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**MDS**

# Countering the Effects of Biological Warfare (BW) Agents:

# An Integrated Approach

A Thesis Submitted

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## Abstract

With the end of the Cold War, there existed the possibility that a new era of peace and stability would dawn. However, this prospect of a new world order has evolved into an international mélange of tribal, ethnic, regional, and coalition interventions.

As part of this instability, some nations have the ability to create weapons of mass destruction (WMD), such as biological warfare (BW) agents that can incapacitate, kill, or even create epidemics of massive proportion. BW agents are relatively easy to produce compared to chemical or nuclear weapons, and any rogue adversary with motivation, and limited technological capability could render an unprepared foe defenseless.

Currently, the Canadian Forces employs a triad of force protection measures, which provides an inadequate level of protection. With this level of protection, deployed personnel are at great risk. As this paper will demonstrate, the effects of a BW agent exposure on a medical unit would greatly reduce its capability.

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# Chapter 1

# Introduction

"**In forming the plan of a campaign, it is requisite to foresee everything the enemy may do, and to be prepared with the necessary means to counteract it"**[1]

**Napoleon Bonaparte**

## 1.1 Introduction

Though written over 200 years ago, this maxim[2] of Napoleon Bonaparte is still as applicable today, if not more so. Napoleon gained his military expertise from being a soldier rather than from being a philosopher of war.[3] He considered his maxims as a rulebook of war with the intent of guiding future generations of military thinkers. Today this maxim is still relevant and noteworthy on any modern battlefield.

With the end of the Cold War, there existed the possibility that a new era of peace and stability would dawn. However, this prospect of a new world order has evolved into an international mélange of tribal, ethnic, regional, and coalition interventions. Therefore, as outlined in the in 1994 Defence White Paper,[4] the Canadian Forces, more

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[1] Translated by Lieutenant-General Sir George C. D'Anguilar, CB. Intro D.G. Chandler. The Military Maxims of Napoleon, Greenhill Books,1987, pg 85.

[2]The Concise Oxford Dictionary defines the term (maxim) as coming from the Latin adjective *maxima,* meaning 'greatest.' Napoleon's *Military Maxims* provide a generalized guide to actual military conduct.

[3] Philosophers of war have pondered issues of war and peace for several centuries. They can be divided into two periods, ancient and modern. Sun Tzu is who wrote the book The Art of War, was a military advisor, who lived during the Warring States period (453-221 BC) in ancient China. There are two modern philosophers of war. Antoine-Henri Jomini, was a well-known military theorist he observed personally the remarkable rise and abilities of Napoleon Bonaparte. Jomini wrote Summary of the Art of War. Carl Von Clausewitz who was a military theorist from Prussia. He became the director of Prussia's war college. It was at this time he began work on a major theoretical treatise On War. He died before it was published.

[4] The White Paper creates the need to maintain multi-purpose, combat-capable sea, land and air forces that will protect Canadians and project their interests and values abroad. Within the White Paper Canada will remain as a strong supporter of international security, therefore, Canada may have to respond in a quick manner in defence of NATO or as directed by the UN. With this, the Canadian Forces may participate in environments that may include weapons of mass destruction.

specifically the Land Force, must prepare to meet the diverse challenges of this new era of international instability.

As part of this instability, some nations have the ability to create weapons of mass destruction (WMD),[5] such as biological warfare (BW) agents that can incapacitate, kill, or even create epidemics of massive proportion. BW agents are relatively easy to produce compared to chemical or nuclear weapons, and any rogue adversary with motivation, and limited technological capability could render an unprepared foe defenceless.

## 1.2 Approach

This paper is divided into three parts: Part I provides an introduction to the BW threat, Part II explores the operational impact of a BW event on medical capabilities, and Part III presents a model of an integrated approach to BW agent protection. It concludes with recommendations on future detection, protection, and medical countermeasures to counter BW agents based upon a comparative study between the United States, United Kingdom and Canadian force protection capabilities.

The research draws on sources and interviews from government, and academics, including counter proliferation, and intelligence, also the scientific community involved in the research and development of new procedures to better prepare our forces.

[5] Weapons of Mass Destruction (WMD) include nuclear, chemical, and biological.

## 1.3 Thesis Statement

*Within the current asymmetric threat environment, medical personnel of the Land Force are more likely to be exposed to BW agents. This would cause an unacceptable degradation of medical capabilities, which is of concern because this affects the combat power of a formation. Therefore, the impact of BW agents on medical personnel must be reduced. This would be best done by employing a triad of force protection measures: detection, protection, and medical countermeasures.*

# PART I: THE THREAT

# Chapter 2

# Threat

**"When making plans,
it is as well to take into account those of the enemy."**

**Winston Churchill**

## 2.1 Introduction

This chapter begins with an overview of current geo-strategic challenges facing the Canadian Forces. It then focuses on the asymmetric threat.

## 2.2 Geo-strategic Concerns

According to the *Canadian Military Assessment* (2000), the geo-strategic challenges of the future will be molded by multiple political, military, socio-economic, and technological trends that could have great effect upon Canada's security.[6] One of the most significant factors in this is the United States continued dominance of the world's security setting, however one can expect to see emerging world powers to have an increasing effect on this environment.

Further to this, the United States Department of Defence *Quadrennial Defence Review 2001*, states "the current geo-political system, which was born out of the Cold War by the division of countries into a bi-polar environment has become more fluid and unpredictable."[7] The future challenges provided by this will definitely change the way in which the United States defines its security needs and will have a similar affect on

[6] Scot Robertson, Dr., Directorate of Defence Analysis, Military Assessment, 2000, pg 1.
[7] Quadrennial Defense Review Report, pg 3.

Canada as well. Therefore, our current attention is now directed towards non-traditional threats, from cyber-terrorism to eco-terrorism around the world.[8]

In keeping with this new environment, the Canadian Forces must plan for UN/NATO roles in response to armed conflicts which are likely to break out in those regions of the world where the legitimacy of post cold war borders are in question, or perhaps where regime stability is uncertain as witnessed in the Balkans.[9] It is strongly held by the academic world, that the chance of Super Power confrontation is unlikely, however small niche wars driven by ethnic or religious motives will persist. This threatens regional and global security, which inevitably affects Canada's national objectives at home and abroad.

Not only is this outlook of concern to Canada, but also it is firmly believed by the United State's Department of Defence that over the next decade the threat from weapons of mass destruction (such as biological weapons) will increase.[10] The current consensus amongst the academic world is that more nation states with current biological production capabilities will enhance this capability with the use of bio-engineering.[11] This would result in more effective BW agents that are harder to detect, may be resistant to fielded medical countermeasures, and therefore harder to defend against.

To compliment this capability, present and future adversaries can expend significant resources in developing new methods to counter western military technologies and defence capabilities, especially within the area of BW agents. These adversaries

[8]Scot Robertson, Dr., Directorate of Defence Analysis, Military Assessment, 2000, pg 3.
[9] Scot Robertson, Dr., Directorate of Defence Analysis, Military Assessment 2000, pg 4
[10] Department of Defense Chemical and Biological Defense Program, Annual Report to Congress, July 2001, pg 10.
[11] In his book, *Biological Warfare in the 21st Century*, Malcolm Dando, describes biotechnology as a cheap way to produce weapons that are extremely powerful. He further states, that the nature of this new technology requires careful study, for it would be almost inconceivable were such a new and powerful technological capability not at least considered for application in the military sphere.

might formulate a myriad of asymmetric strategies that will deliver BW agents in unorthodox manners.

### 2.3 Asymmetric Threat

In its basic form, an asymmetric threat[12] is a version of not fighting fair. This can include the use of a variety of strategies at the strategic and operational levels, and in the use of weapons systems that are employed in an unorthodox manner.[13] This concept of not fighting fair includes changing conventional strategy, which includes the acquisition of weapons of mass destruction such as BW agents.

In the *1998 United States Strategic Assessment*, four asymmetric threat options were presented. The first option and the most alarming is the acquisition of BW agents. This represents a low cost and attractive means of asymmetric warfare: which might be used to induce paralysis of medical systems,[14] psychological panic, and mass causalities.[15]

### 2.4 Desired End-State

The driving force behind this asymmetric strategy is to prevent a technologically superior force from bringing to bear the full strength of its fighting force. Some developing countries could take advantage of lessons learned from Serbia's defeat in Kosovo in 1999, and employ asymmetric strategies such as BW weapons to counter vastly superior conventional forces. As a historical example, "Syria's chemical and BW

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[12] Asymmetric threats are inherent to the theory of Sun Tzui. In his book The Art of War, he recommended that armies seek the enemy's strongest capability (hsing) but instead seek and attack the weaknesses. The Art of War, ed. R. Sawyer, (Boulder, Westview Press, Inc., 1994), pg 183.
[13] Malcolm Dando, "Biological Warfare in the 21st Century," pg 1.
[14] The US medical system was paralyzed after the minimal anthrax attacks post-Sep 11.
[15] 1998 Strategic Assessment Engaging Power for Peace, Chapter 11, [www.ndu.edu/inss/sa98/sa98ch11], pg 2.

capabilities may have played a role in restraining Israel's response to a provocative Syrian troop redeployment near Israeli positions on the Golan Heights in August 1996."[16]

In addition, asymmetric threats may play a key role in areas of the world where countries may pursue regional ambitions. The Middle East is an example of this strategy in that small insignificant players trying to destabilize regional autonomy may affect the influence of larger powers. Since the dissolution of the Soviet Union[17], the potential of this type of threat has become more prevalent. This supports the theory that countries, which formerly depended upon Moscow to keep the United States at bay, have lost this support and now must rely more on their own military resources. BW agents are an effective and less expensive way to increase influence over outcome. Therefore, "for this reason, a credible threat of BW could be effective in deterring or curtailing intervention by regional or extra-regional powers."[17] Finally, there is also the threat of attacks on superpowers or allies on their own territory.

In support of this increasing asymmetric threat, a report issued by the Committee on Armed Services, United States, House of Representatives, cited 11 nations that may possess BW agent capability. Table 1 lists the known countries.

[16]Jonathan B. Tucker, ed. R. Zilinskas, "The Case of the Middle East," Lynne Rienner, 2000, pg 31.
[17] During the Cold War, the Soviet Union's reluctance to extend its nuclear umbrella to Arab states such as Egypt, Iraq may have led Moscow to assist some countries in developing a biological capability.
[17]B, Roberts., Controlling the Proliferation of biological weapons. The Nonproliferation Review, 1994, pg 50.

**Table 1. International BW Weapons Programs**

| Known: | Probable: | Possible: |
|---|---|---|
| Iraq<br>Former Soviet Union | China<br>Iran<br>North Korea<br>Libya<br>Syria<br>Taiwan | Cuba<br>Egypt<br>Israel |

Source: Committee on Armed Services, House of Representatives. Special Inquiry Into the Chemical and Biological Threat. Washington DC: US Government Printing Office; 23 Feb 1993. Report to Congress.

It is evident that these countries could want to acquire BW agents based on their perception of an "acute security threat, accompanied by a deficit in the ability of the state to counter that threat with alternative means."[18] Then again, they may find added security incentives (summarized in Table 2) that make the acquisition of biological weapons attractive.

**Table 2. Security Incentives for Acquiring BW Agents.**

| Incentives |
|---|
| To deter biological attack. |
| As a force-multiplier against regional or extra regional powers possessing superior conventional capabilities. |
| To achieve regional hegemony by intimidating neighbor states. |
| As a tactical weapon for battlefield use. |
| For covert warfare or economic sabotage against enemy states. |
| For state-supported terrorism. |
| For counterinsurgency warfare against internal groups. |
| For assassination and harassment of political opponents. |
| **Source: An article written by J.Tucker, Motivations for and Against Proliferation: The Case of the Middle East.** |

[18] Jonathan Tucker, Motivations for and against Proliferation,, ed Zilinskas, pg 28

To close this chapter it is important to note that the United States Armed Forces document, *Joint Venture 2020*, has clearly stated that "the potential of such asymmetric approaches is perhaps the most serious danger the United States and its forces face in the immediate future,"[19] which relates to Canada's national security such attack by weapons of mass destruction.

## 2.5 Summary

This chapter began by providing an oversight of the current geo-strategic environment and further described the emerging asymmetric threat as it pertains to the use of BW agents. Chapter 3 introduces the BW agent primer.

[19] Joint Vision 2020. pg 6

# Chapter 3

# BW Agent Preparation

**"For a charm of powerful trouble Like a Hell-broth boil and bubble."**

***Witches from Macbeth***

## 3.1 Introduction

This chapter provides a definition and history of BW agents. It then outlines factors that are essential in the production and dissemination of an effective BW agent.

## 3.2 BW Agents

To fully understand BW one must understand the fundamental principles of infectious disease caused by pathogenic organisms. BW agents can be divided into two groups depending on whether disease is caused directly by living microorganisms or indirectly by non-living poisonous toxins they produce.

The microorganisms include bacteria, viruses, and fungi that cause disease and they are classified as follows:

> 1. Bacteria. Bacteria are small free-living organisms, most of which may be grown on solid or liquid culture media. The organisms have a structure consisting of nuclear material, cytoplasm, and cell membrane. They reproduce by simple division. Some such as rickettsiae and chlamydia can only grow inside host cells and therefore cannot be grown readily on artificial media. Other bacteria, for example that causes anthrax, can form spores that enable them to survive for long periods in the environment. Diseases produced by bacteria almost always can be cured by specific therapy with anti-bacterial drugs such as antibiotics[18]

[18] NATO Handbook on the Medical Aspects of NBC Defensive Operations, Amed –6(B), Jan 2001, pg 1-4.

2. Viruses. Viruses are organisms that require living cells in which to replicate. They are therefore intimately dependent upon the cells of host, which they infect. They produce diseases which do not respond to antibiotics but which may be responsive to anti-viral compounds, of which there are few available, and those that are available are of limited use.[19]

3. Fungi. Fungi are simple organisms wide spread in nature. Most fungi form spores, and free-living forms are found in soil. Fungal diseases may respond to various anti-fungal druTs 12 2Al0 1ugh60228 Tm(Fungal dij121

### 3.3 History of BW

The history of BW is difficult to assess accurately. This is because of numerous factors, including the difficulties in verification of suspected or attempted attacks, use of attacks as a mechanism of propaganda, questionable reliability of some epidemiological data, and because of overlying incidences of naturally occurring disease and epidemics.[23]

From the dawn of warfare, military leaders recognized the potential impact of infectious diseases on armies. This resulted in the crude use of filth, cadavers, animal carcasses, and contagion as weapons of war.[24] The use of these means for military advantage were used to contaminate wells, reservoirs, and other water sources of armies and civilian populations under attack since antiquity, through the Napoleonic era, and into the 21st century.[25]

From a historical context, there are two striking possible examples of proof of biological attacks. One of the earliest recorded uses of biological weapons was during the 14th-century siege of Kaffa (now Feodossia, Ukraine). The attacking Tartar force had people dying of bubonic plague.[26] They attempted to take advantage of this by catapulting their deceased into the city of Kaffa. This incident created the first epidemic of plague; thereafter, ships carrying plague-infected refugees and rats sailed to points within the Mediterranean area such as Constantinople, Genoa, and Venice, and may have

[23] George, Christopher, Theodore, Cieslak, Julie, Pavlin, Edward, Eitzen, "Biological Warfare: A Historical Perspective," Journal of American Medical Association, Vol 278, No. 5, August 6, 1997, pg 412.
[24] George, Christopher, Theodore, Cieslak, Julie, Pavlin, Edward, Eitzen, "Biological Warfare: A Historical Perspective," Journal of American Medical Association, pg 412.
[25] George, Christopher, Theodore, Cieslak, Julie, Pavlin, Edward, Eitzen, "Biological Warfare: A Historical Perspective," Journal of American Medical Association, pg 412.
[26] George, Christopher, Theodore, Cieslak, Julie, Pavlin, Edward, Eitzen, "Biological Warfare: A Historical Perspective," Journal of American Medical Association, pg 412.

been the cause of the second Bubonic plague epidemic.[27] While this is an interesting historical example, its importance should not be exaggerated, considering the epidemiology of plague "it may be an oversimplification to implicate the biological attack as the sole cause of the plague epidemic in Kaffa."[28]

The second incident took place during the French and Indian War (1754-1767). The Commander[29] of the British forces is reported to have suggested that smallpox be introduced to the Native Americans to reduce their numbers. As a result, an outbreak of smallpox occurred after blankets and clothing from the smallpox hospital were given to the Native Americans. Thereafter, epidemic smallpox killed large numbers of non-immune Native Americans. This form of dissemination of a biological agent is less than ideal, however the significance of this event lies in the intent rather than the result.[30]

### 3.4 Disease in Battle

Before World War II, disease in battle played a major role in determining the outcome of military operations. In the American Civil War, the ratio of death from disease to death on the battlefield dropped from 10 to one to two to one.[31] By the beginning of the 20th century, bullets finally matched microbes in lethality. As noted by famed British historian James Keegan, "The Boer War (1899-1902) was the last in which the British army suffered more fatalities from sickness than from missiles."[32]

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[27] Journal of American Medical Association, Vol 278, No 5, pg 412.
[28] Journal of American Medical Association, Vol 278, No 5, pg 412.
[29] Sir Jeffrey Amherst was the Commander of the British troops; he suggested the deliberate use of smallpox against Native Americans. It just so happened that an outbreak of smallpox occurred at Fort Pitt. This was the perfect time to execute Amherst's plan; on June 12 1763, blankets and handkerchiefs were given to the local native population- an epidemic of smallpox ensued.
[30] Journal of American Medical Association, Vol 278, No 5, pg 412.
[31] Marchand, Philip., "A pox on pesky germs," The Toronto Star 3 November 2001: J 2.
[32] Marchand, Philip., "A pox on pesky germs," The Toronto Star 3 November 2001: J 2.

During World War II, Field Marshall Rommel, despite his acclaimed brilliance as a tactical commander, suffered extreme casualties in North Africa due to disease. It was reported that his army suffered greatly from dysentery, hepatitis, malaria and other preventable diseases. While few of his soldiers died, he lost three to illness for every one to battle injury.[33] Finally, it was stated by a military physician in 1936 "that battles and wars were decided not by force of arms alone but more by the army which suffered the least at the hands of disease."[34]

### 3.5 Background to BW Agent Preparation

The concept of using disease as an instrument of death has motivated governments to tighten international control on biologicals that could be used as weapons. In addition, it requires planners to develop new technology and doctrine to improve detection and protective measures against BW weapons. In spite of this, more nation states and radical factions are suspected of developing pathogens for use as weapons of mass destruction.

Biological weapons disseminate disease-producing organisms or toxins by suspension in water, by insect vector, or as an aerosol.[35] As expected after exposure to any infectious disease, those infected would experience an incubation period. The length of the incubation period would be affected by variables such as size and route of inoculum, and individual's immune response. The incubation period could, vary from

[33] Ronald, Bellamy., Craig, Llewellyn, "Preventable Causalities: Rommel's Flaw, Slim's Edge," Army, May 1990, pg 53.
[34] Lt Col N. Mercer, "Disease in Military Campaigns," The Military Surgeon 78, no 2 (Feb 1936), pg 133.
[35] Thomas, Inglesby, Tara, O'Toole, Donald, Henderson,. "Preventing the Use of Biological Weapons: Improving Response Should Prevention Fail," {www.journals,uchicago.edu/C..sues/v30n6/000065}, 2000, pg 1.

minutes in the case of toxins to hours to days to weeks in the case of bacteria. Most importantly, if sufficient numbers of people were infected by the spread of an agent in the case of microorganisms or the agents were highly transmittable from person-to-person, the result could be large-scale, perhaps catastrophic epidemics.[36]

### 3.6 Biotechnology

Currently, there is a revolution in biotechnology. More and more countries are now utilizing the broad field of biotechnology to enhance their BW agent capabilities, and this is opening a large number of possibilities for belligerent nations. Harmless, non-disease producing microorganisms can be modified to become highly toxic or to produce diseases for which medical countermeasures are unavailable.[37] Therefore, altering through biotechnology can create unique variants of microorganisms that are extremely effective.[38]

### 3.7 Delivery Systems for BW Agents

Other challenges faced by designers of BW agents are the difficulties relating to the delivery of the agent. On the battlefield, there are several methods for delivering a BW agent payload: line-source delivery systems, multiple-point and single-point sabotage. Of importance, is the target population eventually determines the most appropriate method of delivery to maximize the payload.[39]

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[36]Thomas, Inglesby, Tara, O'Toole, Donald, Henderson,. "Preventing the Use of Biological Weapons: Improving Response Should Prevention Fail," {www.journals,uchicago.edu/C..sues/v30n6/000065}, 2000, pg 1.
[37] Defense Intelligence Agency, "Soviet Biological Warfare Threat," US Government, 1986, pg 12.
[38] Defense Intelligence Agency, "Soviet Biological Warfare Threat," US Government, 1986, pg 13.
[39]Defense Intelligence Agency, "Soviet Biological Warfare Threat," US Government, 1986, pg 129.

Line source delivery of BW agents can be accomplished by using external tanks, which can be carried by high-performance aircraft, helicopters, surface ships, automobiles, and even individuals employing such items as garden sprayers.[40] According to Jane's Defense, "line-source dissemination is the most efficient means of delivering biological agents."[41] However, there are disadvantages to this system of delivery such as wind direction, wind speed, and temperature.

The second form of dissemination is multi-point delivery systems, which includes projectiles, artillery shells, bomblets, and mines. These methods of delivery utilize dry powders, which are composed of small particles of bacteria. This form of dry agent delivery represents a high level of sophistication over their liquid cousins.[42] It is important to note that dry powders are easy to disperse and they can be carried a great distance, if the meteorological conditions are right. In terms of technology and funding, this is an important factor when considering the nations acquiring BW agent production.

The last form of dissemination is single-point sabotage. A good example of this form of dissemination would be sabotaging potable water.

To illustrate the lethality of a line-source attack, the following scenario is presented from Jane's Defense,[43] and Table 3 details the impact.

1. Target is downwind;
2. The BW agent is *Bacillus anthracis**;***
3. Munition is a spray tank;
4. Spray tank is 350 litres of liquid slurry at 3 x $10^{10}$ spores per millimeter;

[40] Janes Chemical and Biological Guide, pg 129.
[41] Janes Chemical and Biological Guide, pg 129.
[42] Janes Chemical and Biological Guide, pg130.
[43] Janes Chemical and Biological Guide, pg 128.

5. The length of the release line is 80 kms; and

6. Exposed population is unprotected.

**Table 3. Fatalities Downwind of Release Line.**

| Downwind Distance (km) | Dosage $3 \times 10^{10}$ (# of spores) | Fatalities (%) |
|---|---|---|
| 1 | 84,000 | 76 |
| 5 | 31,000 | 66 |
| 20 | 15,000 | 57 |
| 50 | 9,000 | 52 |

Source: Mathew Meselson, "Background Notes on Biological Weapons," unpublished document, Department of Molecular and Cellular Biology, Harvard University, 20 August 1997.

The conclusion drawn from this scenario is as follows: *Bacillus anthracis* has potential as a lethal weapon of war. Fatality rates ranging from 52 – 76 % would be a great loss for an unprepared military force. Losses of that degree would render a military force ineffective.

### 3.8 Dosage

A majority of BW agents are, by weight, thousands of times more lethal or effective than equivalent amounts of chemical agents.[44] The lethality of a BW agent is directly related to the total dose received. The total dose received will depend on the

[44]CA/US/UK Memorandum of Understanding, On the International Task Force 23, pg III-B-12.

duration of exposure, the concentration of the agent, and the route of exposure.[45] The following definitions are provided:

1. Effective Dose - Quantity of agent required to infect or intoxicate an individual;[46]

2. Infective Dose - The infective dose is the number of microorganisms or spores required to produce an infection;

3. Lethal Dose - Lethality is the ability of an agent to cause death without treatment. Some pathogens produce toxins that can result in disease(cholera, and typhus).[47]

### 3.9 Summary

This chapter outlined the history of BW, and then described terminology as it relates to BW agents. The following chapter examines BW agents of military significance.

[45]CA/US/UK Memorandum of Understanding, On Chemical and Biological Defensive Material: International Task Force 23 Development of a Trinational Biodefence Concept, pg III-B-12.
[46]CA/US/UK Memorandum of Understanding, On Chemical and Biological Defensive Material: International Task Force 23 Development of a Trinational Biodefence Concept, pg III-B-12.
[47]CA/US/UK Memorandum of Understanding, On Chemical and Biological Defensive Material: International Task Force 23 Development of a Trinational Biodefence, pg III-B-12.

# Chapter 4

# BW Agents of Military Significance

**"It is better to carry out the bloodiest battle than to quarter the troops in an unhealthy place."**

***Napoleon Bonaparte***

## 4.1 Introduction

This chapter begins with an overview of BW agents of military significance with a focus on *Bacillus anthracis*. The second part explores the military significance of these agents.

## 4.2 Background

Since 10 April 1972, 142 signatory nations have ratified the Biological and Toxin Weapons Convention (BWC). It is officially known as the Convention on the Prohibition Of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction.[48] [49] Upon its inception, the BWC was unusual amongst existing weapons control treaties in that "it prohibited an entire class of weapons, yet lacked specific mandatory enforcement measures to ensure compliance by participants."[50] Over the past several years, events have raised the awareness of the BWC's shortfalls and cast a shadow of extreme doubt on its effectiveness. Evidence of this is presented by the United States Arms Control and Disarmament Agency suggesting

[48] Journal of American Medical Association Vol 278, No 5, "Biological Weapons Control," 6 Aug 1997, pg 351

[49] The States Parties to this Convention, determined to act with a view to achieving effective progress towards general and complete disarmament, including the prohibition and elimination of all types of weapons of mass destruction, and convinced that the prohibition of the development, production and stockpiling of biological weapons and their elimination, thru effective measures, will facilitate the achievement of general and complete disarmament under international control.

[50] Journal of American Medical Association Vol 278, No 5, "Biological Weapons Control," 6 Aug 1997, pg 351.

that the number of known or suspected countries having biological weapons capability doubled since the convention went into force in 1975.[51]

The employment of BW agents for military purposes has been most evident in the Middle East. It is hypothesized that there are Middle Eastern governments that consider biological weapons as a force-multiplier than can offset the weakness in their conventional forces, in the face of technologically superior enemies.[52] One could argue that for most battlefield applications, biological weapons might be employed in a limited role tactically if quick results were not essential, and if friendly forces were protected. Biological weapons could also be used in a long drawn out war of attrition, for example: contingency biological attacks against fixed enemy positions; and against targets deep behind enemy lines such as airfields, supply dumps, port facilities, command centers, logistical staging areas, and reserve forces.

BW agents would be most effective against personnel who lacked effective detection, protection, and medical countermeasures. BW agents can have a devastating psychological effect against both military troops and against civilian populations, as witnessed in the United States post-September 11. Another significant factor in the use of BW agents against military troops is that they would have to wear cumbersome protection gear, which would degrade their physical ability and would adversely affect their morale.

[51] Holum J.D. Remarks for the Fourth Review Conference of the Biological Weapons Convention, Switzerland, 26 Nov 1996.
[52] J., B., Tucker., ed. R.Zilinskas, "Biological Warfare: Modern Offense and Defense," Lynne Rienner, Publishers, 2000, pg 31.

## 4.2 BW Agents of Military Significance

The Stockholm International Peace Research Institute (SIPRI) study of 1973 analyzed and classified a number of BW agents that are desirable for military purposes. Table 4 summarizes this list.

**Table 4. Characteristics of BW Agents of Military Significance.**

| Principal Characteristics | | Examples | Militarily Significant features |
|---|---|---|---|
| | Incapacitating | Influenza virus | Military attraction limited by potential uncontrollability |
| | Lethal | *Yersinia pestis* (plague) | |
| Not infectious from first victim | | | |
| | Incapacitating | *Coxiella burnetii* (Q-fever) | Decay rate in air; incubation period; Length of illness etc. |
| | Lethal | *Bacillus anthracis* (anthrax) | |

Source: Taken from Malcolm Dando, Biological Warfare in the 21st Century, pg 32.

Reviewing the list of agents, one can see that there are both incapacitating and lethal agents. In addition, some BW agents are more effective however; most importantly from a military planning perspective, the use of lethal agents may be limited by the potential of collateral infections against civilians. Therefore, incapacitating agents would be the BW agents of choice.

In addition, the SIPRI study reviewed other military considerations, for example: rates of infectivity, characteristics of dissemination, incubation periods and finally, types and duration of illness.[53] The study further defined and outlined a list of unique characteristics of BW agents that make them desirable to the military. These characteristics are summarized in Table 5.

[53] Malcolm, Dando. "Biological Warfare in the 21st Century: Biotechnology and the Proliferation of Biological Weapons," Brassey's, pg 32.

**Table 5. Summary of Characteristics.**

| |
|---|
| An agent should produce a certain effect consistently. |
| The dose needed to produce the effect should be low. |
| There should be a short and predictable incubation period. |
| The target population should have little or no immunity. |
| Treatment for the disease should not be available to the target population. |
| The user should have the means to protect troops and civilians. |
| It should be possible to mass-produce the agents. |
| It should be possible to disseminate the agent efficiently. |
| The agent should be stable in storage and transportation in munitions. |
| **Source: Malcolm Dando, Biological Warfare in the 21st Century, pg 32.** |

Likewise, the *United States Army's Manual of Biological Casualty Management* identified BW agents that are of concern to a deployed military force and they are: *Bacillus anthracis, Yersinia pestis, Francisella tularensis, and smallpox.* [54] This chapter will now discuss the importance of *Bacillus anthracis* as a biological weapon**.**

## 4.3 Anthrax as a Biological Weapon[55]

Throughout the past millennia, anthrax has caused disease in animals and occasionally in humans. In terms of its use as a biological weapon, research on anthrax began more than 80 years ago.[56] Of the countries believed to have biological weapons, it is uncertain how many have conducted research with anthrax. It is felt that the biggest threat of an anthrax capability is from Iraq.

[54] Management of Biological Casualties on the battlefield. Pg 8
[55] For the remainder of the paper**,** *B. anthracis* will be the bacterium of discussion and review.
[56] JAMA, 12 May 99, pg 3

In 1979, there was an accidental aerosolized release of anthrax spores from a military microbiology laboratory in Sverdlovsk in the former Soviet Union. This resulted in 79 anthrax cases and 68 deaths, which demonstrated the lethal potential of anthrax aerosol.[57] Of significance in the aftermath of this incident, it was discovered that anthrax aerosol is odorless and invisible following release and it has the potential of traveling many kilometers before causing disease.[58]

As an example of the lethality of anthrax it is estimated by the World Health Organization (WHO) that casualties after a "theoretical aircraft release of 50 kg of anthrax over a developed urban population of 5 million would be 250,000. Of this, 100,000 would be expected to die, if they did not receive treatment."[59] To further substantiate this lethality, the United States Congressional Office of Technology Assessment, estimated that between 130,000 and 3 million deaths could follow the aerosolized release of 100 kg of anthrax spore upwind of Washington DC area[60]- "lethality matching or exceeding that of a hydrogen bomb.[61]

## 4.4 Epidemiology

In nature, anthrax is primarily a disease of cattle and sheep. It is transmitted by contact with anthrax-infected animals or anthrax-contaminated animal products.[62]

[57]JAMA, 12 May 99, pg 3
[58]JAMA, 12 May 99, pg 3
[59] JAMA, 12 May 99, pg 3.
[60] JAMA, 12 May 99, pg 3.
[61] JAMA, 12 May 99, pg 3.
[62] Text book of Microbiology, pg 580.

In humans, anthrax spores can cause infection if they come in contact with the skin, if they are inhaled, or if they are ingested in food or water. As was reported in Sverdlovsk in 1979, "inhalation anthrax is expected to account for most morbidity and essentially all mortality following the use of anthrax as an aerosolized biological weapon."[63]

### 4.5 Microbiology

The name *Bacillus anthracis* is taken from the Greek word for coal, *anthrakis,* and this is because of the black, coal-like lesions it forms.[64] *Bacillus anthracis* is an aerobic, gram-positive, spore-forming, non- motile *Bacillus species.*[65] With at least 1000-x magnification, bacilli look like small rods. The anthrax bacillus has a distinctive appearance in that the ends of the rods may be concave and somewhat swollen to give it the appearance of a bamboo fishing rod.[66]

The anthrax bacillus is a spore-forming bacterium. Spores are metabolically dormant bodies produced at a late stage of the cell growth. Of importance, spores are extremely resistant to adverse physical conditions such as high temperatures and dessication.[67] Spores can remain dormant for centuries.

In culture, the colonies of the anthrax bacillus are irregular and have a curled or hair-like structure giving it what is "sometimes called a 'Medusa head' appearance."[68] Anthrax spores germinate when they enter an environment rich in amino acids,

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[63]JAMA, 12 May 99, pg 4.
[64] JAMA, 12 May 99, pg 5
[65] JAMA, 12 May 99, pg 5
[66] Textbook of Microbiology, pg 577.
[67]Michael, Pelczar., "Elements of Microbiology," pg 88.
[68]Michael, Pelczar., "Elements of Microbiology," pg 578

nucleosides, and glucose, such as found in the blood or tissue of animals or human hosts.[69]

[69] JAMA, 12 May 99, pg 5

## 4.6 Pathogenesis

Inhalation anthrax follows deposit of spores of 1 to 5 μm into alveolar spaces.[70] [71] It was noted that in Sverdlovsk, cases occurred from 2 to 43 days after exposure.[72] Anthrax is a two stage-illness; clinically it is found that casualties would first develop a spectrum of non-specific symptoms, including fever, dyspnea, cough, headache, vomiting, chills, weakness, abdominal pain, and chest pain.[73] The second stage would develop very quickly, with a sudden fever, dyspnea, diaphoresis and shock.[74]

## 4.7 Anthrax's Military Significance

The use of *Bacillus anthracis* as a weapon was first tested in the 1950's. Anthrax is a BW agent of choice because it is easy to cultivate and spore production is rapidly induced. Spore production is a key feature because spores are very stable and are highly resistant to sunlight, heat and disinfectants.[75] Weaponized anthrax can be in either a dry or wet form, then the agent is stabilized and delivered by aerosol cloud as a line or point source.[76] Aerosol is the delivery method of choice because it can cover a large area of terrain, and delivery could come from a missile warhead.[77]

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[70] Druett, Henderson, Studies of respiratory infection, Journal of Hygiene. 1953, 51
[71] Hatch, Distribution and deposition of inhaled particles in respiratory tract, Bacteriological Review, 1961;25,237
[72] Meselson, Guillemin, Hugh-Jones, The Sverdlovsk Anthrax outbreak of 1979. Science 1994, 266:1202
[73] Text book of Microbiology, pg 576.
[74] JAMA, 12 May 99, pg 6
[75] Management of Biological Casualties, pg 15
[76] Management of Biological Casualties, pg 15
[77] Management of Biological Casualties, pg 15

## 4.8 Summary

This chapter began by providing background information of BW agents of military significance. Details of criteria for characteristics of BW agents provided the groundwork that led up to a description of *Bacillus anthracis*. The paper now focuses on the operational impact of BW agents on deployed medical capabilities.

# PART II: OPERATIONAL CHALLENGES

# Chapter 5

# Operational Degradation

**"It is a war of scientist against scientist. This war above all in history will be one in which the application of science to warfare will give one side or the other the advantage."**

***Frederick Banting***
***WWII***

## 5.1 Introduction

In the last chapter, BW agents of military significance were presented with a focus on *Bacillus anthracis*. Now, the paper focuses on the theoretical impact of a BW event on medical capabilities.

The mission of the medical branch is "conservation of manpower." This is done during war and peacetime by the provision of health care and patient evacuation. The Canadian Forces Health Services Support (CF HSS) is challenged by a multitude of environmental and tactical factors. Additionally, the HSS must be able to anticipate health requirements, health services planning support, and future planning requirements in order to conserve fighting strength.[78] The task of the CF HSS is complicated by the challenges listed in Table 6.

[78] Canadian Forces Manual, Health Service Support, pg 4.

**Table 6: Operational Challenges.**

| Operational Challenges: |
| --- |
| • Providing this support in ever-increasing areas of operations<br>• Having widely dispersed medical and dental resources<br>• Providing health service support on a non-contiguous battlefield<br>• Having isolated pockets of friendly troops to support<br>• Having greatly increased evacuation distances<br>• Experiencing more concentrated casualties in short, more decisive, operations<br>• Working in an NBC environment |

Source: Information taken from the Canadian Forces Health Services Manual

Since friction and uncertainty make it impossible to anticipate all support requirements, the HSS system must remain flexible, adaptable and responsive.

## 5.2 Medical Capabilities of Concern

One of the most significant challenges for the HSS system is the requirement to be able to work in an NBC environment. In theory, there is a multitude of medical capabilities affected by a BW exposure. For discussion purposes this paper will focus on the following key areas: command and control, evacuation, handling of a mass casualty, specialist care, degradation of medical capability, location of HSS facilities, casualty management and triage. Table 7 outlines the role and function of each of the capabilities before a BW agent exposure. The paper then discusses the impact of an exposure on each capability.

**Table 7: Medical Functions – Pre-exposure to BW Agent**

| | **Function** |
|---|---|
| Command and Control | Medical units included in the order of battle of a divisional formation are under command of a functional medical commander. The medical element of a unit is under the command of the unit medical officer, who reports to his unit commander. Before an attack, timely and accurate intelligence is an essential element of biological defense. Therefore, $C^2$ must direct optimal defensive (medical) posture of forces. Many factors should be considered within the operations planning process to protect the force. Medical planners must analyze medical intelligence of locations of deployed forces and consider endemic disease, vectors, zoonotic evidence, and enemy preventative medicine and treatment capabilities that may divulge indicators of their biological agents. Most importantly, pre-exposure surveillance of natural occurring disease and non-battle injury rates. Planners must also consider vector control, and the disposal of infectious waste and medical materials. This and this information must be disseminated to all units within the formation. |
| Evacuation | The evacuation policy is established by the senior commander in the area of operation, based on the recommendation of the senior medical advisor. The evacuation policy is expressed in a maximum number of days that a patient may be held in treatment facilities at each line of medical support within the area of operation. Patients who cannot be returned to duty within the time of the evacuation policy are evacuated as soon as their condition and the availability of evacuation means permits. There are numerous factors affecting the evacuation: operational situation, location, availability of tactical and strategic resources. In a combat zone the recommended evacuation, policy is two days. Medical planners may consider pre-positioning evacuation assets forward to deal with increase in evacuation. Planners must also be concerned with dealing with dirty/clean routes and resources. Evacuation resources may be restricted of movement or denied certain areas. |
| Mass Casualty | Mass casualties may result from any type of operation. The term 'mass casualty' applies when the number of casualties produced in a relatively short period overwhelms the available medical and logistics capability. Medical planners should consider peacetime morbidity rates and patterns, which will provide a baseline for surveillance in operations. Pre-positioning of additional medical resources may reduce the initial inflow of a mass casualty. |
| Specialist Care (Surgery) | These services or specialties may include surgery, radiology, internal medicine, urology, psychiatry, epidemiology, and many others. Consultants take care of patients and also make recommendations that aid in establishing patient management policies for the formation and abide by established in-theatre policies. |
| Medical Staff | At all levels of medical support, there is a continuous demand for a high standard of medical care. Strong effective leadership is required to ensure that medical staff is ready to accomplish the medical mission. Detection capability in and around a medical facility is paramount in protecting the staff and patients. |
| Location of Medical Facilities | The allocation of real estate is an operational function and will be coordinated with the commander's priorities. The priority is to be located as close to the maneuver units as tactically possible. The sighting of medical units before an exposure will be done in consultation with the formation operations staff. Adequate protection from terrain is essential to ensure survivability as is existing meteorological data |
| Casualty Management | Casualty management is the continuous process of medical care, increasing in complexity by roles. The pre-positioning of medical stores before an exposure is essential. Waste and dealing with contaminated resources will create problems, |
| Triage | Triage consists of immediate sorting of patients according to type and seriousness of injuries. |
| | Source: Material sourced from the Canadian Forces Health Services Manual. Memorandum of Understanding On Chemical and Biological Defensive Material, International Task Force 23, May 1995. |

### *5.3* Biological Exposure – *Bacillus anthracis*

The uses of an agent such as Bacillus anthracis will not only produce a large number of casualties but may also severely compromise HSS capabilities. It is critical that the occurrence of a disease outbreak be identified as early as possible and that an epidemiological investigation be initiated to determine the cause of the outbreak. Table 8 lists indicators that a disease outbreak might have been caused by exposure to a BW agent.

**Table 8. Epidemiologic Clues of a Biological Exposure.**[79]

- The presence of a large epidemic with a similar disease or syndrome, especially in a discrete population
- Many cases of unexplained disease or deaths
- Unusual routes of entry
- A disease that is unusual for a given geographic area or transmission season
- Intelligence of a potential attack, claims by an aggressor of a release and discovery of munitions

**Source: United States Army Manual: Management of Biological Casualties**.

Upon identification of a BW agent exposure, HSS personnel must first protect themselves from contamination and from the effects of the exposure. With this, HSS personnel would be able to continue with their mission. An emphasis on self-protection must be strictly enforced at all levels during the handling and treatment of BW casualties. If BW agent detection fails, or if other defencive measures are insufficient then HSS personnel and medical capabilities are at risk. Table 9 discusses capability degradation issues.

[79] The identification of clinical symptoms after a biological attack is often indistinguishable from those produced by endemic infections. Moreover, and of concern biological agents are capable of infecting a military force before the organism is detected. This issue becomes critical when one considers that upon occasion military forces operate in exotic areas where diseases are prevalent and where our forces lack natural immunity.

**Table 9. Post-Exposure – Degradation of Medical Capabilities.**

| | Function |
|---|---|
| Command and Control | After a BW exposure, an increased demand for direction is expected at all levels of command. Control will be to allocate appropriate resources to where they are required. As the demands of a BW exposure continue, staff at this level would demonstrate symptoms of exposure, and become casualties. Therefore, over all $C^2$ would be degraded. Interruption in communications caused by the effects of a BW event may delay the passing of vital information. Alternate methods of passage of information such as messenger or helicopter may have to be used. With this complex event unfolding, staff at all levels must be able to respond quickly, however, wearing of NBC suites and the shear psychological factor will delay the staffing process. Lack of medical information being passed will limit operational effectiveness. Not knowing where medical assets are will contribute to confusion post attack. This will also reduce morale. |
| Evacuation | The lethality of a BW exposure may influence evacuation at the tactical and operational levels; therefore, the coordination of evacuation of exposed casualties is critical. Most importantly, routes may be closed or subjected to restricted traffic control, large number of casualties will influence overall load capacity of evacuation assets, and finally exposure of the evacuation personnel will reduce their overall capabilities. Traffic control points may have to be established to control dirty clean routes of evacuation, thus delaying the movement of casualties to the next level of care. Evacuation resources may be restricted or denied access to quarantined areas. This will delay medical care to exposed personnel. |
| Mass Casualty | With large numbers of BW casualties, this will severely disrupt the doctrinal approach to treatment and evacuation, this problem would be compounded by degradation of HSS capability due to protective measures, and or infection thru biologic agent. |
| Specialist Care (Surgery) | One area of specialty care is surgery. Battlefield surgery relies upon an organized pre-hospital treatment and evacuation system; therefore, the affects of a biological exposure would greatly affect this well-established drill. Surgical capability would be reduced and perhaps minimized until the affects of the exposure had passed. |
| Medical Staff | Throughout this process the demand on the HSS staff will be greatly increased by such events as mass casualties, change in doctrine to meet the challenges of a biological exposure, slower evacuation times, exposure, and finally exhaustion. Staff must continue to maintain high levels of biological defensive measures, including field hygiene. |
| Location of Medical Facilities | A medical facility could be directly targeted with a biological exposure. Resulting in an increased number of HSS personnel being infected thereby leaving the facility at minimal manning. This in theory would completely degrade the HSS capability within a formation. |
| Casualty Management | Actual diagnosis of BW agent casualties is likely to be difficult. They may co-exist with conventional, nuclear and or chemical casualties. In all cases the medical staff must be protected i.e. IPE or COLPRO. Etiology of the infection may be common to many diseases. The treatment required for BW casualties will not differ from that in patients suffering from the same disease incurred by natural means. Overall, this approach will place additional demands on the medical staff and they will need to consider additional factors relating to operating in this environment. Units attacked with BW agents may be quarantined and may not be evacuated therefore; primary care may be the responsibility of unit commanders with limited augmentation from medical units. There may be a requirement to deal with contaminated clinical material and bodies that will degrade the overall capability of medical resources. |
| Triage | Triage of arriving casualties will place greater demands on medical staff. This triage would be quick process, only the basics would be done before decon: airways, pressure dressing and IV. Other demands that will degrade the medical staff for example: EMT measures may have to be performed in rapid sequence with decontamination. |

Source: ATP-35 Land Force Tactical Doctrine, CFHSS, B-GL-343-001/FP-000, and NATO Handbook on the Medical aspects of NBC Defensive Operations, AmedP- (B). Memorandum of Understanding, On Chemical and Biological Defensive Material, International Task Force 23, May 1995.

## 5.4 Summary

In this chapter, the paper reviewed and determined the effects of a BW exposure (*Bacillus anthracis)* on medical capabilities. The following conclusions and deductions are drawn from the research provided (also find at the Annex a list of factors (sourced from Task Force 23) that should be integrated into HSS SOPs that pertain to NBC protocols: pre and post BW event).

1. CFHS is a capable organization, trained to conduct operations in all environments;
2. A BW event could (such as exposure to *Bacillus anthracis)* create a mass casualty event;
3. Medical facilities are a target of priority for a biological attack;
4. Command and control of HSS assets during a BW event is difficult especially when dealing with the timely passage of information;
5. Evacuation is degraded, and lines of evacuation are extended to compensate for dirty/clean routes;
6. A mass casualty created by a BW event is difficult to manage;
7. Specialist care such as surgery, is directly affected and degraded in a BW event; and
8. Most importantly, medical capability is operationally degraded because of increased workload, the mental and physical stress of working in IPE (individual protective ensemble), and because of exposure to a BW agent.

It is imperative that the Canadian Forces take all necessary measures to reduce the potential effects of a BW event. The next chapter will analyze current Canadian force protection capabilities and doctrine that are available to support deployed forces.

## Annex to
## Chapter 5

### Staffing Planning Protocols*

### A – 1. Pre-deployment Actions

Command and control:

- Review of Standard Operating Procedures (SOPs)
- Contingency Plans in light of Biological attack
- Mission analysis to include actions of BW attack
- Initiate BW warning and reporting chain
- Issue BW protection states
- Deploy counter-surveillance measures

Active Defence:

- Deploy resources to active defence
- Consider enemy's BW capability as a critical vulnerability

Detection:

- Initiate background aerosol check
- Conduct routine sampling and analysis
- Deploy detectors
- Test reporting procedures
- Pre-position medical countermeasures
- Deploy medical liaison teams to threatened area

Warning and Reporting:

- Review warning and reporting procedures
- Test equipment and forward samples to laboratories
- Review $C^2$ functions
- Ensure liaison teams are established

Recce, Survey and Monitoring:

- Pre-position assets
- Initiate and maintain disease and non-battle injury reporting system
- Continue with liaison coordination

Individual Protection

- Ensure all unit members are familiar with unit SOPs for BW defence
- Conduct refresher training
- Adopt appropriate threat posture

Collective Protection (COLPRO):

- Adopt full COLPRO on order

Medical:

- Provide medical input to Commanders operations planning process
- Disseminate medical intelligence to medical elements
- Ensure appropriate medical treatment protocols are disseminated

- Identify specialist teams to respond
- Pre-position evacuation assets to threatened area
- Deploy liaison teams

**A – 2. Protocols During Attack**

Command and Control:

- Disseminate BW reports
- Sound alarm

Detection:

- Redeploy detectors as required
- Collect samples as required
- Forward samples to laboratory
- Continue with close liaison
- Conduct downwind hazard analysis and prediction
- Advise commander of updates

Warning and Reporting:

- Implement warning and reporting procedures
- Immediately report and warn of biological agent attack
- Make and disseminate alarm/protective posture decision

Recce, Survey and Monitoring:

- Implement warning and reporting procedures applicable to detection, sample collection and agent identification
- Forward evidence of biological agent attack to command and medical authorities
- Collect any available aerosol, environmental, zoonotic, medical and clinical samples

Individual Protection:

- Adopt appropriate individual protection

Collective Protection:

- Initiate COLPRO procedures

Medical:

- Initiate medical $C^2$ procedures
- Monitor outbreaks
- Confirm detection system results
- Characterize agents
- Initiate treatment as required

****Information sourced from US/CA/UK Memorandum of Understanding on Chemical and Biological Defensive Material:: Task Force 23.***

# Chapter 6

# Current Protocols

**"Typhus and its brothers and sisters-plague, cholera typhoid and dysentery-has decided more campaigns than Caesar, Hannibal, Napoleon, and all the Generals in history. The epidemics get the blame for defeat, the Generals the credit for victory. It ought to be the other way around.**

***-Hans Zinsser***
***Rats, Lice and History***

## 6.1 Introduction

In the previous chapter, the impact of a BW exposure on medical capabilities was presented. This chapter explores current Canadian biological defence protocols employed to mitigate the effects of such an event.

## 6.2 The Barton Report

One of the first reports to review Canadian biological policy was the Barton Report.[80] The task assigned to the Barton group was to conduct a review of chemical and biological policies and programs of the Department of National Defence. The group considered a myriad of conventions and scientific documents. As an example, it considered the military advantage of BW agents. Additionally, the report further studied scientific advances especially within the areas of biotechnology. Finally, the Barton Report presented the following position: "Canada must retain a modest capability to effect essential defensive research and development to permit the conduct of

[80] The Barton Report was tabled on the 31 Dec 88, and it is a review of Canada's policy of NBCD. It supports Canada's policy of maintaining a defensive biological capability.

conventional military operations under the threat of BW agents."[81] Today, this statement is still valid.

### 6.3 Government Policy

The Government of Canada's Biological policy is defined in the Biological and Chemical Defence Review Committee (BCDRC) 2000 Annual Report and it states, "the policy of the government of Canada is to press for global, comprehensive and verifiable treaties to ban all BW agents.[82] Furthermore, the report states "while the threat from such weapons endures, Canada has an obligation to ensure that members of the Canadian Forces (CF) have adequate training and equipment to protect themselves against exposure to BW agents."[83]

Most importantly, the BCDRC concluded that research and development in the following triad of force protection measures are essential:[84]

1. BW agent detection and identification;
2. Better personal protection; and
3. Prophylaxis and therapy for threat agents.

Government policy clearly indicates that all treaties banning production of BW agents will be honoured, however it also states that proactive research and development must continue to enhance our defensive capabilities within the triad of force protection measures.

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[81] William Barton, Department of National Defence, "In Chemical and Biological Defence, 1989, pg 12
[82] 2000 Annual Report of the biological and chem. Def review committee, pg 2
[83] 2000 Annual Report of the biological and chem. Def review committee, pg 2
[84] the committee made approx 6 recommendations in their priority of effort list, for this paper only three have been id.

## 6.4 Current Doctrine

Over the years Nuclear Biological and Chemical Defence tasks have changed, for example "rather than survive and operate, NATO direction now states: survive the event, mitigate the effects and be prepared to continue operations."[85] The Canadian Forces doctrine now infers that the first principal is to avoid the hazard; this principal consists of pre –attack, attack and post-attack actions to detect, avoid and minimize the effects of a BW exposure. If avoidance fails, then it is essential that a triad of force protection measures be employed (detection, protection, and medical countermeasures), to minimize the effects of a BW exposure.

## 6.5 BW Agent Detection

There are two types of detector systems: point detection[86] and standoff detection.[87] Real-time detection and identification of biological agents poses a significant challenge. At this time, no single technology is able to detect and identify all biological agents. The current concept is to use a number of layered complementary technologies to detect multiple indicators of a BW attack.[88]

The Land Force's current Bio-detection capability is the BIO-Sentry (2556 CF Biological Agent Detection). The BIO –SENTRY is a point detection system. The major drawback with BIO-Sentry is its size, which limits its employability. It is too large for tactical level deployment, and would be best suited in a standoff detection role (i.e.

[85] CF NBC equipment manual, pg 2
[86] Point detection. Is detection and identification at the point within the aerosol of biological material or where the detector system is actually placed.
[87] Standoff detection. Detection and identification at a distance away from the aerosol or from the detector system.
[88] Memorandum of Understanding, On Chemical and Biological Defensive Material, International Task Force 23 Development of a Tri national Bio defence Concept, Updated 2001, III-2.

detection capability for logistical nodes). According to the Land Force Director of Doctrine 8-3[89] (NBC Defence), the land force is requesting a small shoebox size detector that can be vehicle or UAV mounted. Other projects relating to BW agent detection are currently in developmental and trial stage at the Defence Research Establishment Suffield (DRES).[90]

### 6.6 Individual Protection

Doctrinally,[91] all members of the Land Force are to be equipped and trained to survive and operate in a BW environment. NBC protective clothing (Individual Protective Ensemble, IPE) and equipment protects against the effect of an exposure. The level of individual protection is a command decision based upon available intelligence information, and an assessment of the threat. It is important to note "the protective posture selected should reflect the desired balance between the likelihood of exposure to and subsequent infection from a BW agent, and the combat performance degradation likely to arise from operation in IPE."[92]

Individual Protection Equipment (IPE) available is broken down into two areas. First, is Eye/Respiratory Protection. "The respiratory tract is the usual route of biological agent entry into the body and the majority of agents can

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[89] Source

be expected to be delivered in aerosol form. Therefore, measures should be taken to protect the respiratory track and the eyes."[93]

Second, the C 4 Mask with C2/7 canisters is employed to provide skin protection. "The skin is much less vulnerable to biological agent penetration and very few agents pose a percutaneous hazard. Typical lightweight combat clothing will provide sufficient protection from cutaneous anthrax. Only insect vectors and a small number of toxins (e.g. mycotoxins) can have a direct action on the skin or mucous membranes. Individual protective clothing will provide sufficient protection against these toxins and should be donned when their use is likely."[94] The Protective coveralls, boots and gloves protect against biological agents.

### 6.7 Collective Protection

Collective protection (COLPRO) is the process in which groups of individuals are protected form the hazards of a biological event. COLPRO is extremely important when it is operationally unrealistic to avoid the hazard. There are currently three categories of collective protection that are approved by the Canadian Forces:

1. Fixed - fixed in static locations;
2. Mobile – consist of vehicles or ship installed; and
3. Transportable – usually based on tent equipment that is air transportable.[95]

[93]Memorandum of Understanding, On Chemical and Biological Defensive Material, International Task Force 23 Development of a Tri national Bio defence Concept, Updated 2001, pg III-15.
[94]Memorandum of Understanding, On Chemical and Biological Defensive Material, International Task Force 23 Development of a Tri national Bio defence Concept, Updated 2001, pg III-16.
[95] Source of this information is B-GG-005-004/AF-001, pg 3-3-6.

## 6.8 Medical Countermeasures

Medical countermeasures effective against biological agents include pre and post exposure immunization. The current Canadian Forces policy on immunization refers only to immunization limiting the spread of communicable disease.[96] There are other unlicensed drugs/biologics that can be used by the Canadian Forces,[97] when indicated by assessment of the threat. An example of this is the anthrax vaccine.[98] The protocols are as follows:

Pre-exposure: This phase is a matter of preparedness – measures such as inoculation against potential BW threats, i.e. the Anthrax Vaccine; and

Post-exposure: This phase is a matter of treatment and will depend upon a variety of factors such as agent identification, means of delivery and dose. Treatment regimes, such as broad-spectrum antibiotics may be given as a prophylaxis. Vaccines and anti-sera normally given as a pre-exposure measure may also be given during this phase.[99]

## 6.9 Canadian Forces Modernization Plan

Canada is currently undergoing a BW defence modernization program, which will enhance our capabilities in the near and long term. Table 10 provides an overview of Canadian short, mid, and long-term Modernization Strategy.

[96] Medical Directive 1/97, Immunization Policy, 9 April 1997.
[97] Procurement and Reporting Requirements for Surgeon General Restd Products, Particularly Unlicensed Drugs/Biologics, 1605-1(DGHS), 261333Z Jul 99.
[98] The anthrax vaccine project is discussed in detail at Chapter 7.
[99] B-GG-005-004/AF-001, pg 4-2-9.

**Table 10. Modernization Strategy.**

| Capability | Short Term - 2005 | Mid Term - 2010 | Long Term - 2015 |
|---|---|---|---|
| Biological Detection | Fielding of point detection | Networking of point detectors | Standoff detection capability integrated into networked system |
| Respiratory Protection | Maintenance of existing C7 canister/C4 mask | R&D into next generation of respiratory protection equipment | Fielding of next generation of Respiratory equipment |
| Percutaneous Protection | Fielding of Bio garments for hot climates | R&D into next generation NBC protective clothing | Fielding of next generation protective clothing |
| Transportable Collective Protection | Fielding of transportable collective protection shelter for $C^2$ and medical facilities | | |
| Medical Counter measures | Collaborative R&D work into joint vaccination program for a multitude of BW Agents | Fielding of joint vaccination program | |

Source. Canadian Forces Nuclear, Biological and Chemical Defence Concept, 2000-2015, pg A 57/58.

## 6.10 Summary

The Canadian Forces (Land Force) employs a triad of force protection measures to protect personal from a BW event. This triad is detection, protection, and medical countermeasures.

Biological detection. Canadian detection capabilities are effective, but are not at a developmental stage to meet the miniaturized version that is required for land force employment, i.e. for reconnaissance vehicles, and early warning capability. Detection capabilities will in future be enhanced by medical identification and diagnostic capabilities.

Individual Protection. Canadian protective clothing is adequate to meet the protection level required. However, further development is required to reduce the psychological and physical demands of this ensemble. As will be discussed in

subsequent chapters, the United States is moving ahead with new lightweight protective clothing to reduce this burden on personal.

Medical Countermeasures. Immunization of military personal is a function of force protection to counter the effects of BW agents.[100] Therefore, pre and post exposure immunization is essential. Thus, our immunization protocols must clearly state that all members of the Canadian Forces receive vaccinations to match the threat. The following chapter explores an integrated model that employs state of the art technology. This model focuses on the United States Armed Services triad of force protection methods that Canada should explore to improve our biological defence modernization program.

[100] B-GL-300-002/FP-000, Ottawa, 2000, pg 2-10.

# PART III: AN INTEGRATED APPROACH

# Chapter 7

# Force Protection Measures

## An Integrated Approach

**"There is nothing more difficult to take in hand, more perilous to conduct, or more uncertain in its success, than to take the lead in the introduction of a new order of things."**

***Machiavelli, The Prince.***

### 7.1 Introduction

This chapter presents an advanced integrated model of force protection in a BW environment. This model is based upon fielded and future trends within the United States Armed Forces Biological Defense Programme.

### 7.2 An Integrated Approach

Primarily, BW agent detection presents a somber obstacle for military planners. Figure 1 illustrates the imperative of detection as being one of the pillars in an integrated approach of force protection measures to counter a biological threat.

The United States and the United Kingdom have identified the requirement to have point and standoff, real-time, BW agent detection capabilities. In addition, they have placed a high priority on research and development in this capability.[101] With an end-state of detection supremacy, this would reduce casualties and provide early warning for threat areas.

[101]Ali, J., Rodgrigues, L., Moodie, M. Jane's Chemical-Biological Defense Guidebook, Janes Information Group,1997, pg 165.

More importantly, as argued by Jane's Biological Defense Handbook, "given the delay between initial exposure and the emergence of life-threatening symptoms, warning and identification systems will assist in ensuri

The United States Armed Services placed a high priority on the importance of detection capabilities. The schedule of their modernization strategy is as follows: Contamination Avoidance Modernization Strategy for Near (FY 01 – 02), Mid (FY 03-07), and Far (FY 08 – 17). Table 11outlines this modernization strategy.

**Table 11. Modernization Strategy.**

| | Near (FY 01 – 02) | Mid (FY 03 – 07) | Far (FY 08 – 17) |
|---|---|---|---|
| **Biological Point Detection** | -Fixed site defense biological detection Portal shield network sensor system.<br>-Navy-ship based Interim Biological Agent Detector (IBAD).<br>-Army-Biological Integrated Detection System (BIDS).<br>-Portal Shield network sensor system to protect high value fixed sites against BW attacks.<br>**NOTE: 1. All programs shown are joint or multi-service.** | -Automatic long lines source and point/mobile biodetection to detect and identify bio-agents; programmable (JBPDS Block I).<br>-Complete development of Block II JBPDS – increase number of agents detected and identified with increased sensitivity, lower false positive rates; smaller and lighter with increased reliability. | -Automatic point detection biodetection, to detect and identify; programmable (JBPDS Block II)<br>-Automated, integrated detection of both biological and chemical agents in a single senor package (Joint Modular Chemical/Biological Detector System, JMCBDS)<br>Detection of CB contamination in water (Joint Chemical Biological Agent Water Monitor, JCBAWM) |
| | Source: Detection Modernization Strategy was extracted from: CB Defense Requirements and Programs. July 2001. | | |

The essence of their modernization push is to keep pace with the asymmetric threat. Therefore, the United States Armed Services are concentrating their efforts on providing operational units "real-time capabilities to detect, identify, quantify, and warn

against all biological threats."[104] Unfortunately, scientific data supports the conclusion that real-time detection is unlikely in the near to mid-term.[105]

To better appreciate detection capabilities, the paper examines several systems that are part of the modernization program: a near-term project (Biological Integration System, BIDS) and a mid-term project (Joint Biological Standoff Detection System, JBSDS, which has two sub-sets Point and Standoff Detection).[106]

### 7.3 M31 Biological Integrated Detection System (BIDS)

### Non-Developmental Item (NDI) & Pre-Planned Product Improvement (P3I).

BIDS utilizes a multiple technological approach, both developmental and off-the-shelf material to detect biological agents with a maximum accuracy.[107] It is a vehicle – mounted, fully integrated biological detection system. The system is an over pressurized, HMMVW-mounted S788 shelter, which is modular. The most interesting aspect of its technology is that it has modular component replacement, which will exploit the concept of leap a-head technologies.[108] According to tested variants, the NDI is capable of detecting and identifying four Biological agents concurrently in less than 45 seconds.[109]

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[104] Department of Defense, Chemical and Biological Defense Programme, Report to Congress, July 2001, pg 29.
[105] Department of Defense, Chemical and Biological Defense Programme, Report to Congress, July 2001, pg 29.

[106] Biological Point Detection is a fully cooperative acquisition effort chartered to develop new biological point detection systems for the four US, Army, Navy, Air force, and Marine Corps. It involves the development of an integrated system as well as numerous stand-alone biological detectors.
[107] Department of Defense, Chemical and Biological Defence Programme, Report to Congress, July 1999, pg A-2.
[108] Department of Defense, Chemical and Biological Defence Programme, Report to Congress, July 1999, pg A-2.
[109] Department of Defense, Chemical and Biological Defence Programme, Report to Congress, July 1999, pg A-2..

[110] In addition, the P3I BIDS is capable of detecting and identifying eight Biological agents simultaneously in 30 minutes.[111]

To summarize, BIDS is a lightweight, vehicle mounted detection capability that offers flexibility in detecting multiple agents in a short time span. BIDS would be an ideal system for the Canadian Land Force's reconnaissance LAV/Coyote variants.

### 7.4 Joint Biological Point Detection System (JBPDS).

This system is currently under development and when complete it will replace all existing biological detection systems (BIDS, IBAD and the Joint Portal Shield Network System).[112] It provides biological detection throughout the US services and throughout the battle space.

It consists of a suite which will conduct four functions: trigger (which will detect a significant change in the ambient aerosol in real time), collection (collects samples of the suspect aerosol for analysis by the JBPDS, and confirmatory analysis by supporting laboratories in the planned product improvement (P3I) phase.[113] [114]

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[110] Thirty –eight BIDS NDI were fielded to the 310th Chemical Company (U.S. Reserve) during FY 96. This gave DoD its first credible, rapidly deployable biological detection capability. Of important note BIDS is a Corps level asset.
[111] Department of Defense, Chemical and Biological Defense Programme, Report to Congress, July 2001.
[112] Department of Defense, Chemical and Biological Defense Programme, Report to Congress, July 2000, pg, A-15.
[113] Department of Defense, Chemical and Biological Defense Programme, Report to Congress, July 2000, pg, A-15.
[114] The NDI system is able to detect and track man-made aerosols out to 30 kms, but is non-eyesafe out to about 2.5 kms.

### 7.5 Joint Biological Standoff Detection System (JBSDS).

The final detection system to review is the Joint Biological Standoff Detection System (JBSDS).[115] [116] This system provides early standoff warning and biological detection. Once operational this system will provide near real time detection, on the move, at fixed sites, or when mounted on multiple platforms.[117] Equally as important, this system provides early warning via the Joint Warning and Reporting System (JWARN). JWARN is an automated Nuclear, Biological, and Chemical (NBC) Information system. It integrates the data from NBC detectors and sensors into Joint Service Command, Control, Communications, Computers, Information and Intelligence systems and networks on the digitalized battlefield. This system will provide the operational commander with a capability to employ NBC warning to minimize the risk of weapons of mass destruction.[118] One of the essential elements of this system is that it is able to augment and integrate with other biological detection systems. Finally, from a $C^2$ perspective, commanders could possibly integrate JBSDS within the Intelligence Preparation of the Battlefield (IPB) process, thereby allowing for better warning and reporting procedures.

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[115] The Joint Biological Remote Standoff Detection System (JBSDS) program is intended to give the operational and tactical commander a much improved and shorter decision cycle regarding a biological exposure. Therefore, the commander will be able to react quicker, thereby allowing more personnel the opportunity to don protective clothing and seek other hardened shelters. Ultimately, this will reduce BW casualties, and fewer people will have to take post-exposure medical countermeasures.

[116] Even though not discussed in detail, it is important to note another system JBREWS, which is considered as the system of systems. It is totally integrated, and more robust than JBSDS. The detectors may be employed in numerous ways: vehicle, or as a site detector. Due to its robust capability it would be ideal for point detection at a medical facility.

[117] Department of Defense Chemical and Biological Defense Program, Annual Report to Congress and Performance Plan, July, 2001.

[118] Department of Defense, Chemical and Biological Defense Programme, Report to Congress, July 2001.

## 7.6 Detection: *Bacillus anthracis*

As discussed in earlier chapters, the anthrax bacterium is easily weaponized and is best distributed as an aerosol cloud.[119] The primary difficulty in detecting agent aerosols such as anthrax stems from distinguishing the aerosol from the background organic matter normally present in the atmosphere.[120] Because of this difficulty, detection methods must still be used in conjunction with other force protection measures.

## 7.7 Summary of Detection

The United States Armed Services have placed a high priority on developing detection technology in order to maintain a credible biological defence strategy. As a result of this:

1. United States Armed Services have a robust BW agent detection capability;
2. Strategic and operational level planners can integrate BW agent detection and warning within their operations planning process (it is important to note that the US forces consider that early detection and warning is the key to avoidance);[121]
3. Their detection systems are interoperable with all services command and control systems;[122]
4. Their systems are capable of providing automated biological discrimination;[123]
5. Detectors are ideal for deployment at logistical nodes i.e. medical facilities;

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[119] According to the Centers for Disease Control and Prevention, aerosol delivery systems for biological agents most commonly generate invisible clouds with particles or droplets of < 10 micrometers (μm).
[120] Centers for Disease Control and Prevention, Biological Warfare and Terrosim: The Military and Public Health Response, Satellite Broadcast, 21-23 September 1999, pg 75.
[121] Department of Defense Chemical and Biological Defense Program, Annual Report to Congress, pg 29.
[122] Department of Defense Chemical and Biological Defense Program, Annual Report to Congress and Performance, July 2001, pg A 16
[123]Department of Defense Chemical and Biological Defense Program, Annual Report to Congress and Performance, July 2001, pg A 16

6. Further research and development is required to close the detection gap between BW agents and background organic matter; and
7. Better detection means fewer casualties, therefore less personnel requiring medical countermeasures.

The next factor in the force protection triad is protection. As illustrated at Figure 2, protection contains two sub-sets –individual and collective protection.

### 7.8 Individual Protection

Along with detection technology, the United States is also pursuing technological advances to improve individual protective equipment. Individual protective equipment includes protective mask[124] and clothing. The future evolution of this equipment will provide dependant upon protection from emerging asymmetric threats on the battlefield such as genetically altered BW agents, and from toxins. Likewise, there is also the requirement to produce a suit, which reduces the physiological and psychological burden of donning the ensemble for prolonged periods.[125]

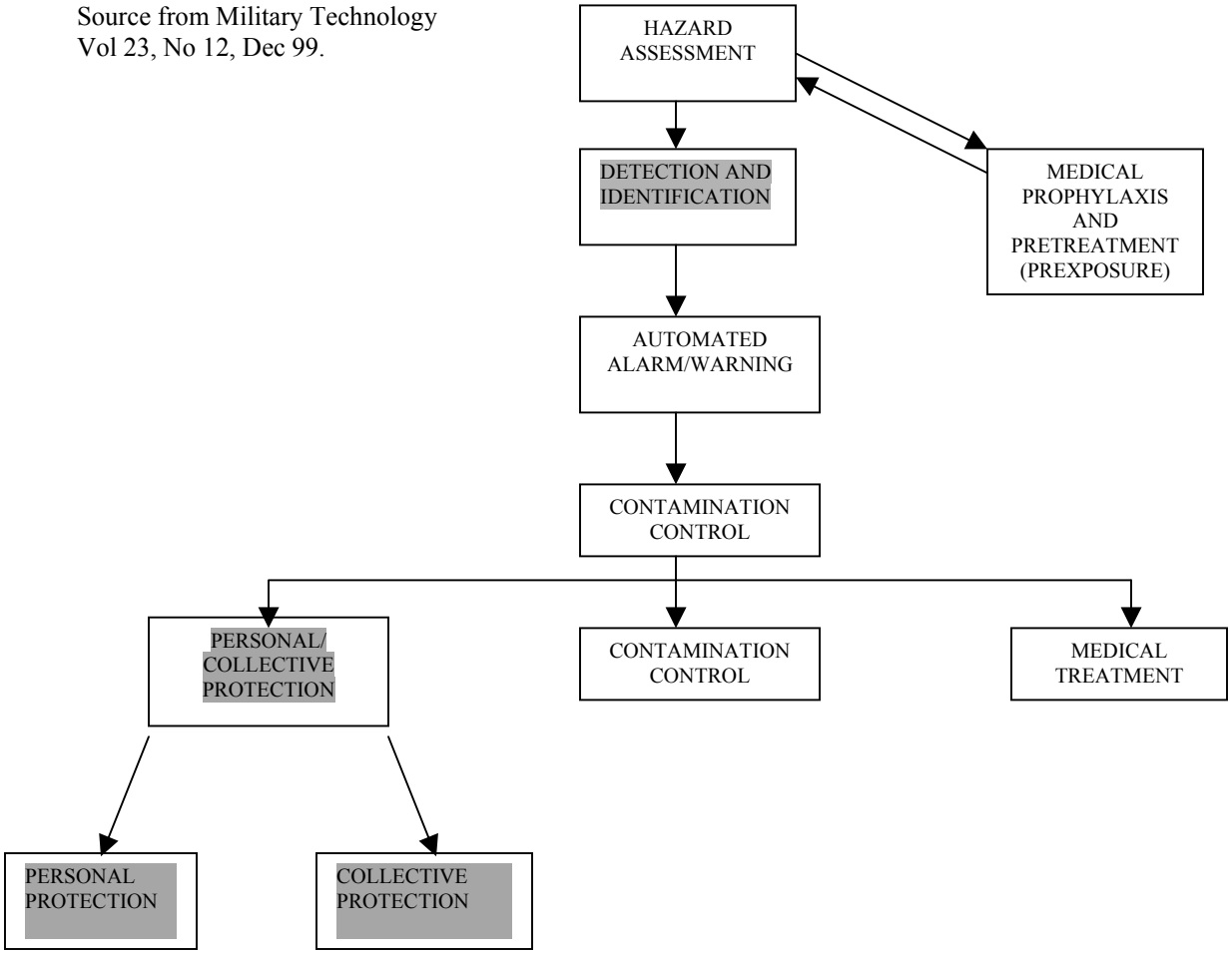
The latest development in over garment protection is the Joint Service Lightweight Integrated Suit Technology (JSLIST). This new technology provides prolonged protection of up to 24 hours after 45 days of wear and six launderings.[126] It is

[124]As outlined in the Annual Report to Congress, July 2001, Technology advances are being pursued to produce mask systems that provide fully compatible vision capabilities, laser/ballistic protection, and further the reduction in logistics and physiological burden.
[125]Department of Defense Chemical and Biological Defense Program, Annual Report to Congress and Performance, July 2001, pg A 16.
[126] Department of Defense, Chemical and Biological Defense Program, Report to Congress, July 2001, pg B7.

designed with an activated carbon bead technology, which replaces the bulky activated carbon technology of previous suites.[127] [128]

**Figure 2: An Integrated Approach.**

Source from Military Technology
Vol 23, No 12, Dec 99.




[127] Department of Defense, Chemical and Biological Defense Program, Report to Congress, July 2001, pg B7.

[128] Currently, the Battle Dress Overgarment (BDO) is principal suite for the Army. BDO is camouflage patterned (desert and woodland), it is two piece and typically worn over combat clothing. The BDO still uses the activated charcoal system, and it is cumbersome. It has a life expectancy of wear of 22 days, extendable to 30 days at the discretion of the commander.

## 7.9 Collective Protection (COLPRO)

The aim of collective protection is the application of overpressure to mobile or fixed command posts, medical facilities as well as other key vital points, in order to offer protection for personnel in a biologically contaminated environment.[129]

The latest COLPRO capability is the Chemically/Biologically Hardened Air Transportable Hospital (CHATH), which includes the Chemical/Biological Hardened Air Management Plant (CHAMP). This is a United States Air Force program with a joint effort with the United States Army. The aim of this production is to enable medical personnel to deploy and setup in chemical and biological threat environments;[130] and to be able to work in a toxic-free environment without wearing protective clothing.

The CHAMP filters greatly increase the capability of this system. They filter chemically and biologically contaminated air, and it re-circulates and filters interior air to maintain a clean hospital standard, allowing for the provision of heating, cooling and over-pressurization.[131] This hospital can deploy in increments of 10, 25, and 50 beds,[132] [133] which allows it maximum flexibility in establishing a medical foot print on the ground, thereby permitting Role 3 medical support as far forward as possible.

As with detection, protection is going through a modernization strategy as shown in Table 12.

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[129] Center for Disease Control and Prevention, Biological Warfare and Terrorism, pg 76.
[130] Department of Defense, Chemical and Biological Defense Program, Report to Congress, July 2001, pg B-14.
[131] Department of Defense, Chemical and Biological Defense Program, Report to Congress, July 2001, pg B-14.
[132] Department of Defense, Chemical and Biological Defense Program, Report to Congress, July 2001, pg B-14.
[133] The United States Armed Forces have other fielded systems such as: CB Protected Shelter (CBPS), this is a highly mobile, rapidly deployable shelter system. And, the Chemically Protected Deployable Medical System (CP DEPMEDS) this is a joint effort with the US Air Force. The plan is to insert environmentally controlled collective protection into currently fielded hospital shelters. Ibid, pg, B-14.

**Table 12. Protection Modernization Strategy.**

| | NEAR (FY 01 – 02) | MID (FY 03 – 07) | FAR (FY 08 – 17) |
|---|---|---|---|
| **INDIVIDUAL EYE/ RESPIRATORY** | -Voice amplification; laser/ballistic eye protection | -Reduced physiological and psychological burden, improved comfort, enhanced optical and communications | -Advanced Integreated Individual Soldier Protection system (Future Soldiers System) |
| **INDIVIDUAL CLOTHING** | Advanced protective suite technology; lighter, improved agent protection. | | |
| **COLLECTIVE PROTECTION** | -Chemically hardened Air Transportable Hospital (CHATH)[134] -Army – NBC protection for tactical medical units | -Improved filters to extend filter life, reduce maintenance. -Reduce logistic burden, improved protection. -Support to medical treatment in a CB environment for Airborne and Air Assault. | -Family of advanced protective filtration systems for vehicles, shelters, ships and light forces. |

**Source: Material was sourced form Department of Defense Chemical and Biological Defense Program, Annual Report to Congress July 2001.**

1. All programs shown are joint or multi-service.

## 7.10 Protection: *Bacillus anthracis*

If detection fails or personnel must operate in a contaminated environment then advanced protection measures are required. Since the most important route of exposure to the anthrax bacterium is through inhalation, it is mandatory that protective masks are available and functional. As well, if the anthrax bacterium is disseminated as a powder or solid, IPE such as the JSLIST must be available.

[134] Even though it indicates chemical, this COLPRO system would be effective in the event of a biological exposure.

### 7.11 Summary of Protection

The United States Armed Services continue to develop new and improved methods of personal and collective protection to match the BW threat. As with detection they have placed a high priority on developing lightweight and easily transportable protective equipment that adds to the strong integrated approach to force protection. As a result of this:

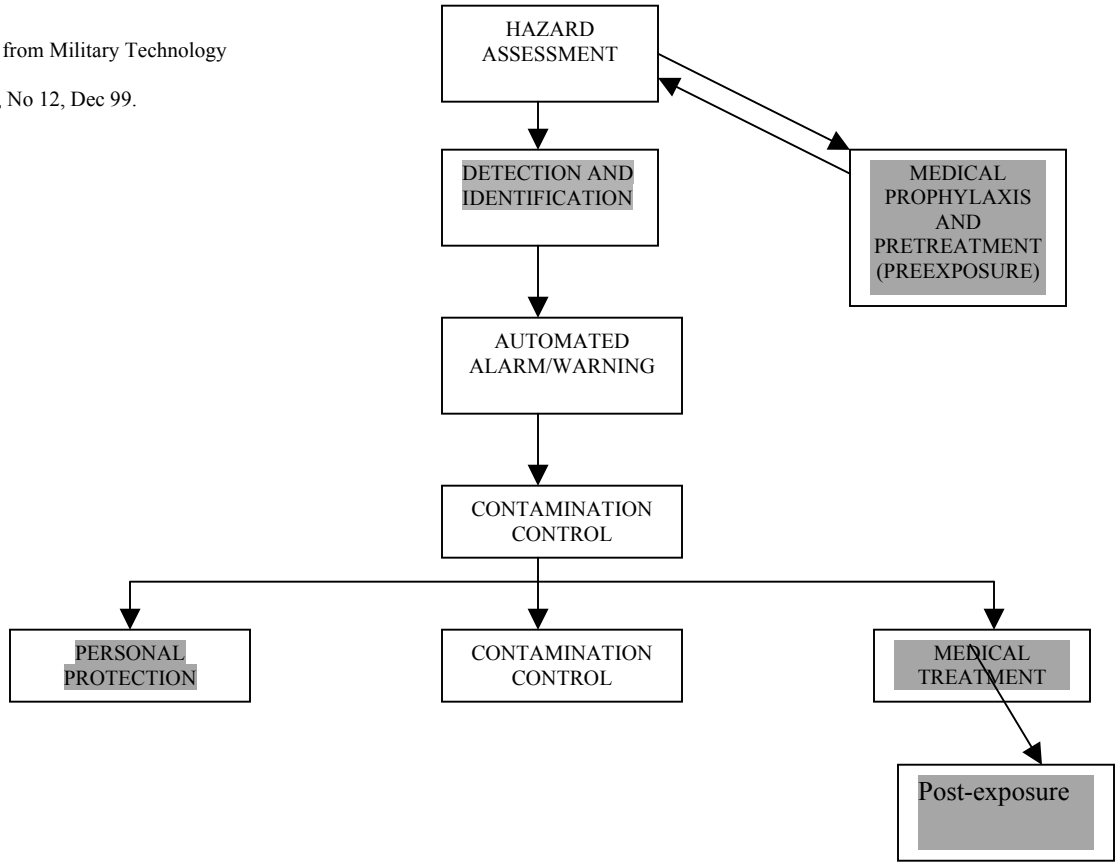
1. United States Armed Services have a robust biological protection capability;
2. Enhanced CB suites are light which helps to reduce the physiological heat burden and psychological burden;
3. Joint service efforts to ensure joint operability;
4. Better protection means fewer causalities, therefore less personal requiring medical countermeasures;
5. Chemically/Biologically Hardened Air Transportable Hospital (CHATH) allows medical staff to work in a toxic-free environment, without wearing protective suites – which facilitates maintaining a high standard of medical care;
6. With the addition of Chemical/Biological Hardened Air Management Plant (CHAMP) to the CHATH project, surgical support can deploy closer to operational maneuver units in a BW threat environment, and deploy in increments of 10, 25, 50 beds; and
7. Operational medical planners will have greater flexibility in establishing a medical footprint to support the deep, close and rear battle.

The final portion of the force protection triad is medical countermeasures as illustrated at Figure 3.

**Figure 3: An Integrated Approach**

Source from Military Technology

Vol 23, No 12, Dec 99.




The United States Forces, Joint Medical Biological Defense Research Program (JMBDRP), is moving ahead with highly sophisticated projects for improving and for developing products and technologies to better protect soldiers, sailors and airmen from the effects of BW agents. These products include multi-agent vaccines capable of

reducing costs and immunization cycles. They also include simple diagnostic tools to quickly identify agents.[135]

As with other force protection measures, medical countermeasures also have a Modernization Strategy as outlined at Table 13. This modernization strategy is forward looking with an aim to developing multi-agent vaccines and second-generation recombinant capabilities that reduce the threat of BW agents.

**Table 13. Modernization Strategy.**

| | Near (FY 01-02) | Mid (FY 03 – 07) | Far (FY 08 – 17) |
|---|---|---|---|
| Medical Biological Defense | -Anthrax Vaccine amendment for new dosing schedule | -Licensed smallpox (vaccinia, virus, cell culture-derived) vaccine<br>-JBAID-Joint Biological Agent Identification and Diagnosis System | -Licensed Next Generation Anthrax vaccine<br>-Licensed new Plague vaccine<br>-Licensed new Venezuelan Equine Encephalitis (VEE) vaccine<br>-Multi-agent Vaccine delivery system<br>-Portable Common Diagnostic System |

**Source: Department of Defense Chemical and Biological Defense Program, Annual Report to Congress, July 2001.**

Included with this strategy are three areas of research that the Joint Medical Biological Defence Research Program is pursuing:

> 1. Pre-exposure Countermeasures: This area involves prophylactic measures undertaken to prevent illness and injury associated with exposure to bacterial, viral, and toxin threat agents. The primary focus of pre-exposure therapy is the production of effective vaccines. The roles of various factors in stimulating cellular and humoral immunity are determined through safe study of specific genes or properties of threat agents. This knowledge provides tools for development of second-generation recombinant or multi-agent vaccine candidates as well as pretreatment therapies to intervene in the pathogenic effects of threat agents;[136] and
>
> 2. Post-exposure Countermeasures: Research efforts in this area

[135] Department of Defense Chemical and Biological Defense Program, Annual Report to Congress, July 2001, pg 57.
[136] Department of Defence Chemical Biological Defense Program, Annual Report to Congress, July 2001, pg 59.

> focused on developing safe, effective treatments to alleviate disease or injury associated with exposure to bacterial, viral, or toxin threat agents. Therapeutic measures may involve administration of anti-microbial, anti-viral, anti-toxin or generic compounds formulated to intervene at the pathogen's site of action. The knowledge necessary to develop such products required in-depth research in basic pathogenesis and physiology of biological agents. These analyses will afford researchers tools to create a universal approach in treating post-exposure casualties of a biological attack.[137]

### 7.12 Bacillus anthracis: Medical Countermeasures
### Pre-exposure

The anthrax vaccine[138] licensed in 1970 protects against anthrax and it has a safety record comparable to other vaccines.[139] The evidence that supports the vaccine effectiveness against aerosol exposure to anthrax spores is convincing.[140] The data accumulated indicates that the vaccine has an "effectiveness of 92.5 percent with a lower 95 percent confidence limit of 65 percent."[141]

From a force protection consideration, anthrax vaccination to personnel assigned to high-risk deployments, or for personnel preparing for contingency operations should be mandatory. This consideration should not be optional, because exposure to anthrax is

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[137] Department of Defense Chemical and Biological Defense Program, Annual Report to Congress, July 2001, pg 59.

[138] The US federal government on 4 November 1970 licensed the anthrax vaccine given to the U.S. forces. For more than 30 years, anthrax vaccine has been recommended for at-risk veterinarians, lab workers and others at occupational risk. According to statistics 150,000 U.S. servicemen and women received the anthrax vaccine in 1991 during the Gulf War. On 15 Dec 1997, the Secretary of Defense, United States Government, approved the plan to immunize the Total Force against anthrax, contingent on four conditions: supplemental testing of vaccine lots, approval of purity, sterility, and safety consistent with Food and Drug Administration (FDA) standards, tracking system, and a review of the health and medical aspects of the program. Each of these conditions was fulfilled. Source of this information is taken from: Department of Defense, Information About Anthrax Vaccine Immunization Program (AVIP), Office of the Army Surgeon General, 15 Aug 01.

[139] Department Defense, Information About the Anthrax Vaccine and the Anthrax Vaccine Immunization Program (AVIP), Office of the Surgeon General, [www.anthrax.osd.mil/Site_fi…d_products/Infopaper.htm], Aug 2001, pg 1.

[140] Department Defense, Information About the Anthrax Vaccine and the Anthrax Vaccine Immunization Program (AVIP), Office of the Surgeon General, pg2.

[141] P. Brachman, MD., H. Gold M.D., S. Plotkin M.D., F. Fekety, M.D., M. Werrin, D.V.M., F.A.P.H., N. Ingraham, "Field Evaluation of A Human Anthrax Vaccine," Original Citation Published in American Journal of Public Health Volume 56 pg 632-645.

a critical vulnerability in the commander's planning process, and this could ultimately affect the success of the mission.

Therefore, based upon a risk assessment, pre-exposure anthrax vaccination[142] should be mandatory to protect the integrity of the fighting force. This medical countermeasure is safe and effective means of protecting personnel from anthrax.[143]

### 7.13 Medical Countermeasures: Post –exposure

Considering the invasiveness of inhalation anthrax, early antibiotic administration is critical. This goal can be difficult to meet because microbiologic diagnosis of anthrax is slow.[144] [145] Experience in the treatment of inhalation anthrax is very limited, but it is recommended that the normal antibiotic regimes noted for sepsis be administered.[146]

The current treatment regime for post-exposure anthrax is ciprofloxacin,[147] and if personnel are unvaccinated, a single 0.5 ml dose of anthrax vaccine should be given.[148] It is also recommended that casualties receive medical care upon discontinuation of the

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[142] Source for the following data is taken from the Medical Management of Biological Casualties Handbook, US Army Medical Research Institute of Infectious Diseases, September 1999, pg 13. The vaccination series consists of six ml doses SC at 0, 2, and 4 weeks, then 6, 12, and 18 months followed by yearly boosters.

[143] Even though outside the scope of this paper, it is important to note that research and development is continuing to produce multi-agent vaccines for biological threat agents. The aim is to produce a vaccine or a delivery system that could be used against a wide range of biological agents. These vaccines would be analogous to commercial multi-agent vaccines i.e. the measles-mumps-rubella vaccine. This concept would give the health services greater flexibility in immunizing members preparing for high-risk deployments.

[144] T. Inglesby, M.D., et al, "Anthrax as a Biological Weapon: Medical and Public Health Management," Journal of American Medical Association," Vol 281, No 18, May 1999, pg 1740.

[145] One also must consider the post-exposure management /decontamination of casualties. As an example handling of contaminated clothing, minimal agitation of clothing, the wearing of protective barriers, and the decontamination of surfaces.

[146]Inglesby, M.D., et al, "Anthrax as a Biological Weapon: Medical and Public Health Management," Journal of American Medical Association," Vol 281, No 18, May 1999, pg 1740.

[147] As outlined in note 48, the recommended therapy for a mass casualty anthrax scenario is Ciprofloxin, 500mg by mouth every 12 hours for 60 days.

[148] Medical Management of Biological Casualties Handbook, US Army Medical Research Insitute of Infections Diseases, September 1999, pg 13.

antibiotics, from a fixed medical facility with intensive care capabilities.[149] This alone would degrade the operational capabilities of the health services; therefore, pre-exposure anthrax vaccination of all personnel, particularly medical personnel, is vital to ensure the continuum of medical care.

### 7.14 Summary of Medical Countermeasures

Medical countermeasures are a vital factor in the triad of force protection measures. Medical countermeasures ensure that the health of a military force remains at a high standard in a high-risk environment, and would reduce additional strain on health service resources.

### 7.15 Summary

In this chapter, a discussion for an integrated approach (which entails: detection, protection, medical countermeasures) to BW defence was presented. In addition, the chapter discussed current stratagems developed by the United States Armed Services to illustrate the triad of capabilities that are the key to countering the BW threat.

The end-state of this integrated process is to protect the force. The Canadian Forces would benefit from the concepts presented as their application would better protect our fighting strength.

[149]Medical Management of Biological Casualties Handbook, US Army Medical Research Insitute of Infections Diseases, September 1999, pg 14.

# Chapter 8

# A Comparative Study and Conclusion

**"I'm not afraid of dying.**
**I just don't want to be**
**there when it happens."**

***Woody Allan***

## 8.1 Introduction

The paper now, by means of a decision-making matrix compares BW agent force protection capabilities of the United States, United Kingdom and Canada.

## 8.2 Existing Capabilities

The best defence against a BW exposure is a developed integrated force protection strategy. The development of this strategy may include collaboration with our allies. Therefore, to develop this stratagem an analysis of current capabilities based upon the biological force protection capabilities is presented at Table 14.

**Table 14. Comparative Study (BW agent is Bacillus anthracis)**

| Scoring is based upon: fielded vs non-fielded, deployable, interoperable, size, and capability. Maximum score is 5 points. | United States | | UK | | Canada | |
|---|---|---|---|---|---|---|
| | Capability | Score | Capability | Score | Capability | Score |
| Detection | Biological Integrated Defense System (BIDS) Joint Biological Detection System (JBPDS) | 5 | Prototype Biological Detection Systems (PBDS) | 3 | Canadian Integrated Bio/Chem Agent Detection System (CIBADS) FLAPS | 3 |
| Individual Protection | Joint Service Lightweight Integrated Suite (JSLIST) | 5 | S10 Respirator NBC No 1 Mk IV suit | 4 | C 4 Mask Individual Protective Clothing | 4 |
| Medical Counter Measures | Anthrax Vaccine Antibiotic therapy | 5 | Biological Agent Treatment Sets (BATS) | 3 | Anthrax Vaccine Antibiotic Therapy | 5 |
| Total Score | | 15 | | 10 | | 12 |

Based upon the Comparative Study, the following conclusions may be drawn:

1. United States Armed Services has a greater integrated BW force protection capability;
2. United Armed Services detection (current and future) capabilities are more technologically advanced and field deployable when compared with the UK and Canada;
3. JSLIST is a superior protective suite against BW agents; also it is lightweight and not as cumbersome as are the UK and Canadian protective suites; and
4. Finally, the United States Armed Services has a more robust, proactive medical counter measures program. Their driving strategy is force protection via immunization before deployment i.e. AVIP, and failing that they have available antibiotics to treat BW casualties. Canadian policy is less robust, as laid down in Chapter 6.

**8.3 Muti-national Approach**

At present, International Task Force 23[150] has determined that a multi-national bio-defence concept is required to allow for the development of doctrine, procurement of equipment, and shortfalls in research and development.[151] The Task Force further recommended that effective biological defence requires a clearly defined national

[150] The International Task Force 23 was organized after the Gulf War to identify shortfalls in BW Defence and allow for the development of doctrine.
[151] Memorandum of Understanding, On Chemical and Biological Defensive Material, International Task Force 23 Development of a Tri national Bio defence Concept, Updated, 2001, pg 1.

strategy and an effective co-operation in the military fields.[152] With this, collaborative and cooperative programs should continue to control resources, increase and improve research/ interoperability, and enhance overall capabilities.

### 8.4 Future Canadian Trends

BW agents continue to pose an ever-present danger to the Canadian Land Force on peacekeeping or peace enforcement operations. Within the triad of force protection measures (detection, protection and medical counter measures), Canada is moving ahead with research and development to enhance our capabilities. However, future research and development as well as new doctrine and training initiatives should concentrate on the following areas:

1. A fully integrated system which is part of the operations planning process;
2. Joint /multi-national doctrine;
3. A capability to quickly and effectively identify BW agents;
4. Reconnaissance capability built into LAV[153]/Coyote[154] variants;
5. An enhanced COLPRO;
6. Light weight or miniaturized detection capability;

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[152] Memorandum of Understanding, On Chemical and Biological Defensive Material, International Task Force 23 Development of a Tri national Bio defence Concept, Updated, 2001, pg III-1.

[153] The LAV III is a key component of the Army's leading edge battlefield systems. This state-of-the-art Light Armoured Vehicle is a fast, well-armed, well protected infantry troop carrier. It can be used in all weather conditions, in normal battlefield smoke, at night and on most types of terrain. The LAV III will give a vehicle commander many more options in both combat and non-combat situations. For example the commander may choose to keep the troops mounted and protected while using the 25-mm stabilized cannon – an option not available in previous vehicles. The driver and the commander have computer display terminals for the Tactical Navigation System (TACNAV), as well as the thermal viewers. The TACNAV links a Global Positioning System (GPS) with a digital magnetic compass and laser range finder. Currently, there is no Biological agent detectors mounted.

[154] The Coyote is a vital component of the Army's leading-edge battlefield systems. This highly mobile, well-armed, and well protected reconnaissance variant of the Light Armoured Vehicle family is employed in the conduct of battlefield reconnaissance and surveillance system provides an all-weather, day and night capability to the Army. As with the LAV III there is no Biological agent detectors mounted on this vehicle.

7. A light weight individual protective ensemble; and
8. A medical countermeasures policy, which concentrates on the next generation of vaccines. These vaccines are part of the AVDP and the future JBAIDS cooperative project with the United States. Future trends should focus on interoperability and commonality with the United States.

**8.5 Summary**

In this chapter, a comparative study was presented. It demonstrated that the US biodefence capabilities surpass that of the UK and Canada. To date, Canadian R & D and doctrine development is moving ahead with the intent of fielding an integrated biological defence capability. Working groups such as Task Force 23 are committed to a collaborative approach to enhancing biological defence capabilities. Future trends call for an integrated and aggressive biological defence posture.

**8.6 Conclusion**

In this thesis I have presented the case that a triad of force protection measures are mandatory factors in a successful biodefence program. BW is a multifaceted concept that forms part of the group of weapons of mass destruction. Throughout the millennia adversaries employed pathogens and toxins. This ancient form of warfare is now part of a revolution in technology whose sole existence it to either kill or incapacitate its victims. Despite international prohibitions to the possession and use of BW weapons, numerous nations as cited in this paper have or are acquiring this capability. Because of this, BW presents an immediate threat to members of the Canadian Forces.

Currently, the Canadian Forces employs a triad of force protection

measures, which provides an inadequate level of protection. With this level of protection, deployed personnel are at great risk. As this paper demonstrated, the effects of a BW agent exposure on a medical unit would greatly reduce its capability. Therefore, in the near future, it will be mandatory for the Canadian Forces to work closely with our allies to ensure that our force protection measures are technological advanced and offer the maximum allowable protection.

## Glossary

**aerosol**. Biological agents can be delivered effectively by a wide range of platforms. The agent can be formulated as either a liquid or dry powder fill. The dissemination can be performed using simple or sophisticated spray devices or by an explosive charge. Most forms of aerial delivery including bombs, shells, missiles and aircraft (usually low flying), sprays can be deployed, however spray devices can be effective from ground level. Depending on the efficiency of the delivery system used: some agent may be destroyed at the time of release; larger particles will fall to the ground producing local contamination and respirable particles generated will present predominantly as an inhalation hazard traveling distances downwind.[155]

**anthrax.** Primarily a disease of lower animals transmissible to man caused by the spore-forming bacterium, ***Bacillus anthracis.***[156]

**antibiotic.** A substance that inhibits the growth of or kills microorganisms**.**

**asymmetric.** In its basic form asymmetric threats are a version of not fighting fair, This may include the use of a variety of stratagems at the strategic and operational levels, and also in the use of weapons systems that are employed in an unorthodox manner.[157]

**Bacillus anthracis**. Is an aerobic, gram-positive, spore forming, nonmotile Bacillus species that causes infectious anthrax in animals.[158]

**bacteria.** Single-celled organisms that multiply by cell division and that can cause disease in humans, plants or animals.[159]

**BCDRC.** Biological and Chemical Defence Review Committee.

**Biological Agent (BA).** The NATO definition of a biological agent is: a microorganism (or toxin derived from it) which causes disease in man.[160]

**Biological Warfare (BW).** Biological warfare is the employment of biological agents

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[155] NATO Handbook on the Medical Aspects of NBC Defensive Operations, Part II – Biological, Janurary 2001, pg 1-5.
[156] William Burrows, "Textbook of Microbiology," W.B. Saunders Company, 1959, pg 577.
[157] M. Dando, "Biological Warfare in the 21st Century: Biotechnology and the Proliferation of Biological Weapons, Brassey's, 1994, pg 1.
[158] Journal of American Medical Association, "Anthrax as a Biological Weapon," Vol. 281 No. 18, May 12 1999, pg 2.
[159] Chemical and Biological, Radiological Incident Handbook, pg 9.
[160] NATO Handbook on the Medical Aspects of NBC Defensive Operations, Part II – Biological, January 2001, pg 1-1.

to produce casualties in man or animals and damage to plants or material. The NATO definition then continues, to include, "or defence against such employment.

**Biological Weapon**. A biological weapon is an item of material, which projects, disperses, or disseminates a biological agent; including for example, arthropod vectors.[161]

**BWC**. Short name: "Biological and Toxin Weapons Convention."
Long name "Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction."

**causative agent.** The organism or toxin that is respondsible for causing a specific disease or harmful effect.[162]

**fungi**. Any group of plants mainly characterized by the absence of chlorophyll, the green coloured compound found in other plants. Fungi range from microscopic single-celled plants (such as molds and mildews) to large plants (such as mushrooms).[163]

**host**. An animal or plant that harbors or nourishes another organisms.[164]

**incapacitating agents.** Produce temporary physiological and/or mental effects via action on the central nervous system. Effects may persist for hours or days, but victims usually do not require medical treatment. However, such treatment speeds recovery.[165]

**incubation Period**. The time between exposure and the appearance of symptoms is known as the incubation period.[166]

**infectivity**. The infectivity of an agent reflects the relative ease with which Microorganisms establish themselves in a host species. Pathogens with high infectivity cause disease with relatively few organisms, while those with low infectivity require a larger number. High infectivity does not necessarily mean that the symptoms and signs of disease appear more quickly, or that the illness is more severe.[167]

**Joint Venture 2020**. Strategic level vision for the United States Armed Services.

**Operations Planning Process.** The operations planning process is a coordinated process

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[161] Ibid, pg 1-1.
[162] Chemical, Biological, Radiological Incident Handbook, 1998, pg 10.
[163] Ibid, pg 10.
[164] Ibid, pg 10.
[165] Ibid, pg 8.
[166] NATO Handbook on the Medical Aspects of NBC Defensive Operations, pg 1-3.
[167] Ibid, pg 1-3.

to determine the best method of accomplishing assigned operational tasks or of planning for possible future tasks.

**line-source delivery.** A delivery system in which the biological agent is dispersed from a moving ground or air vehicle in a line perpendicular to the direction of the prevailing wind.[168]

**point-source delivery.** A delivery system in which the biological agent is dispersed from a stationary position. This delivery method results in coverage over a small area than the line-source system.[169]

**mycotoxin.** A toxin produced by fungi.

**pathogen.** Any organism (usually living) capable of producing serious disease or death, such as bacteria, fungi and viruses.[170]

**pathogenicity**. This reflects the capability of an infectious agent to cause disease in a susceptible host.[171]

**plague.** Caused by bacteria, occurs in humans in three forms. The most common is bubonic plague, a highly fatal disease.[172]

**rickettsia.** Short rods, no flagella or capsules, but an outer layer of amorphous material is occasionally seen with an electron microscope. Growth takes place in cytoplasm. Human beings are the reservoirs of the type species, incidental hosts of the other species. Small rodents and other vertebrates serve as reservoirs.[173]

**SIPRI**. Stockholm International Peace Research Institute.

**spores.** A resistant body formed by certain microorganisms.[174]

**Tartars**. Natives of Central Asia, member of a group of peoples including Turks, and Mongols.[175]

**toxicity**. A measure of the harmful effect produced by a given amount of a toxin on a living organism. The relative toxicity of an agent can be expressed in milligrams of toxin needed per kilogram of body weight to kill experimental animals.[176]

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[168] Chemical, Biological, Radiological Incident Handbook, 1998, pg 10.
[169] Ibid, pg 11.
[170] Chemical, Biological, Radiological Incident Handbook, pg 10.
[171] NATO Handbook on the Medical Aspects of NBC Defensive Operations, pg 1-2.
[172] M, Pelczar., E,C,S, Chan. "Elements of Microbiology," McGraw-Hill, 1981, pg 531.
[173] Pelczar, pg 661.
[174] Pelczar, pg 681.
[175] The Concise Oxford Dictionary of Current English, Oxford at the Clarendon Press, 1976, pg 1144.
[176] Chemical, Biological, Radiological Incident Handbook, 1998, pg 11.

**toxin**. Poisonous substances produced by living organisms[177]

**vaccine.** A preparation of killed or weakened microorganism products used to artificially induce immunity against a disease.[178]

**vector.** An agent, such as an insect or rat, capable of transferring a pathogen from one organism to another.[179]

**virus.** An infectious microorganism that exists as a particle rather than as a complete cell. Particle sizes range from 20 to 400 manometres (one-billionth of a metre). Viruses are not capable of reproducing outside a host cell.[180]

**WHO.** World Health Organization.

[177] Chemical, Biological, Radiological Incident Handbook, pg 11.
[178] Chemical, Biological, Radiological Incident Handbook, pg 11.
[179] Chemical, Biological, Radiological Incident Handbook, pg 11.
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