons after World War II, and the development of biological weapons in the form of dry, storable micropowders dates back to the 1950s.

As has been touched upon earlier, the technology necessary to produce biological weapons is proliferating as part of the broad transfer of biotechnology throughout the world. Many, if not most of the key technologies involved are now commercialized for food processing and pharmaceutical purposes. Modern biological weapons have become far more lethal and easy to deliver since World War II and have been stockpiled. For example US had stockpiles of seven weapons in 1969, at the time it renounced the use of biological weapons, and then was testing advanced biological warheads for the Polaris and Snark cruise missile.[2] Russia, France, Britain, China, North Korea, also had extensive stocks of such weapons in 1972, when the Biological Weapons Convention (BWC) was opened for signature. In spite of the fact that some 140 nations have now signed or ratified the BWC, US intelligence exports estimate that at least as 15 countries still stockpile such weapons.

Categorizing the Biological Threat

Modern biological weapons offer many potential advantages. They employ living agents or toxins produced by natural or synthetic agents to kill or injure humans, domestic animals, and crops. There are a wide range of agents with many different and effects and they offer a wide range of ways to attack American citizens, crops, and live stock. They also are nearly ideal terror weapons with massive psychological as well as physiological consequences.

Such weapons fall into five main medical categories: Bacterial agents (Anthrax, plague, brucellosis, typhoid fever); rickettsial agents (typhus, Rocky Mountain spotted fever, Q-fever); viral agents (smallpox, influenza, yellow fever, encephalitis, dengue fever, chikungunga, Rift Valley Fever, and hemorrhagic fevers like Ebola, Marburg and Lassa); toxins (botulinum, staphylococcus enterotoxin, shigella toxin, aflatoxin); and fungal (coccidiodomyocosis). There are other anti-plant and anti-animal weapons that are not used against humans.

There are many different ways to categorize biological weapons according to lethality. The CDC divides them into three main categories: Category A, Category B, and Category C. The Category A weapons are.high-priority agents include organisms that pose a risk to national security because they can be easily disseminated or transmitted person-to-person; cause high mortality, with potential for major public health impact; might cause public panic and social disruption; and require special action for public health preparedness. Category B agents include biological weapons that are moderately easy to disseminate; cause moderate morbidity and low mortality; and require specific enhancements of CDC's diagnostic capacity and enhanced disease surveillance. Category C agents have third priority and include emerging pathogens that could be engineered for mass dissemination in the future because of their availability; ease of production and dissemination; and potential for high morbidity and mortality and major health impact. The preparedness for Category C agents requires ongoing research to improve disease detection, diagnosis, treatment, and prevention.

Many of these weapons offer a means of attack that is potentially cheap, lethal, and hard to detect. At the same time, much depends on how well they are weaponized, both in terms of the agent and the way in which it is delivered. For example, the same disease is generally far more lethal in the form of a dry micropowder than can be disseminated and inhaled over a wide area than as a wet agent. Explosive warheads may waste much of the agent while spraying it upwind in a line source delivery may be highly effective. Wind patterns, temperature, and the presence of ultraviolet light can affect both lethality and the life of the agent. As a result, the same amount of the same agent can be several orders of magnitude more lethal under optimal weaponization and delivery conditions and potentially highly lethal agents can have minimal effectiveness under the wrong weaponization and delivery conditions.

This helps explain why the lethality models involved in estimating the impact of biological weapons are far more uncertain than those associated with conventional explosives, chemical weapons, and the immediate effects of nuclear weapons.[3] There is also little historical experience to build upon. Up until 1945, the development of biological weapons had only limited success. In fact, a recent history of biological weapons has found that every major power in World War II failed to develop highly effective weapons while its scientists either lied about their success or exaggerated their potential success, and their intelligence experts grossly exaggerated the potential threat from other states.[4]

The CDC also warns that there is no way to know in advance which newly emergent pathogens might be employed by terrorists and that it is imperative to link “bioterrorism preparedness efforts with ongoing disease surveillance and outbreak response activities as defined in CDC's emerging infectious disease strategy.”[5]

Other estimates of the biological weapons that might be used by states or terrorists illustrate this point. The NATO handbook dealing with biological warfare lists 31 agents. A Russian panel assessing microbiological agents identified 11 that were “very likely to be used.” The top four were smallpox, plague, Anthrax, and botulism. These four were chosen because they can all be delivered as aerosols, and have theoretical lethality rates of 30-80%, and smallpox and Anthrax are particularly attractive because they are easy for states to produce in large quantities, and the organism is resistant to destruction. The other items on the list included tularemia, glanders, typhus, Q fever, Venezuelan equine encephalitis, Marburg, and the influenza viruses.[6]

It should be noted that none of these lists include biological weapons directed at livestock or food groups, or the use of "eco-weapons" such as introducing new strains of agricultural disease or new plants, animals, and insects that could exploit vulnerabilities in the ecological balance of the US. There is ample recent experience to show, however, that such attacks occur regularly in the course of nature and as part of global transit and trade, and that they could potentially be highly effective.

The sheer diversity of biological weapons-- and the difficulties in predicting how they will be weaponized and how strains of the disease will have been altered during militarization--presents major problems in detecting, characterizing, and responding to such threats, particularly because they may be used in covert attacks.[7]

State Actor, Proxy, and Terrorist/Extremist Incidents to Date

While some sources claim that there was almost no use of biological weapons in covert and terrorist attacks before the recent Anthrax attacks, this was not the case. Work by W. Seth Carus indicates that there are 51 cases of reported biological terrorism, of which 24 involved significant activity and five involved confirmed use. In addition, there are 77 cases of criminal use of biological agents and poisons, 49 of which can be confirmed, and 93 more cases where the perpetrators cannot be characterized clearly as either terrorist or criminals. There are 19 cases involving allegations of covert state activity, of which 11 can be documented.[8]

This does not mean that there have not been many more cases where false reports have been made. Dr. Carus found a total of 234 reported cases, of which 150 involved significant activity. A total of 109 cases out of the 150 involved threats or hoaxes, but 10 involved a serious interest in biological agents, 10 more involved actual efforts to acquire biological agents, and 21 more involved actual acquisition and use. It is interesting to note that 16 of the latter 21 cases of actual use involved criminal activity and only five involved terrorism.[9]

The tempo of such activity also seems to be increasing. A total of 33 out of 49 confirmed criminal cases occurred in the 1990s, and 16 out of the 24 confirmed criminal uses. If one includes all possibilities including threats and hoaxes, 123 out of 150 cases occurred in the 1990s, versus 9 during 1980-1989, 8 during 1970-1979, 1 during 1960-1969, 1 during 1950-1959, 1 during 1940-1949, 3 during 1930-1939, 0 during 1920-1929, 3 during 1910-1919, and 1 during 1900-1909.[10] The actual level of casualties, however, has remained limited. Carus estimates that there were 881 casualties as a result of biocrimes and bioterrorism, of which 130 resulted from biocrimes and 751 from one successful incident of bioterrorism. These casualties produced only 10 deaths, only one of which has occurred since 1945.[11]

There have been several serious terrorist and extremist efforts to use biological weapons. Germany's Red Army Faction, Italy's Red Brigades, and some Palestinian groups have at least discussed the manufacture and use of chemical and biological weapons. Chemical poisons have been used in ways that skate the definition of biological weapons. Palestinian terrorists once poisoned a shipment of Jaffa oranges from Israel, and a shipment of Chilean grapes shipped to the US was dusted in cyanide. In 1984, a member of the Baghwan Shree Rajneesh cult used salmonella gastroenteritis to poison the salad bars in a town in Oregon and 751 people became ill.[12] In 1989, a cell of the German Baader-Meinhof gang was discovered with a culture of clostridium botulinum.

Aum Shinrikyo is the one known case in which a terrorist/extremist group had vast financial resources and actively attempted to use biological weapons. It is not clear, however, that it represents anything other than a fluke. Few religious extremist movements turn to radical terrorism of the kind that involves the potential use of weapons of mass destruction. Aum's vast financial resources, ability to buy modern equipment, and access to some scientists also do not mean that cult based on a lunatic view of the world sets the standard for effective planning and work efforts.

Cases in the US

There were a number of domestic extremist attempts to use such weapons in the US long before the Anthrax attacks began following September 11th, although many were little more than threats and none have been particularly successful. Some food poisoning efforts have succeeded in causing illness, but a few sick and dead scarcely compare with an average of 9,000 deaths from food poisoning a year in the US from natural causes. The FBI reports that:[13]

- 37 cases involving chemical and biological weapons were opened in 1996,
- There were 74 cases opened in 1997, 22 of which were related to biological agents,
- There were 181 cases opened in 1998, 112 of which were biological,
- As of late May 1999, 123 cases had been opened in 1999, 100 of which were biological,
- In 1998 and 1999 combined, over three-quarters of the cases opened threatened the release of biological weapons. The most common threat was Anthrax.

Most of these cases can be dismissed as mere threats and extortion attempts, often by deeply disturbed "loners." FBI sources do indicate, however, that some involve relatively well-equipped home labs, and that there were some successful efforts to produce Ricin, botulinum, and Anthrax.

The Lethality and Effectiveness of Current Biological Weapons

One of Buffy's constant problems is that demons are more lethal than vampires, and simple minded as this may be, it illustrates the point that some weapons of mass destruction are far more lethal than others. Biological weapons can be far more lethal than chemical weapons. The theoretical lethal dose for botulinum toxin, for example, is 0.001 micrograms per kilogram of body weight, while the lethal dose for VX – the most lethal form of nerve gas – is 15 micrograms per kilogram of body weight. In theory, one milligram of Anthrax spores contains one million infective doses. Efficient modern biological weapons can also be extremely lethal or merely incapacitating. They can be infectious or transmitted only by contact with a wet or dry delivery medium. They can be quick or slow to react, and can be chosen from weapons for which there are well known and proven cures or from weapons for which there is no present vaccine or effective treatment. It should be noted, however, that most of the estimates of the impact of attacks used in this study are drawn from military models where the threat was assumed to be weaponized.

As in the case with chemical weapons any such lethality estimates are extremely uncertain although, the CDC and Defense Threat Reduction Agency (DTRA) are working on more sophisticated classified models. There is no operational experience to back up theoretical estimates, and the limited test data supporting such estimates is often highly dated and has little to do with modern, highly weaponized agents. In many cases, the assumption is made delivery will occur under near optimal conditions but the agent will then behave in a manner that is somewhat similar to a natural epidemic. In the case of biological weapons, however, these uncertainties affect a far wider range of potential casualties.

The sheer range of uncertainty in such estimates creates massive problems in judging the priority the US should give to defense against biological weapons, deterring and retaliating against their use, and developing suitable response measures. Even if such weapons are not developed in ways that deliberately defeat current vaccines and medical treatment, many forms of biological attacks, and some chemical attacks as well, would present major problems in terms of effective medical treatment.

Means of Delivery

Some of these issues become clearer after a review of different means of delivery and here again, the uncertainties in Buffy may be more realistic than efforts to create predictable methods of attack. Unlike chemical weapons and most nuclear weapons, biological agents generally are compact and low in weight. They can be disseminated in a wide number of ways – such as insects, the contamination of water and food supplies, contact, spreading powers or liquids, and by aerosol. The Department of Defense reports that dissemination of infectious agents through aerosols, either as droplets from liquid suspensions or by small particles from dry powders, is by far the most efficient method.[14]

Tests conducted during the 1950s and 1960s showed that an aerosol cloud of fine (2-5 microns) particles behaves more like a gas than a suspension, and penetrates interior spaces as well as exterior spaces. The US found that release from ships, aircraft, and tall buildings could achieve some lethality over distances of 50-100 miles, although without anything approaching uniform density.[15]

The military means for delivering biological weapons include artillery, missiles, and aerial sprayers. There are two basic types of actual munition: point source bomblets and line source tanks. Within each category there can be multiple shapes and configurations. BW munitions and delivery systems are very interdependent; frequently**,** the munition dictates the delivery system. With the evolution of sophisticated line source hardware, the agent, the munition, and delivery system must be carefully integrated. Like chemical weapons, the effectiveness of BW munitions is very dependent on meteorological conditions and many are also sensitive to exposure to daylight.

Covert attacks against the American homeland could involve a wide range of different methods of delivery. They could include disseminating agents through contact, using the wind or spreading them from high buildings, crop sprayers, commercial aircraft, and helicopters. Arthropod vectors and the contamination of food and water supplies could be significant modes of dissemination for BW agents. So could contamination of food and water supplies or aerosol dissemination since only relatively small quantities of relatively impure agent are required for terrorist use, the range of possible agents is almost unlimited.

The Department of Defense estimates indicate the quantity of an agent could be small (a single gram, possibly less). Production and purification methods and dissemination means could range from simple to complex. All of the elements of such a program might go undetected until use has occurred. Broad areas or individual buildings are potential targets. In the case of buildings, off-the-shelf aerosol generators could be used to disperse a BW agent into the air inlet ducts of the target structure, especially in the case of toxins, in that much less toxic agents could be employed and/or that quantities of agent required would be much less than for other targets.

Attacks could involve a *mix* of different biological weapons that each required radically different treatment. Because some weapons take a long time before their effects are clear, attacks using multiple agents of "cocktails" could be carried out over days or weeks before their nature and impact became clear, and attacks on agriculture or humans could be masked as the natural outbreak of disease. Accidental "attacks" on American agriculture have been common, and have often had a major impact. Such "attacks" have consisted of importing the wrong pet, diseases brought in the form of a few infected animals or plants, and insects and parasites that have arrived in on birds, aircraft, cars, and ships.

These have all had a major impact on given crops, and have affected the ecology of whole states, particularly in the southern and western US and Hawaii. The potential lethality of such attacks is further illustrated by the costs of "mad cow" disease (variant Cruzfeldt Jakob disease or VCJD) in Europe, and the fact that one infected pig could destroy an entire swine industry in Taiwan. Such a form of delivery offers many advantages: it could be virtually undetectable, it could be unattributable and it might never been seen as a deliberate attack, and the effects could be lasting and nation-wide.

Manufacturing Biological Weapons

Another lesson of the Buffy Paradigm is that it is not possible to know how successful any group or individual will be in producing a major threat. The manufacture of highly effective biological weapons to use against humans does present significant problems. Producing such weapons is not a problem for most governments, but the ease with which most domestic or foreign terrorists/extremists can obtain or manufacture such weapons has sometimes been exaggerated. Nevertheless, the recent Anthrax attacks in the US indicate that difficulties in manufacturing biological weapons may not prevent attacks that have massive political, social, and economic consequences even without the aid of a state.

The steady dissemination of the required technology and equipment is also reducing the problems in making biological weapons. For example, a recent survey of 1400 US academic institutions found that 16% possessed human, animal, or plant pathogens that appear **on** the draft Biological Weapons Convention's list of biological agents. Another 11% have high-level containment facilities, 7% conduct research on vaccines, 5% perform research for the military or Department of Energy to develop defenses against biological weapons, and 3% have high volume bioreactors.[16]

In the 25 years that have followed the development of recombinant DNA technologies, over 2,000 firms have been founded in the US alone. More generally, there are roughly 1,308 US companies now actively commercializing biotechnology. They employ 108,000-116,000 people, and the market for such products is estimated to grow from $7.6 billion in 1996 to $24 billion in 2006. These figures do not include the growth of agriculture biotechnology**,** which may be as much of a source of threats as the technology tailored to deal with humans, and which is expected to grow from $295 million in 1996 to $1.74 billion in 2006. Unlike most companies, such firms also train a large number of individuals in research and development. Biotech firms spent $69,000 per employee on R&D in 1995, versus a US corporate average of $7,651.[17] While there are no precise figures, much of this activity involves foreign scientists and technical personnel.

Other regions are not yet as advanced. For example, Japan is estimated to lag roughly 10 years behind the US in biotechnology (a factor to be considered in assessing Aum Shinrikyo), but the volume is growing. Japan's pharmaceutical market is now worth about $37 billion. Europe is also experiencing significant growth. The number of biotechnology firms grew from 486 in 1994 to 584 in 1995, and the number of employees grew from 16,100 to 17,200. What is more significant is that spending on R&D increased by 21% in one year, to $795 million.[18]

Technology transfer from the former Soviet Union (FSU), however, is a very serious potential problem. The Cold War effort involved some 60,000 to 70,000 people.[19] There is no meaningful current accounting of their whereabouts. It is clear, however, that at least 75,000 Russian scientific workers emigrated between 1989-1992, and many have left since. There are also repeated unconfirmed reports that some of these scientists are working in Iran and North Korea. The Department of Defense has warned that even the production and development of biological weapons by foreign states might not be detected, much less terrorist or extremist groups:[20]

The problem in detection would be compounded by the fact that neither states nor independent groups have to adopt the safety procedures used by the US. Department of Defense reporting also notes that while the US developed elaborate containment facilities for conducting infectious disease research at facilities like the Fort Detrick Biological Warfare Research and Development Laboratories during the Cold War, "Other countries do not necessarily share these safety concerns."[21] Iraq did not follow such procedures, and did not provide all of its dispersed biological weapons with guards or special security storage arrangements during the Gulf War.

The Growing Lethality of Biological Weapons and Growing Ease of Manufacture

Biological weapons also represent an area where the rapid pace of technical change creates the ability to make far more effective weapons. Biotechnology can offer many benefits.[22] At the same time, genetic engineering and other new technologies can now be employed to overcome product deficiencies in the classic agents and toxins normally addressed in such discussions. Moreover, toxins that exist in nature in small amounts were once considered not to be potential threat agents because of their limited availability. Today, the Department of Defense estimates that a number of natural toxins could be produced through genetic engineering techniques in sufficient quantities for an adversary to consider producing them as an offensive weapon. There are many microorganisms, or their metabolic byproducts (toxins) that can now meet all of the criteria for effective BW agents.[23]

Studies like those of the Jason project indicate that this situation will become much worse in the future. Genetically engineered pathogens can be designed to have any or all of the following attributes:[24]

- *Safer handling and deployment*, including the elimination of risks from accidents or misuse – the "boomerang effect".
- *Easier propagation and/or distribution* eliminating the need for a normally-hydrated bioagent or any use of aerosols. Microorganisms with enhanced aerosol and environmental stability.
- *Improved ability to target the host*, including the possible targeting of specific races or ethnic groups with given genetic characteristics.
- *Greater transmissivity and infectivity:* Engineering a disease like Ebola to be as communicable as measles. Microorganisms resistant to antibiotics, standard vaccines, and therapeutics.
- *New weapons:* Benign microorganisms, genetically altered to produce a toxin, venom, or bioregulator.
- *Increased problems in detection:* Immunologically altered microorganisms able to defeat standard identification, detection, and diagnostic methods. Problems in diagnosis, false diagnosis, lack of detection by existing detectors, long latency, binary initiation.
- *Greater toxicity, more difficult to treat:* Very high morbidity or mortality, resistant to know antibacterial or antiviral agents; defeats existing vaccines; produces symptoms designed to saturate available specialized medical treatment facilities.

- *Combinations of some or all of the above.*

New Types of Biological Weapons

While any such analysis is speculative, scientists postulate that the following new types of biological weapons are now deployable or can be manufactured during the coming decade:[25]

- *Binary biological weapons* that use two safe to handle elements which can be assembled before use. This could be a virus and helper virus like Hepatitis D or a bacterial virulence plasmid like E. coli, plague, Anthrax, and dysentery.

- *Designer genes and life forms*, which could include synthetic genes and gene networks, synthetic viruses, and synthetic organisms. These weapons include DNA shuffling, synthetic forms of the flu – which killed more people in 1918 than died in all of World War I and which still kills about 30,000 Americans a year – and synthetic microorganisms.

- *"Gene therapy" weapons* that use transforming viruses or similar DNA vectors carrying Trojan horse genes (retrovirus, adenovirus, poxvirus, HSV-1). Such weapons can produce single individual (somatic cell) or inheritable (germline) changes. It can also remove immunities and wound healing capabilities.

- *Stealth viruses* can be transforming or conditionally inducible. They exploit the fact that humans normally carry a substantial viral load, and examples are the herpesvirus, cytomegalovirus, Epstein-Barr, and SV40 contamination which are normally dormant or limited in infect but can be transformed into far more lethal diseases. They can be introduced over years and then used to blackmail a population.

- *Host-swapping diseases:* Viral parasites normally have narrow host ranges and develop an evolutionary equilibrium with their hosts. Disruption of this equilibrium normally produces no results, but it can be extremely lethal. Natural examples include AIDS, hantavirus, Marburg, and Ebola. Tailoring the disruption for attack purposes can produce weapons that are extremely lethal and for which there is no treatment. A tailored disease like AIDS could combine serious initial lethality with crippling long-term effects lasting decades.

- *Designer diseases* involve using molecular biology to create the disease first and then constructing a pathogen to produce it. It could eliminate immunity, target normally dormant genes, or instruct cells to commit suicide. Apoptosis is programmed cell death, and specific apoptosis can be used to kill any mix of cells.

Changes in Disease: Piggybacking on the Threat from Nature

Alternatively, an attacker might take advantage of the fact that the world – and Americans – are under constant natural attack from evolution. A recent national intelligence estimate found that at least 20 well-known diseases had emerged in resistant form during the last 20 years, including tuberculosis, malaria, and cholera.[26] The strains of streptococcus pnemoniae, staphylococcus aureus, and mycobacterium tuberculosis in the US are now 10-35% immune to treatment.

At least 30 previously unknown diseases have emerged since 1973, including HIV, Ebola, Hepatitis C, and Nipah virus for which there are no known cures. As a result, the annual deaths from infectious diseases in the US have doubled to 170,000 a year from their historic low in 1980. Many have been caused by new immigrants such as West Nile virus. Europe continues to suffer from new zoonotic diseases like Creutzfeldt-Jakob or "mad cow disease," which have had massive economic consequences even with minor human losses. (A total of 70 deaths have occurred over a period of six years, with some seven additional cases still alive.)[27]

To put these trends in perspective, 890,000 Americans are now infected with HIV/AIDS, 4 million are chronic carriers of Hepatitis C, 27,000 a year now catch TB – which is 32-52% resistant to established drugs – and 14,000 a year die of streptococcus pnemoniae and staphylococcus aureus. The flu now kills about 30,000 Americans a year – twice the number as in 1972-1984. Experts at the US Center for Disease Control predict a new epidemic – similar to the one that killed 500,000 Americans in 1918 – could kill 197,000-227,000 in spite of improvements in medical treatment.[28]

Much more massive outbreaks of resistant diseases are taking place outside the US, and TB, malaria, hepatitis, and HIV/AIDS continue to surge. For example, roughly 700,000 died from AIDS in 1993, and 2.3 million in 1998. There were an estimated 5.8 million infections and many in developed countries: the HIV population in Russia could reach one million by 2000, and double by 2002. There were 33.4 million people infected with AIDS in 1998, and there will probably be 40 million by the end of 2000.

The inability to predict the impact of even a well-established disease is illustrated by the fact that the World Health Organization (WHO) predicted that deaths from HIV/AIDS would peak in 2006 with 1.7 million deaths, and the death rate was already 2.3 million in 1998. The cumulative global economic cost of AIDS is already estimated to have reach $500 billion.[29]

The WHO has warned that "globalism" means that developed countries like the US are becoming progressively more vulnerable to the new variants of disease emerging in the developing world,[30] This illustrates the fact that Homeland defense cannot be separated from public health policy. The effectiveness of treatment for most of these diseases is now forecast to decline over the near to mid-term, and humanitarian crises are projected to create a further problem. There were 24 major humanitarian crises in 1999, involving at least 35 million refugees and displaced people. Further, immigration had reached the point where 180 million people lived outside the country of their birth. Roughly 88% of the population growth in Europe in the 1990s came from immigration.[31]

Future attackers could piggyback on the natural evolution of disease to use new or resistant weapons, or genetically engineer diseases that might not be distinguished from a natural outbreak – at least not quickly and in a form where the attacker could not be identified. They could also use stealth attacks and proxies to deliver new or resistant diseases, and the previous data show that some attacks on the US might take years to mature – which makes detection and retaliation extremely difficult.

Agricultural and Ecological Attacks

As has been touched upon earlier, the uncertainties surrounding biological attacks on human beings are compounded by the risk of biological attacks on crops and livestock, which could be combined with attacks on human beings. Agriculture accounts for 13% of the US GNP, and 17% of total employment (860,000 jobs) although less than 2% of the US work force is on farms. [32] The US exports well over $140 billion worth of agricultural goods annually. The US also has special regional and local vulnerabilities. Some 84% of its cattle are in the southwest, 60% of swine are in the northeast, and 78% of chickens are in the southeast Atlantic region. Some feedlots hold 150,000 to 300,000 cattle and 78% of all cattle pass through only 2% of the feedlots. Some pig farms hold 10,000 hogs and chicken farms pen over 100,000 birds.[33]

Nature has already shown how easy it might be for a sophisticated, technically informed state, group, or individual to attack crops and livestock by introducing a new parasite, predator, or disease. There is no clear record of how many times such problems have occurred naturally in the US since World War II, but instances like the introduction of the Mediterranean Fruit Fly (which involved a group called the Breeders protesting the use of insecticides in California), cross breeding of "killer bees," poisoning of Chilean grapes, importation of mosquitoes with West Nile fever, and mere rumors that US apples might be covered in carcinogens are examples of cases involving millions of dollars. There are a host of "rusts" and "smuts" that can attack grain crops. Wheat rust, for example, can affect must of the Western and Great Plains wheat crop and some 12% of the California wheat crop was lost to this rust in one recent year. The following pathogens already threaten US crops as a result of natural causes: Soybean Rust (Soybean Plant), Ear Rot (Corn), Karnal Bunt (Wheat), Ergot (Sorghum), Bacterial Blight (Rice), Ring Rot (Potatoes) and Wirrega Blotch (Barley).

There is an even longer lists of threats to US livestock. They include Animal Disease Plant Disease, Foot and Mouth Disease, Vesicular Stomatitis, Rinderpest Gibberella, African Swine Fever, Highly Pathogenic Avian Influenza, Rift Valley Fever, Lumpy Skin Disease, Bluetongue, Sheep and Goat Pox, Swine Vesicular Disease, Contagious Bovine Pleuropneumonia, Newcastle Disease, African Horse Sickness, and Classical Swine Fever

Anthrax, Foot and Mouth Disease, Rinderpest, and Swine Fever are well researched ways to attack live stock.[34] In the case of "mad cow disease," less than 200 cases of sickness over more than 10 years caused billions of dollars. In contrast, foot and mouth disease is extremely contagious, has seven variants and 70 sub-variants, and airborne infections have been spread up to 150 kilometers by winds. Even single cases of foot and mouth disease have halted all exports of meat products from cloven-hoofed animals from some countries. The March 1997 outbreak of Foot and Mouth Disease in Taiwan forced the immediate destruction of 900,000 animals and an eventual total of up to 1.6 million, affecting exports which made up 41% of Japan's pork supply. The cost to the Taiwanese economy was one billion dollars a year. Alternatively, African Swine Fever is non-virulent against its natural hosts in Africa (ticks and warthogs), but is lethal enough against US pigs to act as the equivalent of a swine Ebola. [35]

While agricultural and ecological attacks do not offer quick results or the kind of shock impact that can decide the outcome of short wars or achieve high immediate visibility, the other side of the coin is that they may also be extremely difficult to trace to any deliberate cause, have long-term effects that are very difficult to deal with and offer a potential means of revenge and punishment even to weak movements and states.

This risk explains why the Department of Agriculture has the mission of detecting and defending against such attacks. As is the case with human biological weapons, however, it is far from clear how genetic engineering will change the balance between defense and attack. Virtually all of the advances in biotechnology that can affect human diseases can be applied to the agents to attack crops and livestock and with far fewer risks in handling the materials and in weapons development.

The Problem of Response

One real question is whether the US government will ultimately be much more successful in its response efforts than the characters on Buffy. Like chemical weapons, biological weapons *can* be a weapon of mass destruction with which most first responders and law enforcement agencies are able to deal. Attacks with limited medical effects can be dealt with as outbreaks of disease, and be contained and treated accordingly. Attacks on critical or sensitive facilities present more serious individual risks, but so do chemical attacks and bombs used against the same target. Similarly, false threats only need to be taken seriously to the point of ensuring that they do not produce mass panic.

Most responders feel -- probably correctly -- that the estimated total casualties from most limited or crude biological attacks of the kind that are unlikely to put an impossible burden on local and regional medical services. The law enforcement aspects, and forensics, of dealing with such biological attacks present challenges, but law enforcement experts believe most incidents will have a clear location and clear chains of evidence. This is more questionable in the case of attacks on livestock, crops, food, and the environment, but small, crude attacks of this kind also seem likely to be limited in effect and containable.

At the same time, there is the same broad consensus that there are still major problems in the rapid detection and characterization of even a limited biological and relatively crude biological attack, and in training and equipping suitable emergency medical personnel and facilities. These problems could be much more serious if a small and/or crude biological weapon **were** combined with an explosive or chemical device in attacking a building or facility, and/or responders had to characterize and deal with two sets of different biological weapons at the same time.

Funding Half-Measures and False Solutions?

The problems in responding to biological attacks radically change character, however, if they involve attack with enough agent to affect a large area, are conducted in a stealth or delayed mode, and/or involve attacks using highly lethal militarized agents. Such attacks could rapidly exhaust the response capabilities of any urban area or region. They could also involve weapons with very different methods of transmission, effects, and treatment requirements than a normal outbreak or epidemic.

Early response is critical in dealing with most attacks. It is unclear, however, that the US intelligence community is prepared to give warning of any kind against biological attacks. CIA Director George Tenet testified to the Senate Foreign Relations Committee on March 20, 2000 that biological warfare programs, "are becoming self-sufficient, challenging our detection and deterrence efforts, and limiting our interdiction capabilities…Biological and chemical weapons pose arguably the most daunting challenge for intelligence collectors and analysis." Tenet was referring largely to the threat posed by states, although he mentioned that a number of terrorist groups – such as Osama Bin Laden – were seeking to develop or acquire biological and chemical weapons.[36] Given the risk that US intelligence may not even detect the weaponization of biological agents, it seems almost certain that there is a much greater risk that any intelligence warning of a potential attack will not be able to name the agent(s) involved, and indicate the degree to which genetic engineering, the use of militarized strains, cocktails of mixes of different agents, and/or weaponization affect dissemination, lethality, and the effectiveness of the agent.

Detection might well lag behind the deadlines for effective response and such attacks could infect or kill many local responders. Characterizing the risk of exposure and actual levels of exposure could prove to be a nightmare, as could separating out real exposures from feared exposures. It is unclear that anyone is prepared to determine the area covered by the agent (assuming it is non-infectious) and how many people were actually exposed and with what effect. The number of false reports, and people seeking cautionary or panic medical treatment would rise massively. The potential problem of halting movement, and establishing quarantines could overload law enforcement as well as create major lethal and ethnical issues. The fear of sequential or follow-on attacks would grow, and so would the problems in decontamination.

Advances have been made in detection and characterization at the military level. In October 1996, the Army fielded its first biological defense unit equipped with state-of-the-art biological detection capabilities, the Biological Integrated Detection System (BIDS). In 1999, a second unit was fielded with the BIDS Phase II Pre-Planned Program Improvement (P3I), which provided technology insertion from concurrent development efforts to upgrade the Phase I (4-agent detection capability) core configuration to 8-agent detection capability, automated detectors, and computerized integration of detection equipment outputs. In addition, the Army has fielded the Long Range Bio-logical Standoff Detection System (LR-BSDS), used for remote detection of aerosols and particulates. Also, the Interim Biological Agent Detector (IBAD) has been installed on selected Navy ships to provide a mobile biological point detection capability.

Department of Defense reporting does, however, provide a clear warning about the limits of current detection and characterization systems and technology, and in the research efforts to improve them. These limitations are severe even when the threat is confined largely to military operations against a relatively limited military target against fully alert forces in the field:[37]

The current weapons effects literature simply cannot prepare defenders and responders for what would really happen if large amounts of given agents were broadly disseminated, or highly infectious military agents were used. No currently deployed detection system can accurately measure the area coverage of such an attack, and most projected detection systems – including most biochips -- would present problems in reliably characterizing the exact weapon used and/or the amount of the weapon present in given areas, and the degree to which it does or does not mimic all of the patterns of a normal disease. While more sophisticated individual detection and characterization devices are becoming available, and much more reliable and advanced systems are completing development, there as yet are no rapidly deployable arrays that can be used in urban environments, and must responders have no funds to acquire them. In fact, the NSC was just beginning to examine the kinds of “systems” that might be required in August 2000.

The resulting response problems will be greatly complicated by the steady decline in public health funding and in the number of hospitals and emergency facilities per patient that has affected the US and virtually every nation in the West. The US saw over 1,000 hospitals close in the 1990s, medical services shift to minimize stocks and any kind of surplus capacity, and many emergency wards close. In the late 1990s, nearly 30% of America’s remaining hospitals were losing money. The US Public Health Service, and state and local public health departments, have been badly underfunded and the overall system can barely cope with its normal caseload.[38]

No hospital in the country can deal with more than 50-100 patients requiring isolation. It can also take a critical 24-48 hours to move federal and state resources to a local facility once (and if) an attack is detected, and hospitals are not funded to do anything to bridge the gap. Furthermore, it is far from clear that detection of some kind of bioattack is any guarantee that such an attack can be characterized in a sufficiently precise way to allow hospitals/caregivers, and local, state, and federal authorities to know what kind of services and treatment to provide and what kind of aid to ask for.[39]

The end result could easily be to funnel patients into a public health system and hospital network with almost no surplus capability, which had neither the facilities nor the stockpiles to treat the result of a biological attack, and which would be incapable of rapidly diagnosing the exact nature of an attack. While similar problems would occur in responding to any major CBRN attack, biological attacks ultimately place a critical response burden on hospitals and advanced medical facilities. The creation of federal groups like the Office of Emergency Preparedness in HHS and the Bioterrorism Preparedness and Response Office of the Center for Disease Control, and training of state and local health departments, training of military and National Guard personnel are all useful measures. So is the creation of the 7,000 volunteer force in 30-person Disaster Medical Assistance Teams, although few members of the teams are doctors. No system can work, however, that then cannot treat the patient load, and the burden of treatment/isolation/quarantine would be far greater in the case of an infectious attack, particularly one that was only detected after it had spread.

Current plans to stockpile vaccines and given types of treatment aids seem to assume that attacks will be limited and will not involve militarized or highly effective agents or mixes of agents that cannot be detected and/or treated as regular diseases. This may well be valid, but it is unclear that the classified work done by the military services, DTRA, and CDC in looking at the full range of biological agents have yet been translated into anything approaching reliable effects models, and that planning which is not familiar with the full range of militarized agents and military risks is always valid for more than limited and unsophisticated attacks. They also tacitly assume that attacks can be detected and characterized in time to react and that vaccines can be moved to effective public health authorities who can discriminate who should be vaccinated and carry out the actual vaccination in time to be effective.

Biotechnology may well give the “defense” as many advantages, or more, than the “offense.” However, anyone can promise the biological equivalent of the philosopher’s stone and universal solvent and some programs seem to be very poorly justified and grossly oversold.

Many of the stockpiling, vaccine, and research and development programs underway do not seem to have been supported by any kind of net technical assessment of the cost to defeat them, the advances taking place in possible attack technologies, and what the cost of national deployment would really be. Many RDT&E programs are being oversold and over-hyped in what seem to be dangerously over-simplistic terms. In many cases, no effort is made to describe their probable deployment and life-cycle costs or even what actual deployment would entail.

The Need for Constantly Updated Net Technical Assessments

Another aspects of the Buffy Paradigm is a lack of any systematic net assessment of the overall nature of the threat. This has been equally true of the US government, and its lack of any clear net assessment of the probable trends in the offensive and defensive capabilities of biotechnology. Some programs hype the problem and some hype the solution. Many assume that a solution that works with current biotechnology will be valid five, ten, or more years in the future, and that sophisticated attackers will not choose new means of attack even though they have years of public warning of the measures the US plans to take to reduce its vulnerability. These problems are made worse by a flood of policy and strategic studies literature with no supporting references to technology.

The unclassified literature is filled with unsubstantiated and poorly referenced assertions, and efforts to sell given programs. The gap between "science" based on normal patterns of disease and the different risks posed by militarized agents is brutally and almost constantly apparent. It is true that no one net technical assessment can hope to accurately predict the future, but the need for well funded assessments that have both classified and unclassified versions is painfully clear.

These problems are compounded by a failure to integrate suggested response and RDT&E efforts for biological attacks into a realistic overall set of procedures that take account of day-to-day public heath needs, real-word pressures to reduce the cost and level of medical services, and the impact of dealing with the aging of the American population. Biological warfare planners and responders sometimes seem to assume that they have an axiomatic priority for resources. They plainly do not.

Reconsidering the Practical Problems in Defense and Response

The threat posed by biological weapons illustrates the need to be able to measure the existing capabilities of federal, state, and local defenders and responders, to determine what can be done to improve their capabilities with minimal or no additional resources, and then to expressly address what level of additional capability the nation is and is not willing to fund. At present, federal efforts are just beginning to develop a detailed picture of existing national capabilities, and much of the governmental effort at every effort is concerned with basic efforts to understand the problem, coordinate, and train. There is no question that this effort is producing progress, but it does not create a system or architecture for Homeland defense, and no one has seriously addressed the question of "how much is enough?"

Biological weapons offer an extraordinarily wide spectrum of means of attack with highly unpredictable effects and lethality. They can vary from limited use of toxins by individuals up to extremely lethal attacks by state actors. It also seems prudent to assume that biological weapons present a serious potential threat in spite of the lack of any past history of effective use, and the problems in manufacturing, handling, and delivering them. Homeland defense requires the US to consider the following factors:[40]

- The psychological and political impact of using such weapons can be varied according to the means of attack. Weapons can be designed to kill or incapacitate, or to attack livestock, plants, and specific foods.
- The amounts of biological weapons needed to achieve a given effect are usually far smaller than for conventional or chemical weapons. Some are easy to smuggle and safe to handle by personnel who have had suitable medical treatment.
- Some biological weapons are so lethal, they potentially approach the lethality of nuclear weapons.
- While the technical skills involved in making such agents are high, biological weapons can be relatively easy to manufacture if such skills are present, and such skills and the required equipment are becoming increasingly common.
- Biological weapons are hard to detect and characterize, particularly if more than one type of weapon is

used, or the nation is not on the alert.

- Defense is difficult at best. Effective vaccines and treatment are often not available, or must be administered very quickly. Casualties often require intensive and long-term care and therapy, possibly saturating available care.
- The impact of an attack can be timed in ways that favor the attacker. The time before the effects of an attack varies. It may be hours, days, or weeks before an attack is apparent, and this could severely restrict warning, detection, and the value of treatment.
- The US would find it extremely difficult to estimate the seriousness of the attack and react accordingly. It is difficult to characterize the scale of the threat and its impact until symptoms appear and the casualties can be judged by the number of sick or poisoned.
- Unprotected medical and emergency personnel are highly vulnerable if they enter areas they do not know have been attacked, or attempt treatment when no cure is available.

It is not clear that anyone can assign valid probabilities to the kinds of biological attacks that will be made on the American homeland. It is also clear that the frequency of given types of attacks is not a meaningful criterion. There already is a flood of false Anthrax threats and attacks, and the frequent efforts by extremists and disturbed individuals to use chemical and biological weapons on a small scale are almost certain to continue. Some attacks will almost certainly eventually succeed. In fact, some attacks on food and agricultural products have already succeeded.

The Problem of Large-Scale or Highly Efficient Attacks

Like most characters in horror shows, Buffy faces both limited threats and ones that approach existential levels. Unlikely as such attacks may still seem in spite of the events of September 11th, the US cannot afford to ignore the fact that a single, well-executed covert attack by a state actor or proxy could produce casualties on the order of tens of thousands – easily resulting in more cumulative casualties than hundreds of small attacks. It could also involve far more stable agents that would survive exposure to heat and light, and involve strains or generic manipulation to reduce or eliminate the effect of conventional medical treatment. There also are no rules preventing multiple attacks and/or the use of multiple biological weapons at the same time, and attacks that hit medical and response capabilities as well as civilians.

The lead times involved in developing an effective deterrent and defense present another critical issue. Advances in biotechnology and food processing, and the proliferation of these technologies and related delivery and weaponization technology, are steadily increasing the ease with which nations and terrorist/extremist groups can acquire the means to make biological weapons. The use of "dry" storage biological weapons is likely to become widespread over the next 5-10 years, and the necessary skills may become available. Genetic engineering is introducing a whole new set of risks to the equation.

The lack of clear lethality and effects data also has major implications for asymmetric warfare, counterterrorism, and Homeland defense:

- It may not be possible to detect and characterize a biological attack (or attacks) until it is too late to provide effective treatment, to determine what levels of medical resources are required, or know how many response and treatment capabilities have been attacked and what level of patient flow will result. Much of the current response planning tacitly assumes that either incidents will be small and familiar enough to allow existing response capabilities to work or that attacks will be detected and characterized in ways that allow effective response planning for reasons that are not clearly explained.

- Much of the response planning assumes that it is possible to predict the required medical treatment based on limited experience with civil incidents and epidemics. It is not clear that the “scaling” involved in estimating the effect of terrorist, extremist or covert use of more sophisticated weapons is more than speculative, and many studies do not cite the special evidence and method used to scale up civil cases into estimates of how biological weapons would behave.

- The uncertainty created by the ability to modify or engineer new weapons or forms of existing weapons greatly compounds these problems. There do not seem to be net assessments of the balance between changes in offensive and defensive biotechnology that allow the US to predict future lethalities or the effectiveness of many proposed response measures.

- Most of the measures the US takes to provide Homeland defense against biological weapons immediately become part of the open literature, and many take years of lead-time to become effective. While this can act as a deterrent, it can also act as a road map for states and sophisticated extremists in finding the weaknesses in US defenses. The ability to select or tailor biological weapons that remain lethal in spite of US efforts at defense has had only limited analysis.

- There are a number of detailed problems in detection, characteristics, and effects analysis. For example, reliable models of biological weapons effects do not seem to exist which cover attacks in major urban areas involving massive complexes of high rise steel and glass buildings. The containment and transmission effects of modern cities are extremely difficult to model.

- Most effects estimates only apply to the use of one biological weapon, but attacks using “cocktails” of several biological weapons were found to be the most effective method of mass attack during the Cold War.

- There is often a gap between generic data on the treatment needed for a given biological weapon and the assumed level of treatment required. There is the tacit or explicit assumption that a weapon can be treated as a conventional disease, and that enough will be known about effects and exposure for treatment to be applied.

- Much of the federal, state, and local response literature effectively dodges around the issue of triage, and the problem of choosing who will receive limited medical treatment and how these victims will be selected. It does not describe what is done with the assumed dying and untreatable or to contain those who may transmit diseases. It also does not address the issue of how hospitals and care givers can determine what level of resources are needed for those who can be treated – a critical issue given the limited specialized medical facilities in most areas in the US.

- Corpse disposal may be a major problem, as may disposal of dead animals and birds. This aspect of response seems to be largely ignored.

- Even military medical handbooks fail to address the psychological impacts of prompt and longer-term effects.

One key problem in dealing with all of these issues and options is that defense and response must general begin at the local level, and state and federal aid will come hours or days after the event. In the case of both advanced biological and nuclear attacks, however, local law enforcement, emergency services, and medical services are likely to collapse relatively quickly. Regional and federal law enforcement, defenders, and responders will have to bear the brunt of trying to stop or contain an incident if there is warning and ameliorate the consequences if it succeeds. Unlike chemical attacks, local and regional capabilities will not be the decisive factors for determining the outcome of limited and unsophisticated biological attacks and high explosive attacks. Regional and federal resources must brought to bear in as little time as possible.

This, however, raises the question of what overall resources are needed, and what federal role is needed to provide them. So far, this question has tended to be answered more in terms of counterterrorism than response, and emergency response capabilities are better trained and organized than medical services. There are serious variations in response capability by town and region, and it is not clear what standards need to be set for each urban area, or to deal with attacks on critical facilities in areas which lack the resources approaching those of major cities.

It is obvious from the testimony and briefings of both responders and medical professionals that public health has been steadily downsized in ways which limit the ability to handle the high patient loads from biological and nuclear attacks. These problems seem likely to grow steadily more serious as more public resources are shifted to dealing with the aging, and are compounded by a search for cost-effectiveness among medical professionals. This again illustrates the fact that effective Homeland defense cannot be separated from national health policy and the overall problems in balancing out treatment cost, the need to provide continuing peacetime services, and changing priorities to meet an aging population and deal with welfare reform. At present**,** cost and capacity constraints are so severe that medical facilities often cannot participate effectively in exercises and training for Homeland defense.

Other Problems in the Present Response Effort

The briefings of responders and law enforcement officials raise other problems that affect biological attacks and other large-scale CBRN attacks in ways that may seriously limit the adequacy of present federal, state, and local efforts to deal with the problem:

- Large-scale biological attacks highlight the conflict between the normal civil rights considerations affecting interference with civil liberties, the law enforcement priorities necessary to obtain evidence and convictions, and the need to take every possible measure to prevent follow-on attacks, the need **to** provide immediate emergency services, and long-standing problems in using US intelligence assets to support defense and response inside US territory when it may involve US citizens.

- Intelligence warning of the exact nature of a probable biological attack can be absolutely critical to effective response – although it may be difficult or impossible. The ability to identify the specific disease that may be used in attacks would greatly simplify detection and treatment. So would warning of the potential difference between relatively unsophisticated attacks using familiar diseases and toxins and more sophisticated attacks using dry micropowders, unfamiliar agents, strains bred to resist treatment or decay, or genetically engineered disease. In many cases, effective response may be impossible without such warning.

- There is a need to provide some kind of cost-effective detection and characterization system that can be rapidly deployed before or after an attack, and which will provide an accurate picture of how much of what agent is present in what area. Models lack the accuracy to substitute for measurement. At present, more effort seems to be going into improving individual detectors than in to creating deployable and affordable systems that can be available for local use – a problem compounded by the need to provide biological and nuclear detection and characterization as well as chemical. This kind of real time information is critical not only to first responders, but to the efficient use and allocation of law enforcement and intelligence resources in defense and regional, state, and federal aid in response.

- No one really seems to want to confront the issue of triage, and of deciding who gets treatment, who is left at risk, and who dies. This simply is not a realistic approach. Triage cannot be improvised by practitioners without a major risk of wasting inadequate resources on the moving dead and leaving the curable untreated. Creating systems to decide what level of risk is involved in urging people to stay put or evacuate, how to control the media, and what level of detail to provide should not be left up to responders in a crisis. Such planning can only be done at a federal level, but it is uncertain that the leadership and moral courage is present to do it.

Dealing with the psychological and political impacts of biological weapons present additional problems. While most urban responders have at least token plans for handling the public relations aspects of biological accidents, it is far from clear that these plans would work in dealing with major attacks or sequential attacks. It is again clear that national and local media are not prepared to report on such attacks, and to perform a civil defense role. The psychological dimension also presents problems because it is not clear that the normal decontamination of areas, facilities, and buildings will not leave trace problems or that the public can be convincingly reassured of what is and is not safe. More broadly, the long-term medical effects of a large-scale attack are very difficult to characterize, and the Gulf War has shown how the resulting uncertainties can create major medical, psychological, and political problems.

Cost-Effectiveness of Real-World Options

There are options for improving US defense and response capabilities to biological attacks, some of which the government is already aggressively exploring and many of which apply to all forms of major CBRN attacks. The existing federal effort is discussed in depth in the following sections of this analysis, which discuss the present size and nature of the federal effort by department and agency. At the same time, it is clear that the following options and issues need continuing examination – particularly in the light of the cumulative long-term risk of major biological (and nuclear) attacks:

- The role of intelligence in defense and response needs to be addressed to determine the probable ability to detect the development of biological weapons, the specific agents under development, the strain, and the nature of the delivery systems. The need to communicate warning to responders and treatment facilities as well as defenders needs to be addressed.

- Zero-based investigation is needed of the probable effects and lethality of biological weapons which examines the use of both normal diseases and militarized strains. This should specifically include the issue of weaponization and the effect of different levels of efficiency in weaponization.

- Specialized intelligence and defense capabilities must be developed for warning, detection, characterization, and defense. This is not only a task for the national intelligence, security, and law-enforcement community, but also for federal, state, and local law enforcement and state National

Guard units. The problem of finding cost-effective mixes of specialized CBRN expertise, and linking these efforts to response activities will present a constant challenge in terms of law, resources, organization, and training.

- As part of the development of intelligence, defense, and response capabilities, explicit analysis is needed of the trade-offs between the risk posed by mass attack and the separation of foreign intelligence from law enforcement, and the priority given to prosecution versus defense. The scale of the treat and the needed response times call for almost total integration of the intelligence, defense, and response effort, but this now presents major legal and organizational problems.

- The ability to convincingly identify attackers needs to be determined, as well as the possible timelines, as part of an effort to create a credible threat of retaliation and punishment at the military and law-enforcement levels.

- A major research and development effort is already underway to improve detectors. The role that new technical aids like strain analysis, VNTR analysis, localization, phylogentics, DNA tags, pathogen isotopes – needs to be addressed as part of an effort to determine what can be done to improve warning, detection, characterization, response, and treatment.

- The CDC and DTRA evidently are already examining models that are capable of providing a more realistic picture of the effects of biological weapons in urbanized environments and how they might behave in real-world attacks. These seem to include the use of modern militarized agents. Virtually the same need exists to improve the modeling **of** all forms of CBRN attack.

- As part of this effort, the need to be able to model and predict the effect of the atmospheric boundary level, and estimate the combined impact of air movements, temperature, and day-night conditions in an urbanized environment is critical to predicting effects and the capability for detection. The need for models capable of reflecting local wind and weather conditions, and water flows is equally important. Nominal models of plumes and weather effects are now so uncertain that they may do more harm than good in providing guidance for detection and response.

- Zero-based investigation is needed of how to link the detection and characterization of biological agents to a system capable of measuring the scale and lethality of attacks. Efforts to develop advanced real time detectors need to be tied to a clear plan for deployment as a system – including fixed versus mobile sensor arrays and the possible use of municipal vehicles as sensor platforms. This should include the ability to provide the data needed to identify the need for containment, isolation, treatment, disposal, and decontamination. This examination must address fundamental cost-effectiveness issues as to whether systems can or should be deployed without strategic and tactical warning, and can be rapidly deployed and should consider the real-world problems of developing such systems to deal with infectious disease and their epidemiology.

- The problem of providing integrated detection and characterization of all forms of CBRN attack must be addressed at the same time, along with its cost-effectiveness. The limits of such systems, their level of accuracy and error, and their ability to reliably address the scale and area of coverage of attacks must be addressed .

- The potential role of any such a detection and characterization system must be examined in a broader context. Methods of transmitting data to defenders, responders, and caregivers – including hospitals and public health facilities need to be identified. As part of such systems, a clear linkage needs to be established between local detection and characterization and communication of the results to state, regional, and federal authorities. Methods need to be developed to use the results to immediately alert caregivers and local, state, and federal authorities to assemble the necessary containment and treatment resources. Contingency plans need to be developed to use the media to alert those in and near the affected area as to what to do in the presence of a given agent(s).

- Current efforts to develop detectors need to be recalibrated to consider the problems of telemetry and triage – including presymptomatic triage.

- The cost-effectiveness of vaccine stockpiling needs careful examination. Focusing on Anthrax and smallpox may be a valid option. It may also drive attackers to choose other diseases or develop strains/genetically engineered variants that are immune. The option of "silver bullet" antibiotics and vaccines capable of dealing with a wide range of existing diseases, militarized strains, and genetically modified diseases needs full net technical assessment.

- The cost-effectiveness of enhancing local public health capability needs examination as does the overall cost-effectiveness of developing suitable response local government systems. It is easy to call for federal support, and HHS/FEMA training and aid efforts. The tangible benefits per dollar in terms of lasting capabilities to deal with attacks are far from clear.

- Adding courses on biodefense to current medical and post-graduate training may be cost-effective.

- The hospital seems to be the current weak link in most serious bioattacks. The cost-effectiveness of federal programs, regulations, and tax credits in creating hospitals with improved CBRN and biodefense and treatment capabilities needs serious examination. At present, far too much of the defense/response effort would simply end in overloading existing medical treatment facilities.

- Efforts are already underway to create specialized National Guard and reserve CBRN defense units. The capability to contain, isolate, perform triage, and treat seems to be the critical current weak link in such efforts, and is compounded by the lack of well-funded public-health programs capable of organizing and training reserves of local caregivers.

- Civil defense options need to be reexamined in terms of building design and modification, personal defense equipment, and possible home protection and care options. These need to be examined in terms of their real world cost-effectiveness, and value in dealing with the full spectrum of CBRN attacks.

- A comprehensive plan is needed for dealing with local, state, and national media. This must involve education efforts, voluntary agreement to provide coverage that will inform without creating panic or misinformation, and some effort to provide clearly official coverage that viewers and listeners will trust. Consideration is needed of bringing back some form of authorized civil defense network in the effect of large-scale nuclear and biological attacks.

- Much of the current planning effort sees one major attack with one agent used in a form that federal, state, and local authorities clearly detect and characterize as the "worst case." Defense and response needs to examine cases involving multiple attacks, deception and false alarms, false characterization, and late detection. The problem of dealing with contagious disease outbreaks that are only detected after they have reached at least scatter regional or national levels is particularly important.

- The nation needs to be prepared for the "morning after." A clear plan is needed for Presidential response and national leadership in the event of a successful attack, and to prepare the American people for both follow-on attacks and the need for a US response.

- The issue of retaliation and counter-offensive options in the event of foreign attacks must be transformed into credible options that can be communicated in ways that reassure out allies, create a clear context for American counter-attacks that the world will understand, and which deter attackers.

The problem with this list is obvious, particularly when considered in the light of the need for federal response to existing public health care and entitlements needs, the existence of the full spectrum of CBRN attacks, the addition risks posed by missile and critical infrastructure attacks, and existing national security requirements. The checklist of necessary options is *very* long, the short-term risks are low, the effectiveness of most options is uncertain, and the cumulative cost is high. Furthermore, it is not possible to prioritize defense and response at this point in time, and the effectiveness of any program may be determined by its weakest and/or most expensive link. Once again, the Buffy Paradigm is not without insight. Anyone on the show can call loudly for action. Developing an affordable and well-justified program proves to be an entirely different matter.

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