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BIOLOGICAL WEAPONS:
AN OVERVIEW OF THREATS AND RESPONSES

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Christian Enemark commenced his PhD at the Strategic and Defence Studies Centre in February 2003 on an Australian Postgraduate Award. His thesis is tentatively entitled 'Biological Weapons and Security in East Asia: Assessing the Threat, Evaluating Responses'. Mr Enemark is supervised by Dr Robert Ayson and Professors Desmond Ball and Ross Babbage. He holds a BA(Hons) and LLB(Hons) from the University of Sydney and previously worked as a policy adviser at the NSW Parliament and NSW Attorney General's Department.

Abstract

The purpose of this paper is to provide an overview of the existence, nature and scope of the biological weapons (BW) problem, and to examine critically the range of possible solutions. BW are too often absorbed into the cover-all term 'weapons of mass destruction' (WMD) alongside chemical and nuclear weapons. This paper instead emphasises the technical uniqueness of BW as living weapons intended for use against living targets. A failure by policymakers to distinguish adequately between the three 'WMD' categories will lead to flawed response strategies. BW are dreaded as instruments of state coercion and terrorist intimidation, and a range of responses have been proposed to address these threats. Military responses include deterrence of BW use by threat of nuclear attack, the use of force to destroy BW assets, and defensive biological warfare programs. Detection devices and other forms of technical and human intelligence can potentially provide warnings of illicit BW production and dissemination. Medical responses to the BW threat include improved disease surveillance networks and strengthened public health system capabilities. Lastly, the BW problem can be tackled legally through domestic law enforcement and the Biological Weapons Convention.

CONTENTS

ABBREVIATIONS

AG	Australia Group
AHG	Ad Hoc Group of States Parties to the Biological Weapons Convention
BW	biological weapons
BWC	Biological Weapons Convention
CBDP	Chemical and Biological Defense Program
CIA	Central Intelligence Agency
CW	chemical weapons
CWC	Chemical Weapons Convention
DIA	Defense Intelligence Agency
FMD	foot and mouth disease
HUMINT	human intelligence
NAS	National Academy of Sciences
NBC	nuclear, biological and chemical
NW	nuclear weapons
OTA	Office of Technology Assessment
SARS	severe acute respiratory syndrome
SIGINT	signals intelligence
UN	United Nations
US	United States
WHO	World Health Organisation
WMD	weapons of mass destruction

Biological Weapons: An Overview of Threats and Responses

Christian Enemark

Introduction

The purpose of this paper is to explore the threat of biological weapons (BW) and the various ways of responding to that threat. Part I (threats) discusses the technical nature of BW as used against human and agricultural targets, the past and present development and use of BW by states, and biological terrorism. Part II (responses) covers military, intelligence, medical and legal means of addressing the BW threat.

A sound understanding of the nature of BW is an essential prerequisite for formulating effective responses. Even the language used by strategists and policymakers can obscure and underscore the uniqueness of BW, particularly through use of the term 'weapons of mass destruction' (WMD). BW are distinct from chemical (CW) and nuclear weapons (NW), and it is vital to understand the peculiar technical factors involved in deploying BW against human, animal and plant targets.

When contemplating BW threats, it is important to remember that the traditional perpetrators of deliberate disease have been states rather than non-state actors. Accordingly, this paper looks briefly at the history of BW use, and at the present-day situation regarding suspected state-based BW programs. While state possession is an important locus of BW threats, the greatest concerns today regarding actual use of BW are overwhelmingly directed to terrorism. Although it is more fashionable to assume the worst regarding terrorism, this paper discusses the important factors that temper terrorists' motivations and capabilities for launching a major BW attack.

Responses to BW generally fall into four categories: military, intelligence, medical and legal. The backdrop to each response is the human dread that attaches to disease. Dread is a psychological factor that can generate responses that may be ineffective or even counterproductive for avoiding a BW attack.

Military responses to the BW threat include deterrence of BW use by threat of nuclear attack, the use of force to destroy BW assets, and defensive biological warfare programs. This paper illustrates how each military response faces its own challenges and sparks its own controversies. The section on intelligence-based responses to BW threats covers the detection

of BW agents, the use of various intelligence sources, and the implications of the WMD intelligence 'crisis' surrounding the 2003 Iraq War. The lesson in each case is that the unique technical nature of BW presents huge challenges for those seeking to locate, assess and respond to a BW threat.

Medical and public health measures are essentially a 'back end' response to the threat of BW. In this regard, effective disease surveillance networks and strong public health system capabilities serve three important functions: (1) they may lead potential BW perpetrators to suppose that the effects of an attack would be thwarted or at least reduced substantially; (2) they directly address human vulnerability to the effects of a successful BW attack; and (3) they serve also to bolster defences against the threat of new and re-emerging infectious diseases of natural origin.

Responding to BW threats by legal means occurs at a domestic and international level. The two dimensions to domestic legal responses are criminal law enforcement and the internal regulation of BW-relevant materials and information. The main instrument of international law is the 1972 Biological Weapons Convention (BWC), which bans the development, production, stockpiling and acquisition of pathogenic agents and their delivery systems. Challenges to the effectiveness of the BWC relate to the norm it creates against BW use, verification of compliance with its provisions, and the Convention's potentially competing objectives of non-proliferation and technology transfer.

PART I

The Threat of Biological Weapons: Existence, Nature and Scope

Part I discusses the technical nature of BW as used against human and agricultural targets, the past and present development and use of BW by states, and biological terrorism.

1. The Nature of BW

A sound understanding of the nature of BW is an essential prerequisite for formulating policy responses. This first section discusses how language itself can obscure and underscore the technical uniqueness of BW, whether as a weapon of mass destruction or otherwise. It is important also to understand the technical factors affecting deployment of BW against human, animal and plant targets.

A. Language Problems: 'WMD', 'NBC' and 'CBW'

The necessity, for policy purposes, of drawing a clear distinction between nuclear, biological and chemical weapons is a common argument in the expert literature on BW.[1] The linguistic device of grouping together under one term weapons that are technically vastly different carries the risk that the uniqueness of each will be overlooked by policymakers. In particular, analyses of BW have often been held hostage to misplaced analogies to NW or CW. Abbreviated terms like 'WMD' and 'NBC' (nuclear, biological and chemical) in the strategic lexicon are part of the problem. This is because each weapon category differs greatly in terms of ease of production, challenges for deterrence, and effective defence measures. The post-September 11 focus on 'WMD falling into the hands of terrorists' has further exacerbated the tendency to distinguish insufficiently between weapon categories.[2]

The apparent rationale for grouping together nuclear, biological and chemical weapons, under the acronyms 'NBC' or 'WMD', is that the effects of each are regarded as similar — inflicting mass casualties, causing fear and panic in a population, and undermining government stability.[3] However, the three-in-one approach has its limitations. A study of US deterrence and defence policy by Joseph and Reichart uses the term 'NBC' throughout. The authors discuss the threat of NBC proliferation, the ability of US forces to operate in an NBC environment, the destruction of NBC

assets, and ballistic missiles as the NBC delivery system of choice. While ostensibly presenting 'NBC' as a unified concept for policy purposes, the authors nevertheless frequently single out BW as a special case for various reasons.[4]

There is also a tendency in academic and policy circles to classify chemical and biological weapons, grouped together as 'CBW', as a non-nuclear category of WMD. However, a report by the US National Academy of Sciences highlighted how pairing off chemical and biological weapons inappropriately blurs the distinction between the two. A practical consequence of this has been that the numerous US 'chem/bio' response teams are, in fact, almost entirely focused on detection, decontamination, and treatment of casualties in a chemical attack scenario only.[5]

Distinguishing clearly between weapon categories for the purposes of responding to a threat makes sense because it mirrors the deliberate choices made by potential users. Terrorists, in particular, would have in mind the specific effects they want a weapon to have. For three reasons, BW (as distinct from CW and NW) have special appeal for the purposes of mass casualty terrorism:

- BW are easier to acquire than NW and do more damage with less material than CW;
- the effects of BW on the target population are difficult to counter; and
- the insidious nature of BW agents is perfect for generating fear.[6]

BW terrorism is discussed further in a later section of this paper.

If the threat of BW is to be taken seriously, a vital first step is to take great care with the language and terms used to portray, assess and deal with that threat.

B. Beyond 'WMD': the Uniqueness of BW

Just as it is essential to distinguish BW from other weapons of mass destruction, it is important to note that BW may not always manifest themselves as such. In contrast to NW, the ability to cause 'mass destruction' is a potential property of BW rather than an inherent one. The common tendency to classify BW as WMD is very misleading as their ability to inflict mass casualties is highly dependent on the type and quantity of agent released and the means by which it is delivered. Documented BW attacks have been small in scale and generally produced fewer casualties than conventional explosives. Historically, terrorist use of BW has been tactical use to kill or punish specific individuals.[7]

BW might be better characterised as a multifaceted threat encompassing bioterrorism, assassination, economic warfare against staple crops, tactical or strategic military use on the battlefield, and weapons of mass destruction.[8] In his paper entitled 'Addressing the Full Range of Biological Warfare in a BWC Compliance Protocol', Wheelis describes the dimensions of biological warfare in terms of the nature of the aggressor, the scale of release of the agent, and the target. There are three prominent divisions within each dimension:[9]

Nature of the aggressor	Scale of agent release	Target
Nations	Point-source release	Human
Subnational groups	Medium-scale release	Animal
Individuals	Large-scale release	Plant

According to the above table, a BW attack could take one of 27 different forms. This could range, for example, from a point-source criminal act by an individual against a particular human victim to a large-scale attack by a nation against an enemy's crops. The choice of a particular BW agent is also relevant to the dimensions of biological warfare, in terms of whether an agent is contagious and how easily it can be treated. This is illustrated by the following scenarios:

- To murder an individual, an aggressor might use ricin — a non-contagious plant-based toxin.
- To commit mass murder, the best agent might be *Bacillus anthracis* which causes anthrax — a non-contagious bacterial disease.
- To cause contagion, an aggressor might use *Yersinia pestis* to cause plague — a contagious bacterial disease that can be treated with antibiotics.
- To wield a weapon of mass destruction, a good choice might be *Variola major* which causes smallpox — a contagious virus disease that cannot usually be treated after infection.[10]

The extent of damage from a BW attack is also highly dependent on the capacity of a target country's public health system to treat victims and contain contagion. Public health system capabilities are discussed further in a later section of this paper.

While BW are so often included in the 'family' of WMD alongside nuclear and chemical weapons, clearly they have uses and effects much more diverse than causing mass destruction. In assessing a BW threat, a bag of castor beans (a precursor to ricin toxin) is less significant than, say, a stolen vial of smallpox virus.

C. Human Targets

Scientists and science fiction writers have presented a great many scenarios of biological warfare, all of them frightening. However, contrary to some of the more gloomy discussions of BW, biological attacks of any magnitude are extremely difficult to plan, develop, execute and fund. Popular accounts of how easy it is to *produce* biological agents often mask the real technological challenge required for a successful BW attack — *weaponisation* of the agent.

Weaponising a biological agent so that bacteria, viruses or toxins can effectively enter the human body involves highly sophisticated procedures. For example, producing 'weapons grade' anthrax for aerosol dissemination requires lyophilization (freeze-drying) and micro-encapsulation to ensure that the *Bacillus anthracis* spores are of an optimal size (1 to 5 microns) for penetrating deep into human lungs.[11] Particles larger than this tend to drop straight to the ground rather than stay suspended in the air ready for inhalation. This technical requirement for precise particle sizes means that the frequently-imagined attack scenario of crop-spraying aircraft delivering BW is probably unrealistic.[12] On the other hand, specially designed or modified aerosol spraying devices might be highly effective at disseminating BW agents.[13]

Despite recent technological advances in the production and weaponisation of biological agents, it may be that BW are still not well-suited to battlefield use. Difficulties undermining the military utility of BW include:

- the potential instability of agents after dissemination;
- their vulnerability to weather conditions;
- the potential unpredictability of the effects of a BW attack; and
- the required incubation period between a target's exposure to BW agents and the onset of disease.[14]

In *The New Biological Weapons: Threat, Proliferation and Control*, Dando argues, however, that there are now fewer uncertainties when considering the potential effectiveness of a BW attack. As a result of an increased capacity for computer modelling, some countries now have a far greater understanding of the atmospheric and weather conditions required for an optimal BW attack. In addition, a greater theoretical understanding of aerosols has developed in order to deal with a wide range of industrial and environmental problems. Of particular relevance to BW delivery issues is that some countries now have an extensive understanding of how inhaled aerosols behave inside the human lung.[15]

The caveat on arguments about the military utility of BW is that they stem mostly from theory and conjecture, not from practice. There has been no documented case of full-scale BW use in modern warfare.[16]

Aside from the actual extent of exposure to agents, a BW attack (and even the threat of an attack) on humans is inherently an exercise in psychological warfare. People exposed, or possibly exposed, will suffer disorders of mood, cognition and behaviour because of the uncertainty, fear and panic that may accompany the incident. For this reason also, a hoax BW attack can take on a life of its own. Moreover, the pharmacology of the agents themselves may induce psychological effects — for example, delirium is possible with anthrax, tularaemia, plague, smallpox and viral hemorrhagic fevers.[17]

Ongoing research as part of the biotechnology revolution might well affect the scale and nature of the BW threat in the future. Today, the primary concern is with classic BW agents because they would not require large-scale testing by proliferators. An often imagined future scenario is that, through the use of genetic engineering techniques, new BW could perhaps be targeted at the specific genetic characteristics of different ethnic groups.[18] Miller and her co-authors argue, however, that the genetic revolution is unlikely to produce completely new agents. Rather, the most likely danger is that classic BW agents will be customised to defeat drugs, antidotes and vaccines.[19]

The future of biotechnology may also carry the potential for precise, non-lethal forms of biological warfare. For example, bioregulators are naturally occurring chemical substances, not of themselves toxic, which operate by sending 'messages' inside the human nervous, endocrine and immune systems. The misuse of neuroscience, for example, could lead to new means of manipulating human behaviour (depression, temporary paralysis, sleep, fear) by chemical means.[20] For the present, however, bioregulators are probably too exotic for the purposes of a BW program, with most proliferators unlikely to go beyond research with these agents.[21]

The production and weaponisation of BW for effective use against human targets presents technical challenges, although humans will be vulnerable to psychological effects even if an attack is ineffective. It remains to be seen whether the biotechnology revolution will make the use of new or existing BW agents more likely in the future.

D. Agricultural Targets

Given the historical record, it is surprising that the vulnerability of agricultural targets to BW attack has not received more attention in the literature and from policymakers. For example, during the Cold War, the US did careful planning for destruction of the staple food crops of its enemies: wheat was to be destroyed in Russia and rice in China.[22] The First World War saw the extensive use of BW against horses and cattle intended for military purposes.[23]

Today, vulnerability to an agricultural BW attack is a consequence of:

- the intrinsically low security of agricultural targets;
- the technical ease of introducing diseases; and
- the large economic repercussions of even small outbreaks.[24]

In developing countries, the lower fertility of infected animals, combined with a reduced ability to pull farm equipment or carts, can lead to human famine.[25] In a developed country like the US, although a plant or animal disease would probably not cause famine, it would still result in the loss of international markets. As the world's largest exporter of livestock and livestock products, the US is economically vulnerable to biological warfare against agricultural targets.[26] In addition to the costs of actual damage, the costs of containing an agricultural disease outbreak can be crippling. Taiwan spent $US4 billion in an unsuccessful effort to eradicate foot and mouth disease (FMD) after it was introduced to the island in 1997.[27]

The use of BW for economic sabotage is also a potentially serious threat to biodiversity – for example, plant bioweapons can have a devastating effect on non-target species of wild and domesticated plants. Failure to prevent or control an agricultural disease outbreak could result in the erosion of genetic diversity within species, the extinction of endangered species, and the destruction of human livelihoods and traditional cultures.[28]

There are several reasons why agriculture might present a softer target than humans. First, the perpetrator of a BW attack on agriculture would not need to worry about contracting a disease that only infects animals or plants. Second, attacking agriculture is potentially quite easy. A few hundred microlitres of mucus scrapings from a FMD-infected animal can provide enough pathogenic agent to initiate an epidemic - virus preparations could simply be smeared on the nostrils or mouths of a small number of animals. Third, there is a substantial moral difference between killing people and killing plants and animals, and a corresponding difference in the intensity of law enforcement response. Thus moral norms and legal consequences are less of a disincentive to agricultural BW perpetrators.[29]

Biological or 'living' weapons are inherently suited to affecting living targets. In the scramble to protect human populations from a direct BW attack, it would be negligent to overlook the protection of a vital means of human survival — agriculture.

2. The Development and Use of BW by States

Although the principal preoccupation today is with biological terrorism by non-state actors, it is important to remember that the traditional perpetrators of deliberate disease have been states. This section looks briefly at the history of BW use, and at the present-day situation regarding suspected state-based BW programs.

A. History of Biological Warfare

Biological warfare is almost as old as war itself and the literature on BW is replete with examples from history. Records from 400BC describe Scythian archers dipping their arrows in putrefying corpses, and Roman soldiers were known to run their swords through rotting animal carcasses before battle. In the Vietnam War, the Viet Cong coated punji stakes in booby traps with human excrement.[30] Diseased cadavers were catapulted over castle wars in the 14th Century siege of Kaffa, the British attempted to spread smallpox to American Indians during the 18th Century French-Indian War using infected blankets, and Imperial Japan deployed an extensive BW program against mainland China before and during World War Two.[31]

Many countries that once maintained BW programs have now abandoned them. These include the United States, the United Kingdom, France, Canada, Germany, Japan, states of the former Soviet Union, and South Africa.[32] A full historical account of state-run BW programs is outside the scope of a paper focusing on today's threats and responses. Suffice to say that such programs are not in the so distant past as regards military doctrine, and they have left a potent technological legacy. Between them, the various state-run BW programs undertook extensive research and testing on many of the biological and toxin agents that are today's prime candidates for weaponisation: anthrax, botulinum toxin, ricin, plague, and smallpox.[33]

B. The Present Day

Information in the English language on states currently pursuing BW programs tends to derive from US sources. According to recent published lists there are 13 suspects: India, Pakistan, Taiwan, China, North Korea, Russia, Libya, Iran, Iraq, Israel, Syria, Egypt and Sudan.[34] A later section of this paper discusses accusations that the US itself is secretly pursuing an offensive BW capability.

As US intelligence is so pervasive, it is difficult to find published assessments of state-based BW threats from a non-US perspective. However, the US arguably has good reason to be gathering more intelligence and making more assessments than other countries regarding the development and possible use of BW. According to Miller and her co-authors in *Germs: the Ultimate Weapons*, the emergence of the US as the world's most powerful nation has made biological attack against it more likely. Many adversaries that resent America's global dominance, envy its wealth, or fear its overwhelming military power feel that they can fight back most effectively with unconventional weapons.[35]

But fighting back against the US with BW may not mean engaging in battle. For Martin (in her journal article 'The Role of Biological Weapons in International Politics: the Real Military Revolution'), it is the ability of BW to serve as a strategic deterrent, rather than as effective tactical weapons, that makes them attractive to states. Although there is greater uncertainty about the effects of a BW attack than is the case with NW, the potential for high casualties from a successfully executed BW attack may be great enough to compensate. Even the small probability of successful retaliation using BW, Martin argues, can deter an attack.[36] The spread of this attractive BW option among poorer countries may lead to a 'biological revolution', comparable to the NW revolution that occurred among the major nuclear powers, providing even weak states with the ability to deter threats to their vital interests. In particular, the use of BW as a strategic deterrent may limit the ability of the US and others to take advantage of emerging high-tech conventional weaponry.[37] Deterrence issues are discussed further in a later section of this paper.

3. Biological Terrorism

While state possession is an important locus of BW threats, the greatest concerns today regarding actual use of BW are overwhelmingly directed to terrorism. Although it is more fashionable to assume the worst regarding terrorism, this section discusses the important factors that temper terrorists' motivations and capabilities for launching a major BW attack.

A. Motivations

Terrorists contemplating using disease as a mass casualty weapon would be mindful that epidemics throughout history have killed many more people than wars. Three advantages of BW for a terrorist are: (1) an optimal death to cost ratio; (2) they are virtually undetectable; and (3) they offer the potential for mass panic.[38] More specific motivational factors for terrorist use of BW include:

- *economic terrorism* — eg, against corporate icons, or to impose crippling agricultural clean-up costs;
- *millenarianism* — eg, the cleansing apocalypse sought by Japan's Aum Shinrikyo cult, or survivalist Christians planning to precipitate Armageddon;
- *exacting revenge or creating chaos* – e.g. rumours that Al Qai'da might use BW in its campaign against the US are causing great alarm;
- *mimicking God* — eg, the fifth plague used by God to punish Pharaoh in the Bible's Book of Exodus was *murrain*, a group of cattle diseases that includes anthrax, and in the Book of Revelations, 'Pestilence' is one of the Four Horsemen of the Apocalypse;
- *the aura of science* — ie, 'impressing' targets with high technology; and
- *the copycat phenomenon* — eg, 'mysterious white powder' anthrax hoaxes.[39]

Aside from political and religious motivations, there may be agricultural motivations — for example, an eco-terrorist attack on genetically modified crops. Another scenario is a revenge attack on American crops by drug lords if the US succeeds in developing and using plant pathogens to kill or reduce the yield of opium poppy, coca and cannabis crops.[40]

The most likely perpetrators of BW terrorism are religious and extreme right groups and groups seeking lasting revenge. Such groups may display an extranormative, transcendental attitude to violence. They are unconstrained by fear of government or public backlash, since their actions are intended to please God and themselves, not to impress a secular constituency. And their victims, being outside their religion, may be viewed as subhuman.[41]

At the same time, there are many reasons why other terrorists might rule out the use of BW. For terrorists pursuing clear political aims in a given territorial area, such an attack will not generally appeal. This is because friends would be at risk, especially if a highly contagious agent were deployed. For example, a BW attack in Ireland would affect Catholics as well as Protestants, an attack in India would hit both Hindus and Muslims, and using BW in Israel would affect Arabs as well as Jews. Similarly, eco-terrorists cannot be certain a BW agent will wipe out only humans and not animals and plants also.[42] Other disincentives to terrorists using BW include the risk of provoking a massive government crackdown and alienating supporters. BW are also inherently dangerous to use.[43] These considerations may lead a terrorist to conclude that conventional bombs, as tried and true weapons, are more 'obedient' than BW. As such, explosives may remain the terrorist's weapon of choice for the foreseeable future.[44]

Some authors suggest that terrorists construct their attacks as a form of theatre. There is a school of thought to say that if terrorists want a lot of people watching a spectacular event, rather than a lot of people dead, they are unlikely to turn to mass casualty weapons. For terror purposes, there is an important psychological element in any attack — 'terror', after all, is an emotion inspired in potential victims. Most terrorists need the demonstration effect — that is, showy attacks that produce a great deal of noise.

By contrast, a BW attack would by its very nature be silent.[45] And, as the disease caused by a biological agent would take time to incubate inside victims' bodies and possibly spread to others, the effect of a BW attack would be delayed and gradual. This means a terrorist attack of this kind would lack a single catastrophic moment for the media to focus upon along with the political message, if any, to be conveyed. Indeed, where a contagious agent is deployed, journalists and camera crews may not even be able to access a BW-affected area because of patient quarantine restrictions.[46] On the other hand, the silence and delayed effect of a BW attack may be attractive for a terrorist wishing to perpetrate the 'perfect crime' and avoid detection. And theatrical considerations would matter little to terrorists with an apocalyptic bent for whom 'a lot of people dead', by whatever means, is the true objective.

Assuming the worst regarding terrorist motivations may lead to the notion that BW acquisition makes an attack inevitable. However, the effects of a successful BW attack are unique and potentially devastating. For these very reasons, the inclination to use BW to achieve particular outcomes may vary enormously from one terrorist organisation to the next.

B. Capabilities

In the more popular literature on BW, there is no shortage of descriptions of terrorists possessing nightmarish capabilities. A 1998 article in the *New Scientist* magazine opens with the scenario of a private plane spreading an aerosol cloud of anthrax spores over San Francisco Bay, and the consequent deaths of 1 million people.[47] Osterholm and Schwarz present their book *'Living Terrors'* as a combination of facts and fiction on bioterrorism. Commencing each chapter with a novel-like scenario, the authors then follow up with a discussion of the scientific and political factors that apply. Scenarios of the rogue BW terrorist include:

- a disgruntled laboratory worker who grows anthrax bacteria in an abandoned farmhouse then disperses it in a crop duster over a sport stadium;

- a hospital worker who steals a deadly strain of *E. Coli* bacteria and uses it to poison the food of hundreds of Catholic schoolchildren; and
- a former Soviet scientist who grows smallpox virus on fertilised eggs, spreads it though a shopping mall air conditioning system, then watches it spread through America.[48]

Unfortunately, a scan of the literature on bioterrorism reveals that insufficient attention has been devoted to assessing dispassionately whether hypothetical scenarios are likely to be transformed into reality. One of the most prevalent features in mainstream discussion of 'WMD' terrorism has been the conflation of motive and capability.[49]

Expert opinion is divided on how easy it is to acquire a BW capability, and estimates on the cost of such a venture range from thousands of dollars to the millions. Some say that an undergraduate biology student could easily produce biological agents in a garage, tool room or kitchen, and that making BW is as easy as brewing beer. Others believe a much higher degree of expertise is required: a BW project would need a group of experts in several fields (for example, microbiology, aerosol physics, pathology and pharmacology), as well as access to a sophisticated bacteriological laboratory.[50] Oehler argues that any terrorist group small enough to ensure secrecy will probably not have the range of talents needed to execute a major BW attack. A group that does have all the necessary skills will probably be large enough that it would be vulnerable to detection by intelligence and law enforcement agencies.[51]

The record of BW terrorism yields mixed lessons regarding capabilities. In Japan, the Aum Shinrikyo cult failed in several attempts in the early 1990s to cause mass casualties with BW agents. This was despite ample finances and scientific expertise, including 20 university-trained microbiologists working in well-equipped laboratories.[52] In the US, by contrast, the October 2001 attacks using high-grade anthrax powder in envelopes made it frighteningly clear that a group or individual had either successfully crossed the weaponisation threshold or succeeded in stealing the germ from a national defence program.[53]

Development and production of BW entails significant technical challenges for terrorists. Firstly, cultivating pathogens can be hazardous to one's health. For example, sloppy laboratory practices in Aum Shinrikyo's BW program led to some cult members becoming infected with Q Fever. Secondly, dissemination of BW can present huge obstacles whether a terrorist is contemplating aerosol delivery of, or food or water contamination with, a BW agent.[54]

On the issue of aerosol delivery, the CIA is presently concerned that Al Qai'da may use agricultural aircraft for large-scale dissemination of anthrax spores.[55] Effective aerosol dissemination requires freeze-drying a BW product and milling it into particles of uniform respirable size.[56] However, it is arguable that crop dusters are probably unsuitable for delivering a BW agent because they produce particles of too big a size to infect the lungs.[57] Contaminating food or drinking water with BW agents is not straightforward either. Dilution, chlorination and filtration work against water-borne BW, and cooking, pasteurisation and other routine food safety precautions are also generally sufficient to kill pathogenic bacteria.[58] Nevertheless, food or water contamination could still be an effective BW delivery method in less developed countries where safety measures are not standard.[59]

Some authors propose that terrorist delivery of BW need not be high-tech at all. For example, highly contagious viruses could be effectively introduced by voluntarily infected terrorists — they would travel to the target area during the incubation period of the disease, then infect as many people as possible before succumbing themselves. Today's suicide bombers may become tomorrow's 'suicide sneezers' carrying smallpox into an enemy population.[60]

Should acquiring an effective BW program from scratch on their own prove too difficult, another possibility is that terrorists might simply be endowed with that capability by a supportive state. For example, US adversaries may 'contract out' mass casualty terrorism to bypass a National Missile Defense system, using terrorists as weapon delivery systems where the long-range missile option is nullified.[61] However, several authors argue that the notion of a state sponsoring 'WMD' terrorism is highly problematic. Bearing in mind that only the most extreme and apocalyptic terrorist groups are likely to employ BW, a state may fear loss of control or treachery by a BW-capable group.[62] Could such a group be entirely trusted not to cause disease in the sponsor state's own territory? The discovery of links between a BW terror incident and a state sponsor may also attract disastrous retaliation by the target country. Whether for fear of disloyalty, incompetence or indiscretion, any state anxious for its own survival would be most unlikely to place a catastrophe-scale BW capability in the hands of terrorists.

For terrorists with sufficient motivation to use BW, there are still huge challenges in producing, weaponising and delivering biological agents in a way that causes mass casualties. The nightmare of biological terror probably does not match up with the technical likelihood of a catastrophic attack. Moving away from worst-case scenarios, a dispassionate assessment of capabilities, whether of states or terrorists, is essential when deciding how to respond to the BW threat.

PART II

Responding to the BW Threat: From Bunker Busters to Hospital Beds

Part II examines military, intelligence, medical and legal responses to the threat of BW. The backdrop to each is the peculiar form of dread associated with disease.

1. Formulating Responses in an Atmosphere of Dread

The fear element of BW, independent of any development or deployment, can be an extremely powerful weapon in itself. The psychological phenomenon of dread is sometimes apparent in the language used to describe the BW threat and it may even be a factor in policy responses to that threat. In the public consciousness, the fearful perception of BW is sustained by constant repetition of 'threats', 'proliferators, 'rogue states', 'mass destruction' and 'catastrophic terrorism'. In the post-September 11 scramble to address the terrorist threat, a pervasive sense of urgency and desperation may be precluding a careful balancing of competing interests. In the BW context, this carries the potential for adverse effects on civil liberties, public health and national security.[63]

Certain hazards evoke particular dread, which can lead to the overestimation of risks or the design of reactive policies whose costs may exceed their benefits. Fear is disproportionately evoked by certain characteristics of risks, including involuntary exposure, unfamiliarity and invisibility.[64] A unique feature of BW — uncertainty — magnifies that fear even further. Unlike a conventional explosion where the casualty count is immediately apparent, no one would immediately know the source and nature of a BW attack or the number of victims.[65] Whereas a chemical attack would necessarily result in a finite number of known casualties, this may not be the case with BW, especially if a contagious agent is used.

A biological attack possesses all the characteristics that psychologists have shown to be conducive to disproportionate dread. It is frightening, disgusting and infuriating that someone would deliberately contaminate us, and that we in turn may contaminate others. Humanity fears disease not only for its ability to kill but also for the horrifying way in which it kills. For example, anthrax elicits horrific symptoms such as disfiguring skin eruptions. Our gut-level fear of disease means we are prone to trying to eradicate the risks of BW with little regard to the costs involved.[66]

In *Toxic Terror: Assessing Terrorist Use of Chemical and Biological Weapons*, Tucker argues that much of the discussion of BW to date has tended to focus on the vulnerability of large cities to terrorist attack, while neglecting a careful assessment of the threat. Vulnerability is potentially unlimited, he observes, so such assessments do not provide a sound basis for policy decisions about the level and type of response.[67] Miller and her co-authors argue that senior US officials have overstated the danger of biological attack, harming their cause with hyperbole.[68] Added to this has been misinformation about technical issues, thus creating unnecessary concern. For example, some press coverage in the US has wrongly described anthrax as a communicable disease.[69]

Dread is an influential force as insidious as disease itself. Language, misinformation and our primal fears of infection can combine to generate ill-considered and counterproductive measures. When deciding on responses to the BW threat, it is important to minimise the dread factor and to concentrate dispassionately on the realities of BW. Indeed, the unique technical nature of BW calls for the special tailoring of military, intelligence, medical and legal responses.

2. Military Responses

Responses to the BW threat by military means include deterrence of BW use by threat of nuclear attack, the use of force to destroy BW assets, and defensive biological warfare programs. This section illustrates how each military response faces its own challenges and sparks its own controversies.

A. Deterrence by Threat of Nuclear Attack

As a signatory to the BWC and the 1993 Chemical Weapons Convention (CWC), the US has eschewed retaliation in kind to a biological or chemical attack. Only the nuclear option remains, yet there is doubt over the utility of NW for deterring BW use and for retaliating if deterrence fails.

One argument is that the great psychological impact and potential destructiveness of a threatened NW response would cause any potential BW user to hesitate. Against this idea, a major concern is that a stated US reliance on NW to deter BW use would undermine efforts to reduce or eliminate the existence of NW worldwide. Stated reliance may not be necessary, however. Rather, the mere existence of NW can inadvertently give them a role in deterring or countering BW use without the US having to make this explicit.[70]

In his paper 'Why the US Should Not Use Nuclear Threats', Sagan argues that the US should not use nuclear threats to deter BW use because, firstly,

it is harmful to NW non-proliferation efforts. Such a policy, if explicit, would serve to legitimise nuclear threats and thus encourage non-NW states to adopt the US method of avoiding BW attacks. Secondly, nuclear threats increase the risk that BW will actually be used. Leaders of BW-equipped regimes, fearing a 'nuclear decapitation strike', might pre-delegate authority to use BW to lower level military officers. This carries greater potential for BW use, either by accident, without authorisation, or as a panic response to false alarms.[71] A third reason not to threaten NW retaliation is that a nuclear threat, to be effective, must also be credible. Arguably, the US cannot make its nuclear threats credible without also creating a dangerous risk that its NW will actually be used in the event of a biological attack.[72]

The implied assumption underlying any discussion of NW as a deterrence tool is that there is a BW perpetrator whose identity and location is known and against whom threats and retaliation strikes can be directed. The launch of a ballistic missile by and from a particular state, for example, would almost certainly be noticed by virtue of its telltale heat signal. Assuming it were not intercepted and destroyed in flight, the absence on impact of a nuclear explosion or instant chemical effects would immediately arouse suspicions that the missile was equipped with a biological warhead. However, for these very reasons, ballistic missile delivery of BW is highly unlikely. To avoid retaliation, it is in the interests of a BW perpetrator to conceal or obscure the origin and occurrence of the attack. Absent the requirement for explosive dissemination, biological attacks are by nature silent, and the first indications may be days or weeks later when people start falling ill. By this time, it may be too late to track down and punish the perpetrator.

Even assuming the identity and location of a BW perpetrator are known, it may be uncertain in what circumstances, and at what point, a nuclear retaliation is a proportionate response to a biological attack. As discussed in Part I, different BW and toxin agents can cause casualties to vastly differing extents, and the number of casualties is highly dependent on the efficacy of the target country's public health system. In contrast to a nuclear strike which instantly causes a large number of deaths, the deadly effects of a biological attack occur gradually. How many casualties or deaths would have to occur before a BW attack deserves a NW response?

Deterrence as a response to BW is even more problematic when it comes to terrorism. Firstly, highly-organised and disparate terrorist groups may be difficult to locate, isolate and punish. Secondly, deterrence may simply not apply against terrorists who are motivated by religion and who believe they are carrying out the commands of their Supreme Being. Thirdly, for

terrorists pursuing an apocalyptic objective, a devastating nuclear response to their BW attack may be just what they want.

Nuclear deterrence is of highly dubious utility in responding to the threat of BW. As an idea, it potentially undermines NW non-proliferation efforts. In practice, targets for NW retaliation could prove too obscure, and the use of NW so disproportionate a response as to be politically unpalatable. It is also doubtful whether the kind of terrorists who would use BW could ever be deterred.

B. Use of Force

The use of force to respond to a BW threat can be to pre-empt an attack or to retaliate and thus prevent another. For this, in their book *Deterrence and Defense in a Nuclear, Biological and Chemical Environment*, the authors Joseph and Reichart recommend the US military acquire the capability to destroy NBC assets.[73] BW, however, present particular challenges to the US military in terms of finding targets and avoiding collateral damage during attacks. Targeting BW stocks is difficult because their manufacture is easily disguised in dual-use facilities, such as pharmaceutical plants, that are often located in populated areas. Sites could also be buried deeply underground and require penetrating warheads to get through several feet of concrete. Each facility, uniquely designed, would react differently to a pre-emptive or retaliatory attack. Even if US mission planners can identify a target, they may have no way of destroying it without causing mass casualties in the nearby area.[74]

Faced with the task of hitting an isolated surface bunker containing anthrax stockpiles, problems range from possible spreading of the germ, to radioactive fallout from using a nuclear bunker buster, to not being able to destroy the anthrax at all. Further practical problems arise because of the current US approach which is to seek a single destructive weapon that can neutralise both chemical and biological agents. This approach leads to shortfalls in the US ability to neutralise biological agents because the requirement that the same technology be able to destroy chemical agents necessarily constrains it.[75] Put simply, destroying an enemy's CW and BW stocks requires different approaches tailored to the technical peculiarities of each weapon category.

The use of force to destroy BW assets would simply not apply in some circumstances. In the case of a contagious BW agent, it may not be necessary to maintain a large stockpile of weapons as would constitute a military target. By its very nature, a tiny amount of an agent like smallpox could spread disease and death far from the initial point of release.[76]

In summary, the use of force against a BW target would only be appropriate where:

- the location of the biological agent was known;
- the destruction of the agent would not cause contamination of the surrounding area; and
- the agent existed in sufficient quantity to warrant explosive destruction.

C. Defensive BW Programs

The BWC permits work with BW agents for peaceful purposes, which includes the development of defences. The US Department of Defense, for example, maintains a Chemical and Biological Defense Program (CBDP). The purpose of CBDP research is to provide core capabilities for defending against chemical and biological threats and to ensure the US can make appropriate technological advances in the long term. BW-relevant research by the CBDP includes advanced biological detection systems, advanced materials for improved filtration and protection systems, advanced decontaminants, advanced information technologies, and medical and biological defence research (including diagnostics, therapeutics, and vaccines for viral, bacterial, toxin and novel agents). Among its many projects, the CBDP is currently working on improved vaccines to protect against botulinum toxin, equine encephalitis, plague, and next generation anthrax.[77]

The benefit of such endeavours is the direct, practical effect of reducing (and possibly avoiding) the human damage that would result from a BW attack. The apparent goal of defensive BW programs is to reduce potential targets' vulnerabilities to such an extent that potential aggressors would not see a biological attack as worthwhile.

In addition to purely defensive research and development, the US conducts threat assessment projects. These ostensibly involve experimenting with offensive BW applications so as to determine matching defensive requirements. Biodefence programs, and threat assessment projects in particular, are nevertheless hugely controversial. They potentially push the line between what is permissible and what is illegal under the BWC. Here, the problem lies in perceptions of intent. Western BW programs are held up as consistent with the BWC even without transparency or clear explanations, whereas similar programs would undoubtedly be viewed by the West as violations of the Convention if administered by governments classified as 'rogue states'.[78]

During the 1990s the US switched from relative openness to secrecy about its biodefence experiments.[79] Then in September 2001 the *New York Times* revealed the existence of three classified US biodefence projects which all appeared to contravene the legal limits laid down by the BWC:

- from 1997 to 2000 Project Clear Vision involved building and testing a Soviet-model bomblet for dispersing bacteria;
- in 1999-2000 Project Bachus investigated whether a would-be terrorist could assemble an anthrax production facility using commercially available materials and equipment;
- in early 2001 Project Jefferson involved the recreation of a vaccine-resistant strain of anthrax bacteria.[80]

A number of authors have questioned the legality of these projects.[81] The revelation of Project Clear Vision caused particular concern. The BWC bans delivery systems categorically, whether intended for biodefence purposes or not. Data from the bacteria bomblet project was aimed at predicting agent distribution and potency as a function of dispersal method, agent type, amount of agent, and environmental conditions — such data appears to have greater offensive than defensive potential.[82]

Rosenberg argues in her paper 'Defending Against Biodefence' that secret 'threat assessment' projects cast a shadow on US integrity and encourage other countries to follow suit. The development of offensive capabilities for threat assessment purposes endangers the norm against BW and increasingly undermines the BWC. The outcome of such projects may be a covert international arms race to stay at the cutting edge of BW development, using defence as a cover.[83] For Tucker, a reasonable level of transparency is required to avoid controversy, such as publicly describing biodefence programs in general terms while omitting technical details. This would help to build confidence in US compliance with the BWC without making it easier for hostile states to circumvent planned defences.[84]

3. Intelligence Responses

This section on intelligence-based responses to BW threats covers the detection of BW agents, the use of various intelligence sources, and the implications of the WMD[85] intelligence 'crisis' surrounding the 2003 Iraq War. The lesson in each case is that the unique technical nature of BW presents huge challenges for those seeking to locate, assess and respond to a BW threat.

A. Detection

A dimension of BW countermeasures on which the US has placed much technical emphasis is detecting attacks on the battlefield. An effective detection device would determine the type and concentration of a BW agent within minutes, enough time to let soldiers on the battlefield don protective gear. The ultimate goal of US researchers is to develop portable, fully automatic, remote sensing systems that can detect a variety of known and novel BW agents before troops on the battlefield are exposed.[86]

However, a reliable and versatile biodetector is still a long way off due to huge technical difficulties. The development of reliable detection for BW has lagged far behind comparable technology dealing with chemical and radiological substances. Accurate biosensors tend to be slow in producing results, and are bulky and expensive. Smaller, portable sensors offering quick results are prone to producing false positives, indicating a danger where none exists. The development of handheld detection devices is currently the subject of intense research. The idea is that sensors could be small enough to be incorporated into military uniforms, or installed in houses like a smoke detector.

Even if such devices existed, it is nevertheless doubtful whether biodetectors would be useful in scenarios outside a defined military setting (arguably the least likely scenario for BW use anyway). Were biodetector technology installed in subways and other public sites, the positive identification of a BW agent would undoubtedly cause panic, and the public would not be likely to tolerate false alarms.[87] Civilian applications of BW detection technology are being pursued in the US as a homeland security measure. The Bush Administration has a plan, dubbed 'BioWatch', to place sensors throughout the US to monitor the air constantly for evidence of biological terrorism. Critics of this plan say that such sensors would not detect harmful agents in enclosed areas such as subways and airports, and that a BW agent would probably not spread far enough through the air to reach a given sensor.[88]

For the present, the most accurate detection and identification of BW agents takes place in laboratories at the test tube level. Recently, scientists at the Massachusetts Institute of Technology have genetically engineered white blood cells from mice to light up when they come into contact with deadly bacteria and viruses. The sensor cells contain a gene that produces antibodies that latch onto a pathogen. Once this happens, a jellyfish gene within the cell produces a protein that emits bright blue light. The technology has been dubbed C.A.N.A.R.Y., or 'cellular analysis and notification of

antigen risks and yields'.[89] In 19th Century coal mines, a canary in a cage was placed near miners to monitor noxious gas levels. If the canary died, that would alert the miners to exit the mineshaft before the amount of gas reached a level that threatened humans. The C.A.N.A.R.Y. technique follows the same tradition of employing a 'living' (biological) early warning system.

Detecting the presence of BW agents is far more difficult than detecting radioactivity or the fallout from a chemical attack. Although new technology is racing to meet the BW detection challenge, a reliable and deployable system still seems a long way off.

B. Intelligence Sources

Three aspects of BW production and proliferation present challenges for intelligence agencies. First, the concealment of BW production facilities is relatively simple because of the technical overlap with legitimate research and commercial biotechnology. Second, some countries are developing indigenous BW programs, thus limiting the possibilities for interdiction of imported ingredients. Third, ongoing advances in genetic engineering, particularly the advent of 'designer germs', are making it increasingly difficult for intelligence agencies to recognise all biological agents that could pose a threat.[90] Further challenges for responding to the BW threat relate to the main categories of information that intelligence agencies draw upon – human intelligence (HUMINT), imagery, signals intelligence (SIGINT) and open-source information.

HUMINT is arguably the key ingredient in any intelligence response to a BW threat. The major sources of HUMINT are not spies, but rather moles and informants controlled by highly manipulative professionals in outside intelligence agencies. Inside information from well-placed sources is especially important as regards the more intangible questions of intentions and objectives. But HUMINT can sometimes be vague or inaccurate. A source may present his or her own assessments, suppositions and interpretations as facts, and these may actually be false. Misunderstanding by a source is a particular problem when the intelligence relates to high technology, as is often the case with BW. A source may also have his or her own political agenda or may be feeding an intelligence agency disinformation on behalf of the target.[91]

Imagery intelligence (film, photographs and infra red) on BW obtained from aerial platforms (satellites and aircraft) is made difficult by the easy concealment of a BW program. For example, a biological agent production facility could be located in a city and be virtually indistinguishable from other buildings in a satellite image. By contrast, NW-related facilities tend

to be more readily identified, especially where radioactivity can also be detected. SIGINT is similarly difficult because of the largely dual-use nature of BW program ingredients. A telephone call to request a fermentation unit for a medical facility could indicate the assembly of BW program components or it could simply be a legitimate request for a common piece of laboratory equipment.

A large, but not necessarily the most important, source of BW intelligence is open data, especially that which is published on the internet. For example, such information can provide indications of the current or near future state of relevant biological technology. In the context of the rapidly accelerating 'biotechnology revolution', the challenge for intelligence agencies is how to monitor effectively the sheer quantity of information in this area being posted and exchanged.

For the purposes of domestic security, the processes for collecting and sharing intelligence are sometimes incompatible with a traditional criminal law enforcement response to biological terrorism. An act of terror is also a crime to be investigated and punished, or prevented if possible. However, the use of some intelligence may be problematic in this regard. For example, intelligence data is often gathered in ways (and is often so imprecise) that may render it inadmissible as evidence in criminal trial proceedings. By its very nature, intelligence is generally focused on the future, is much less specific, and is source sensitive.[92] Exposing intelligence information to rigorous scrutiny by the legal system may compromise vital sources and so jeopardise possibilities for preventing BW attacks in the future.

Easy concealment and the potential dual-use nature of BW-related agents, equipment and facilities means that accurate intelligence, much less evidence, about illicit activities is extremely difficult to obtain. This point is well demonstrated by the difficulties the US has had in producing evidence that its pre-war claims of Iraqi possession of 'WMD' were correct.

C. The Case of Iraq's 'WMD'

The 2003 Iraq War provides an interesting case study to assess the value and effectiveness of intelligence responses to the BW threat. Prior to the commencement of the war in March 2003, the US presented the United Nations (UN) with intelligence information intended to show that Iraq was running WMD programs in contravention of UN resolutions. Disarming the Iraqi regime of alleged WMD was put forward as the main goal of, and justification for, the US-led attack on Iraq. In the aftermath of the war, the failure of the US and its allies to produce conclusive evidence of Iraq's WMD has reignited the fierce pre-war political debate over whether going

to war was the right thing to do. This in turn has created a crisis of confidence in the intelligence community. In the US, the United Kingdom and Australia, parliamentary inquiries have been launched to investigate whether governments may have improperly used faulty or exaggerated intelligence on Iraq's weapons to justify the war.

Senior members of the Bush Administration have attempted to downplay the WMD intelligence dimension. Defense Secretary Donald Rumsfeld was reported as saying the US acted in Iraq not because of new evidence of Iraq's WMD, but because it saw existing evidence in a new light after the terror attacks of 11 September 2001.[93] Deputy Defense Secretary Paul Wolfowitz has stated that the US government must be able to act on 'murky' intelligence to prevent future attacks. The alternative, he argues, is to act after the fact.[94] Nevertheless, the US is persisting in its pursuit of WMD evidence that would validate its pre-war intelligence assessments.

For the purposes of this paper, the most significant WMD intelligence issue is the discovery of two Iraqi trailers, alleged to be part of a mobile biological warfare production unit. These trailers, found by US forces in April and May 2003, have been offered as proof that Saddam Hussein was hiding a BW program. The idea is that, by making its BW production facilities mobile, Iraq could more easily circumvent the pre-war UN inspection process. The significance of the trailers has been the subject of intense debate within the intelligence community, with experts divided on technical grounds over whether the trailers could actually have produced BW.

At the end of May 2003 the CIA and the US Defense Intelligence Agency (DIA) jointly issued a report on their analysis of the trailers. The report describes the results of examinations as being largely consistent with US intelligence reporting before the war. Certainly, the general configuration and design of the trailers are very similar to the mobile BW plants described by US Secretary of State Colin Powell in his presentation to the UN in February 2003. The two trailers are alleged to have been designed to produce pathogenic agents in unconcentrated, liquid slurry form. For this purpose, they were equipped with fermenters, water supply tanks, a water chiller and gas collection devices. The report argues that the trailers were unlikely to have been used for legitimate purposes such as water purification, vaccine production or biopesticides. Rather, the size and nature of the equipment inside the trailers indicates that BW agent production is their only logical purpose.[95]

In opposition to the report's findings, sceptical experts have pointed out that the trailers lack gear for steam sterilisation, normally a prerequisite for

any kind of biological production. Not having such equipment available between production runs would, they argue, result in contamination and failed weapons. On the other hand, the trailers might have obtained steam sterilisation functions by connecting up to a separate supply truck.[96]

Another theory is that the trailers were used to chemically produce hydrogen for artillery weather balloons. The CIA/DIA report states that this was a 'cover story' concocted by the Iraqis to conceal the real purpose of the trailers. Some features of one trailer — a gas collection system and the presence of a caustic substance — are consistent with both biological agent production and hydrogen production. However, the report argues, the trailer is unnecessarily large and its equipment not suited for the efficient production of hydrogen.[97] At the time the report on the trailers was drafted, the DIA's engineering teams had not concluded their work. In findings leaked to the *New York Times*, it has been revealed that a majority of the DIA engineers believe hydrogen production to be the true purpose of the trailers.[98] This casts doubt on the report's opening claim that the trailers constitute 'the strongest evidence to date that Iraq was hiding a biological warfare program'.[99]

Significantly, the report supposes that a third trailer (not located) would need to have been involved for post-production processing, such as spray-drying the liquid slurry into a more useful powder form.[100] As this further processing would have been essential for weaponisation of BW agents, an inference to be drawn from the report is that the two trailers in themselves do not constitute conclusive evidence of a working BW program.

Indeed, a fully-fledged BW program requires much more than production plants. According to a 1993 report by the US Office of Technology Assessment, producing biological agents is only the first step towards acquiring a militarily significant offensive BW capability. Beyond mobile BW production plants, an effective Iraqi BW program (if it existed before the war) might also have featured, for example:

- tried and tested delivery systems, such as cluster bombs for dispersing bacteria;
- aircraft or missiles adapted to the delivery system;
- an established network of logistical support;
- stocks of appropriate vaccines for individual and collective defence;
- strategic and tactical BW battle plans; and
- a program for training troops to use BW and operate in a BW environment.[101]

The case of the alleged BW trailers well demonstrates the difficulties the US has had in producing evidence that its pre-war claims of Iraqi WMD were correct. It is in the nature of BW that such weapons are highly unlikely to be found in ready-to-use form. A nuclear missile, a rifle or a land mine has but one use — as a weapon. The dual-use nature of biological agents, however, means that 'finding' BW is inherently much more complicated. BW intelligence is further challenged by the technical reality that BW agents can, as required, be grown rapidly and destroyed without trace. A later section of this paper discusses the technical difficulty of discovering BW in the context of verifying compliance with the BWC.

4. Medical Responses

Medical and public health measures are essentially a 'back end' response to the threat of BW. In this regard, effective disease surveillance networks and strong public health system capabilities serve three important functions:

- they may lead potential BW perpetrators to suppose that the effects of an attack would be thwarted or at least reduced substantially;
- they directly address human vulnerability to the effects of a successful BW attack; and
- they serve also to bolster defences against the threat of new and re-emerging infectious diseases of natural origin.

A. Disease Surveillance Networks

Because a BW agent takes time to incubate inside a victim's body, it may be days or weeks before the symptoms of a deliberate disease attack are apparent. Post-infection detection of a BW attack happens when cases of disease are diagnosed simultaneously in multiple surgeries, clinics and hospitals. But without adequate networking and communication, nobody would know a disease outbreak was going on or the extent to which it had spread. Faced with the BW threat, as well as an increase in novel infectious diseases of natural origin, a strong case is being made for strengthening domestic and international systems for monitoring disease outbreaks in humans, animals and plants.[102] Using disease surveillance networks to ensure biological security will require improved mechanisms for interagency and intergovernmental communication.[103]

Effective biological security may also demand that advanced countries like the US take the lead to improve the global disease surveillance and response capacity. This is an exercise in pre-emptive defence that has no nuclear or chemical analogy. Outbreaks of deadly, contagious, long-incubating diseases would be detected and stopped rapidly wherever in

the world they occur. To this end, the case is being made for much more funding for the World Health Organisation (WHO) and the creation of regional WHO centres. This would enable a more rapid and effective response to local disease outbreaks and would ensure existing WHO laboratories were not swamped with samples.[104]

In early 2003 the poor response to severe acute respiratory syndrome (SARS) by governments in the Asia-Pacific underscored how ill-prepared and vulnerable this region is to mass outbreaks of deadly diseases, whether naturally occurring or deliberately inflicted. The SARS outbreak demonstrated starkly the enormous practical difficulties associated with containing a highly contagious disease. China was roundly criticised for not advising the WHO sooner of the mystery virus that first appeared in its Guangdong province in November 2002. The subsequent spread of the disease beyond China well illustrated the importance of communication for containment purposes. Close cooperation between national governments is also vital — after all, a virus is no respecter of borders.

B. Public Health System Capabilities

Traditional military approaches to detecting and protecting against BW on the battlefield are not necessarily suitable or easily adapted for use in a peacetime civilian setting. Typical first responders (fire and police) are not sufficient for containing the effects of a biological attack, and nor are specialist 'NBC' defence personnel. A rapid response capability simply does not apply where, as would most likely be the case, no-one even knows a biological attack is going on. Rather, strong civil defence is rooted in the capabilities of a new player in the realm of national security — the public health system. A strong system can quickly identify the presence of a biological attack, contain the number of patients, help restore calm to society and ensure the health of the population.[105]

In 1999 the US Institute of Medicine and the Commission on Life Sciences submitted a comprehensive report on medical responses to chemical and biological terrorism to the US Department of Health and Human Services. The report assessed existing research, development and technology for detecting potential agents and treating victims, and made specific recommendations for priority research and development. These included:

- the need for intelligence sharing with and between medical facilities on actual, suspected and potential terrorism;
- improvements to personal protective equipment;
- improvements in detection technologies;

- improvements in federal, state and local epidemiology surveillance, and long-term support;
- development of improved vaccines against smallpox and anthrax (the biggest threats) and the development of a new anti-smallpox drug;
- education on CW and BW issues for health and mental health professionals; and
- development of computer software on event reconstruction from medical data, dispersion prediction and hazard assessment, and decontamination and reoccupation decisions.[106]

This list exemplifies the high degree of effort and expense required to meet future threats to health security, whether posed by BW perpetrators or by nature. At present, hospitals around the world are currently stretched to the limit on day-to-day matters, with barely enough staff and equipment to deal with each year's influenza epidemic. One possible response to the threat of BW could be to build a surge capacity into the public health system to cope with terrorism contingencies. Public health system preparedness will also require training medical staff to recognise and treat potential BW agent diseases — many have never seen a case of smallpox.[107]

The rise of BW is being paralleled by the introduction of deadly diseases to new areas as a result of human activity and surprises from nature. Incomplete treatment regimes, inappropriate clinical applications, and both inadvertent and deliberate sub-therapeutic uses of antibiotics are resulting in the evolution — through human selection – of highly resistant and virulent strains of disease organisms.[108] The world is now facing varieties, deadlier than ever before, of age-old ailments such as cholera, pneumonia, malaria and dysentery. And nature itself is proving to be a great innovator when it comes to disease. SARS is only the most recent example of newly-emerging infectious pathogens. Others include Legionnaires' disease, AIDS and Ebola. In the last few years, exotic diseases such as West Nile virus and monkeypox have turned up in places where they have never before been seen.[109]

Much of what would avert or mitigate a BW attack is needed anyway to protect populations against the increase in emerging infectious diseases of natural origin. Given this overlap in health security and national security needs, a number of authors advocate a 'dual-use' response as the best approach to BW threats. Because the magnitude of the threat is so difficult to calculate, and the intention of potential attackers so hard to manage, it makes sense to focus on dual-use remedies aimed at limiting vulnerability. Pursuing medical countermeasures will improve public health in general, regardless of whether major biological attacks ever occur.[110] For these reasons,

policymakers may find that medical responses to the BW threat are more politically saleable than other responses requiring comparable expenditure.

5. Legal Responses

Responding to BW threats by legal means occurs at a domestic and international level. The two dimensions of a domestic legal response are criminal law enforcement and the internal regulation of BW-relevant materials and information. The main instrument of international law is the BWC, which bans the development, production, stockpiling and acquisition of pathogenic agents and their delivery systems.[111] Challenges to the effectiveness of the BWC relate to the norm it creates against BW use, verification of compliance with its provisions, and the Convention's potentially competing objectives of non-proliferation and technology transfer.

A. Domestic Law Enforcement

Against the threat of BW, much of the law enforcement effort is standard; conventional surveillance and investigatory techniques apply as much to BW terrorism as to commonplace criminal activity. Clandestine terrorism does, however, present some unique problems for law enforcement. Most notably, the time lag between use of BW and its effect on humans reduces the risk that a perpetrator will be apprehended; no other weapon offers a comparable capacity to inflict potentially catastrophic disruption anonymously.[112] For Kellman, writing in a US context in 'Biological Terrorism: Legal Measures for Preventing Catastrophe, the best law enforcement strategy is two-pronged: to deny access to BW capabilities, and — if they are obtained — to apprehend the terrorist before an attack.[113]

Two important characteristics of a BW attack mean that post-event law enforcement is of limited value: firstly, such a crime is virtually undetectable at the time of its commission; and secondly, its consequences if successful are unacceptable. Kellman therefore prefers pre-attack techniques like surveillance to protect society. His caveat is that terrorism's ultimate target is the US Constitution, such that law enforcement techniques should be mindful of civil liberties.[114] In essence, the principal role of criminal law enforcement agencies is to interdict the suspicious acquisition and trafficking of potentially BW-related materials and equipment.

The ordinary flow of biotechnology materials and information also poses significant legal challenges, and debates are ongoing as to whether and to what extent that flow should be regulated. There is a fear in some circles that potential BW perpetrators may acquire a deadly capability just by reading the open literature and using commercially available materials. A 2002

article entitled 'Biological Warfare Targeted at Livestock' in the journal *BioScience* featured an editor's note that portions of the article were 'intentionally left vague to prevent misuse'.[115]

However, there is cause to be wary of policies for reducing access to dangerous pathogens and related information. Restrictive legislation could impair a country's preparedness for BW attacks as well as infectious disease. For example, classification of research and the vetting of publications threaten three policy priorities other than counterterrorism:

- the fight against newly emerging and re-emerging diseases;
- arms control (secrecy promotes suspicion and encourages proliferation, and classifying defensive programs could give governments an excuse to hide offensive BW research); and
- the promotion of advances in biotechnology research.[116]

Kellman argues for a regulatory agenda, mindful not to overburden the pharmaceutical industry, which would raise barriers to obtaining pathogens and weaponisation technology. To the extent that regulations can reasonably diminish the possibility of a group obtaining and weaponising pathogens, the industry should accept such changes as the price of living in a dangerous world. To the extent that bioterrorists can develop BW without turning to the commercial sector, regulatory burdens might not diminish risks, so it makes more sense to cooperate with industry rather than weigh it down too much with legal restrictions.[117]

Regulating BW agents themselves is highly problematic, especially as seed cultures could potentially be obtained from nature. However, a BW agent is not of itself a weapon, so weaponisation through agent delivery systems is the critical junction where regulatory efforts might be effective. Kellman suggests that complex and large-scale weaponisation equipment — for example, fermentation equipment, centrifugal separators, filtration equipment, freeze-drying equipment, and aerosol inhalation chambers — could be regulated efficiently without undue burden to industry. Each item of critical equipment could be electronically tagged to enable law enforcement or regulatory officials to determine its location at any given time.[118]

As a response to the BW threat, domestic law enforcement means preventing criminal acts and regulating the exchange of BW-related materials, equipment and information. The challenge for lawmakers is to find a just balance between the need for restrictions on medical and business activity and the requirements for a free, secure and healthy society.

B. The Biological Weapons Convention

(i) The Norm Against BW Use

In spite of all the possible high-tech responses to the threat of BW, it may be that the greatest protection is ethical – the norm against BW use. One of the BWC's greatest strengths is the universality of its norm. It is widely accepted in the international community that BW are totally abhorrent, and the norm against use has been internalised into individuals' and nations' value systems. As the BWC is the formal embodiment of this norm, and as only states may be party to the Convention, the norm does not bind non-state actors like terrorists in the same way. Even so, the norm against BW use could undermine political and popular support for terrorists objectives were such a loathsome attack to take place.

In 1969, when the US publicly announced the abandonment of its offensive BW program, it was the first time a major power had unilaterally renounced an entire category of 'WMD'. The decision ended certain longstanding assumptions of US policy regarding BW — specifically, that the US should maintain an offensive BW capability to deter the use of such weapons by others, and that the US should be prepared to retaliate in kind to such an attack.[119] Unilateral US renunciation gave a huge boost to the norm against BW use and thus laid the ground for the eventual entry into force of the BWC in 1975.

Since then, developments such as technological advances and the emergence of new political actors have frequently challenged the norm against BW use and undermined the BWC.[120] For some countries, BW (and CW) disarmament is thought to be unfair and unsafe in the absence of a universal regime banning NW. Such countries are convinced that all three categories of 'WMD' should be prohibited as part of a coherent international law regime. Others say that linking the three will preclude progress in strengthening the BW regime. Arguably, the refusal to acknowledge linkage ensured the successful entry into force of the verifiable CWC regime in 1997. However, such selectivity allows NW states to maintain control of world politics, and this could threaten eventually to undermine the will of non-NW governments to uphold the BW and CW disarmament regimes.[121]

The strong norm against BW use creates a powerful stigma for potential proliferators. Yet the norm requires constant reinforcement in the face of new security challenges. The main danger here is that, in desperate international political circumstances, some countries may be able to convince themselves and others that BW are no longer an illegitimate means of protecting national interests.

(ii) Verification

When the BWC was opened for signature in 1972 many countries chose to believe in the limited military utility of BW and few states were presumed to have a BW capability. Consequently, the intrinsic weakness of a Convention without verification provisions was not seen as a major problem.[122] Times have changed, however, and today's biotechnology revolution is generating new fears that BW have reacquired military significance. Without a verifiable BWC, there is an ever-present possibility that misperceptions about the activities of other states will lead to the initiation or acceleration of offensive BW programs.

For technical reasons already discussed in this paper, the BWC is much more difficult to monitor than nuclear, chemical or conventional arms control agreements. A country's biological research activities might be discerned through the published scientific literature, satellite imagery or human intelligence, but each of these has its limitations for verifying compliance with the Convention.[123] BWC verification focuses qualitatively on states' capabilities; because biological agents can be grown so quickly, quantitative thresholds are of little value. Through a BWC verification protocol, as envisaged by an Ad Hoc Group (AHG) of member states, confidence in compliance would be generated by means of:

- declarations of existing stockpiles and potentially BW-capable facilities;
- routine and unannounced visits to declared or suspected sites; and
- investigations of suspicious disease outbreaks.[124]

The proposal for on-site inspections has been particularly problematic. The dual-use nature of biological equipment means that even rigorous short-notice inspections cannot ensure high confidence of BWC compliance. Advanced industrial equipment can quickly sweep away traces of a biological agent that inspectors might otherwise detect, even if they arrive within a few hours.[125]

The US pharmaceutical industry, responsible for developing over 90 per cent of the world's new medicines, has heavily resisted BWC verification. The argument tends to be that a BWC verification regime would have limited effectiveness in controlling the development, spread, and use of BW. While some theoretical deterrence value would be associated with such a regime, there would only be a small probability of actually catching a violator. The pharmaceutical industry is primarily concerned that BWC-mandated inspections of facilities would endanger proprietary information and materials. The industry also fears that the costs of training, preparing for and conducting inspections and follow-ups would be enormous. Moreover,

any inappropriate connection of a company with suspicion of BW activity would certainly result in a huge loss of sales and goodwill.[126]

In her article 'Tall Order: Crafting a Meaningful Verification Protocol for the Biological Weapons Convention', Smithson argues, however, that the pharmaceutical industry can and should try harder to cooperate on BWC verification. The industry's expert knowledge on how to protect a secret project could be directed towards catching BWC violators. Rather, too few trial inspections have been conducted in the US for the industry to judge fairly the merits of BWC verification, and more field research is needed to determine the real utility of sampling and other inspection techniques.[127]

Verification may not be as intrusive as many fear. Smithson suggests that BWC inspectors might find that the documentation at a biotechnology facility provides some of the most reliable evidence of its activities. Regulatory authorities already require pharmaceutical companies to keep detailed logbooks and charts that record every step of the manufacturing process. While not product-specific, these records can provide very supportive documentation that a legitimate product is being manufactured at a given facility. A BW manufacturer would find it very difficult to 'cook the books'. Smithson estimates that BWC verification centred on inspection of documents would take hours rather than days.[128]

The negotiations to strengthen the BWC were dealt a crushing blow in late 2001 when the US decided not to support a proposed system for verifying compliance with the Convention. Among the stated reasons for this decision was that the verification protocol drafted by the AHG would 'allow rogue states or others to develop and deploy biological weapons'.[129] Without US support, the prospects for addressing the threat of BW through BWC verification measures in the future are bleak. As of the Fifth BWC Review Conference in Geneva, the mandate of the AHG has not been renewed. Until the Sixth Review Conference in 2006, the BWC member states have instead undertaken simply to 'discuss, and promote common understanding and effective action' on BW-relevant issues such as national penal legislation, national oversight of pathogenic agents, responses to suspicious disease outbreaks, disease surveillance, and formulating codes of conduct for scientists.[130]

It may be that policymakers need to adjust their expectations about what BWC verification can accomplish. Even if it is technically imperfect, verification reinforces the moral taboos associated with BW and raises the practical and political costs of building BW. No verification regime could ever be a complete and certain solution to the proliferation of BW. A level of

trust must therefore be accepted within this process, and political approaches sought to resolve the absence of trust.[131]

(iii) Sharing Biotechnology

The greatest illustration of international distrust on BW issues is that developed countries are afraid to share biotechnology with developing countries for fear of misuse. This distrust is paralleled by the inherent tension in the BWC text itself between the requirements for non-proliferation of BW (Article III) and for international cooperation on biotechnology transfer (Article X). Export controls on technology, materials and equipment have been the primary means by which developed countries, through an organisation known as the Australia Group (AG), pursue BW (and CW) non-proliferation. Critics of export controls argue that they are discriminatory in their intent and ineffective in achieving non-proliferation.

On the issue of discrimination, the AG has been criticised for undermining the CWC by maintaining its own 'warning list' (of chemicals not to be exported to certain countries), which differs from and extends the lists of chemicals in Schedules to the CWC. There are fears that this practice could extend to the BWC.[132] On the issue of effectiveness, the experience of India's and Pakistan's nuclear tests shows that technology denial may delay but cannot stop the development of 'WMD' by a determined state. Mashhadi argues that, in order to move towards a universal ban on WMD, it is essential to think about a new international relations paradigm based on cooperation because the coercive paradigm has proved unsuccessful.[133]

A number of authors emphasise how disarmament and development are inextricably linked, making Article X the crucial issue for the success of the BWC.[134] In 'Challenges to Disarmament Regimes: the Case of the Biological and Toxin Weapons Convention', Zanders proposes that a solution to the dilemma of sharing biotechnology lies in compromise from both sides. Developing countries with a greater interest in the non-security clauses of the Convention should adopt policies of greater transparency in order to allay the security concerns of other parties. In turn, industrialised countries must recognise that their security will benefit from verification of their own BWC compliance and from the higher degree of universality that implementing Article X would bring to the Convention.[135]

By their very nature, non-proliferation policies tend to pit possessors of certain technologies against non-possessors. However, biotechnology may be a special case. Emerging and re-emerging diseases of natural origin are a new security problem posing a direct threat to all societies in all parts of

the world. Because of the role of biotechnology in addressing this threat, any future BWC regime has huge implications for the economic, political and social security of states.[136]

It may be that that economic assistance can be provided in a manner that satisfies the interests of both developed and developing countries. Smithson advocates, for example, providing aid to strengthen national and international capabilities to determine emerging diseases. This measure addresses Article X while also providing a much-needed boost for global early warning systems of disease outbreaks.[137] It must be remembered that the primary and ongoing biological security concern of many countries lies in controlling natural disease outbreaks and not in the possibility of a BW attack.[138]

The sharing of biotechnology between developed and developing countries is a vexed issue in negotiations to make the BWC work more effectively. From one point of view, pursuing non-proliferation through export controls only aggravates international tensions. The alternate perspective is that to allow too liberal an approach on the transfer of biotechnology is to make BW use more likely. It remains to be seen whether parties to the BWC can strike a just, equitable and secure balance between these opposing viewpoints.

Conclusion

The threat of BW is to be sharply distinguished from that posed by CW and NW. Biological agents deployed deliberately for military or terrorist purposes have a unique effect on their human and agricultural targets. If the threat of BW is to be taken seriously, a vital first step is to take great care with the language and terms used to portray, assess and deal with that threat. While BW is so often included in the term 'WMD' alongside nuclear and chemical weapons, it has uses and effects much more diverse than causing mass destruction.

The production and weaponisation of BW for effective use against human targets presents great technical challenges, although humans will be vulnerable to psychological effects even if an attack is ineffective. It remains to be seen whether the biotechnology revolution will make the use of new or existing BW agents more likely in the future. As BW are literally 'living' weapons, they are as such inherently suited to affecting any living target. In efforts to protect human populations from a direct BW attack, it would be negligent to overlook the protection of a vital means of human survival — agriculture.

Biological warfare is almost as old as warfare itself. In the modern age, the development and use of anthrax-, plague- and toxin-based weapons by states has left a lasting and deadly legacy. Although offensive BW programs are banned by the BWC, many states are still suspected of maintaining or attempting to acquire such a capability. The technology for producing and weaponising known and future BW agents is constantly improving. Without adequate response mechanisms in place, the use of such technology for state or terrorist purposes could be devastating.

Assuming the worst regarding terrorist motivations may lead to the notion that BW acquisition makes an attack inevitable. However, the effect of a BW attack is unique and potentially uncontrollable in its magnitude. For these very reasons, the inclination to use BW to achieve particular outcomes may vary enormously from one terrorist organisation to the next. For terrorists with sufficient motivation to use BW, there are still huge challenges in producing, weaponising and delivering biological agents in a way that causes mass casualties. This means, for the present, that the nightmare of biological terror probably does not match up with the technical likelihood of a truly catastrophic attack.

Against present and future BW threats, there is a spectrum of possible responses. In choosing a response, however, it is important to be mindful

that a decision should be driven by dispassionate threat assessments and not by irrational fear. Dread is an influential force as insidious as disease itself. Language, misinformation and our primal fears of infection can combine to generate ill-considered and counterproductive measures. A realistic understanding of the technical uniqueness of BW is vital for tailoring military, intelligence, medical and legal responses appropriately.

On the military side, this paper has argued that nuclear deterrence is of highly dubious utility in responding to the threat of BW. As an idea, it potentially undermines NW non-proliferation efforts. In practice, targets for NW retaliation could prove too obscure, and the use of NW so disproportionate a response as to be politically unpalatable. It is also doubtful whether the kind of terrorists who would use BW could ever be deterred. The use of conventional force against a BW target would only be appropriate where: (1) the location of the biological agent was known; (2) the destruction of the agent would not cause contamination of the surrounding area; and (3) the agent existed in sufficient quantity to warrant explosive destruction. Defensive BW programs are an important component of a country's response to BW threats and may yield valuable technology for combating and detecting BW agents, and for preventing, diagnosing and treating disease. However, secret threat assessment experiments involving offensive BW scenarios can stimulate fears that a country may be in material breach of the BWC.

Intelligence responses to BW threats are made difficult primarily for technical reasons. Detecting the presence of BW agents, for example, is far more difficult than detecting radioactivity or the fallout from a chemical attack. Although new technology is racing to meet the BW detection challenge, it seems a reliable and deployable system is still a long way off. Easy concealment and the potential dual-use nature of BW-related agents, equipment and facilities means that accurate intelligence, much less evidence, about illicit activities is extremely hard to obtain. This is well demonstrated by the difficulties the US has faced in producing evidence that its pre-war claims of Iraqi possession of WMD were correct.

Responding to BW threats (and attacks) by medical means is in some ways more straightforward. Whether or not a large-scale BW attack ever happens, the natural emergence of known and novel infectious diseases creates an imperative for improved disease surveillance networks and stronger public health system capabilities. The first indication that a BW attack has taken place may be patients presenting themselves to clinics, surgeries and hospitals. Networked reporting of contagious diseases would assist authorities to contain outbreaks and limit the human damage from a

natural or deliberate disease event. A strong public health system, featuring a physical surge capacity and appropriately trained staff, is also important for minimising casualties. The SARS outbreak of early 2003 demonstrated starkly the importance of communication and cooperation to resist disease. It also exposed the grave weaknesses of many countries' public health systems.

The primary contribution of legal responses to the BW threat is a preventative one. Domestic law enforcement means preventing criminal acts and regulating the exchange of BW-related materials, equipment and information. The challenge for lawmakers is to find a just balance between the need for restrictions on medical and business activity and the requirements for a free, secure and healthy society. At an international level, the BWC establishes a strong norm against BW use and creates a powerful stigma for potential proliferators. Yet the norm requires constant reinforcement in the face of new political and security challenges.

A verification regime would be the principal means by which the BWC could be strengthened, however there has been no consensus reached among member states in the 30 years of the Convention's existence. Declarations, inspections and disease outbreak investigations are all measures which, some countries argue, could compromise confidential security and business information. Different BWC member states have divergent views on what verification is about. For some, even if it is technically imperfect, verification reinforces the moral taboos associated with BW and raises the practical and political costs of building BW. Others, like the US, are convinced that a verification regime could never be a complete solution to BW proliferation, and that it is better to concentrate on military and medical countermeasures.

Article X of the BWC provides for the sharing of biotechnology between developed and developing countries. In this provision lies the nexus between disarmament and development. Developed countries prefer to pursue security and non-proliferation through export controls, yet this has a huge capacity to aggravate international tensions. Developing countries see access to medical and biological technology as vital for the survival of their populations, yet the unregulated transfer of some aspects of biotechnology to hostile and irresponsible regimes may make BW use more likely. In facing a future of new and re-emerging infectious diseases of natural origin, the challenge is to protect population health without facilitating the abuse of knowledge about human vulnerability to disease.

Assessing accurately the threat of BW requires a sound technical understanding of how weaponised biological agents affect living targets. BW are not like nuclear and chemical weapons and they are not always

'weapons of mass destruction'. A failure to distinguish adequately between the three arms categories will lead to flawed responses. BW are feared as instruments for state coercion and terrorist intimidation, yet the threat posed by deliberate disease should not be overstated. It is not good enough to say that a major biological attack is only a matter of time. By steadfastly pursuing appropriate military, intelligence, medical and legal responses, the dreaded threat of BW may yet be thwarted.

Notes

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Part II: Responding to the BW Threat: From Bunker Busters to Hospital Beds

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Sometimes known as â€œgerm warfare,â€ biological weapons involve the use of toxins or infectious agents that are biological in origin. This can include bacteria, viruses, or fungi. These agents are used to incapacitate or kill humans, animals, or plants as part of a war effort. In effect, biological warfare is using non-human life to disrupt â€” or end â€” human life. Because living organisms can be unpredictable and incredibly resilient, biological weapons are difficult to control, potentially devastating on a global scale, and prohibited globally under numerous treaties. Of course, treaties and int The following report, first published on South Front, provides an overview of the Pentagon's secretive development of biological weapons in bio-labs around the world. @dgaytandzhieva.Â Metabiota services include global field-based biological threat research, pathogen discovery, outbreak response and clinical trials.Â Operation Bellweather: The US Army Chemical Research and Development Command, Biological Weapons Branch, studied outdoor mosquito biting activity in a number of field tests at Dugway Proving Ground, Utah, in 1960. Virgin female Aedes aegypti mosquitoes, which had been starved, were tested upon troops out in the open air. The Biological Weapons Convention (BWC) was the first international agreement to effectively prohibit an entire class of weapons of mass destruction. In the years since its entry into force in 1975, the BWC has helped to ensure that the idea of using biological weapons remains, as the Preamble to the treaty states, "repugnant to the conscience of mankind". This short film was produced by the United States Mission to the UN in Geneva and includes footage from an event organized in March 2015 to mark the BWC's 40th anniversary. The event took place in the Council Chamber of the Pa