

# Calculations of the Potential Impact of BW and BT

## Lecture No. 5

# 1. Overview

- Military Characteristics of BW Agents
  - Slides 2 - 5
- WMD/Strategic BW Attacks
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- Production of BW Agents
  - Slides 13 - 16
- Other Types of BW Attack
  - Slides 17 - 20

## 2. Military Characteristics (i)

- The diversity of potential BW attacks
  - Different targets (humans, animal and plants)
  - Different agents (bacteria, viruses, fungi, toxins, bioregulators)
  - Different scales (assassination, tactical military, strategic military, WMD)
  - Different purposes (overt or covert war or terror)

# 3. Military Characteristics (ii)

- A military classification of BW agents
  - Potentially infectious from first victim
    - Incapacitating (e.g. influenza virus)
    - Lethal (e.g. *Yersinia pestis* - plague)
  - Not infectious from first victim
    - Incapacitating (e.g. *Coxiella burnetii* - Q-fever)
    - Lethal (e.g. *Bacillus anthracis* - anthrax)

# 4. Military Characteristics (iii)

- Militarily-desirable characteristics of BW agents
  - 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

# 5. Military Characteristic (iv)

- Militarily-desirable characteristic of BW agents (cont.)
  - Treatment for the disease should not be available to the target population
  - The user should have means to protect troops and civilians
  - It should be possible to mass produce the agent
  - It should be possible to disseminate the agent efficiently
  - The agent should be stable in storage and transport in munitions.

# 6. WMD/Strategic Attacks (i)

- United Nations Study in 1969
  - Single bomber using 10tons of BW agent
    - Area affected 100,000 km<sup>2</sup>
    - Morbidity 50%, 25% deaths if no treatment
  - Area affected if a 1 megaton nuclear bomb was used
    - 300 km<sup>2</sup>
  - Area affected if 15 tons of nerve agent was used
    - 60 km<sup>2</sup>

# 7. WMD/Strategic Attacks (ii)

- SIPRI 1973 Study
  - Single bomber with 5-6 ton bombload
  - Area in km<sup>2</sup> over which 50% casualties would be possible
    - High explosive 0.22
    - VX nerve gas 0.75
    - 10kt nuclear bomb 30
    - Biological agent 0 -50 (depending on weather conditions)



# 8. WMD/Strategic Attacks (iii)

- Fetter's 1991 study in the journal *International Security*
  - Missile with throw weight of one tonne attacking a large city with 30 people per hectare density
    - 20kt nuclear weapon would kill 40,000
    - 300kg Sarin would kill 200 - 3,000
    - 30kg anthrax would kill 20,000 - 80,000

# 9. WMD/Strategic Attacks (iv)

- US Office of Technology Assessment 1993 report: Scenario I
  - Attack with a missile delivered on an overcast day or night, with a moderate wind on a city with 3,000 to 10,000 unprotected people per km<sup>2</sup>
    - 12.5 kt nuclear weapon would destroy 7.8km<sup>2</sup> and kill 23,000-80,000 people
    - 300kg of Sarin would kill 60-200 people in an area of 0.22km<sup>2</sup>
    - 30kg of anthrax would kill between 30,000 to 100,000 in cigar shaped plume from the warhead covering 10km<sup>2</sup>

# 10. WMD/Strategic Attacks (v)

- US Office of Technology Assessment  
1993 report: Scenario II
  - Attack by a plane releasing 10kg of anthrax along a line on the windward side of a city like Washington DC
    - On a clear sunny day with a light breeze, 46km<sup>2</sup> would be affected and 130,000 to 460,000 people could die

# 11. WMD/Strategic Attacks (vi)

- OTA Scenario II (cont)
  - On an overcast day or night with a moderate wind, 140km<sup>2</sup> would be affected and 420,000 to 1,400,000 people could die
  - On a clear, calm night an area of 300km<sup>2</sup> would be affected and between 1 and 3 million people could die
  - Clearly the use of such a line source of such an agent in ‘ideal’ conditions (e.g. in the absence of UV light that would kill the spores more rapidly) could be devastating as it would be difficult to assist so many people

# 12. WMD/Strategic Attacks (vii)

- Some munitions known from the US BW programme
  - Warhead for guided missile M210 with bomblets (M143) in the warhead under development in 1967
  - Spray tank for liquid agent A/B45Y-1 used by high speed tactical aircraft under development in 1965

# 13. Production of BW Agents (i)

- Growth of a bacterial agent by fermentation requires
  - A seed culture of the virulent pathogen
  - Initial propagation in small fermenters
  - Growth in production-scale fermenter
  - Collection of the agent from the fermenter
  - Final processing such as freeze drying

# 14 Production of BW Agents (ii)

- Estimation of the quantity of agent needed for a line attack
  - Consider first a point source from which the dose ( $D$ ) received by a victim is
    - $Q$  the source strength (units/m) times  $b$  the breathing rate (volume/minute) divided by  $h$  the depth of the air layer times  $\bar{u}$  the mean surface wind speed
    - Thus

# 15. Production of BW Agents

## (iii)

- Consideration of a point source (cont)
  - The source strength required is clearly
    - $Q = \frac{D \cdot h \cdot \bar{u}}{b}$
  - Using typical values for these quantities
    - $b = 20$  litres/min ( $2 \cdot 10^{-2} \text{ m}^3 \text{ min}^{-1}$ );  $h = 1$  km ( $10^3 \text{ m}$ );  $\bar{u} = 5$  m/s ( $3 \cdot 10^2 \text{ m min}^{-1}$ )
  - Thus if  $D$  is 10 times the Infective Dose ( $ID_{50}$ )
    - $Q = \frac{10 \cdot ID_{50} \cdot 10^3 \cdot 3 \cdot 10^2}{2 \cdot 10^{-2}}$
  - So the attacker needs about  $10^8 ID_{50} / \text{m}$



# 16. Production of BW Agents

## (iv)

- For a line source 10km long attacker needs
  - $10^8 \text{ ID}_{50} \text{ times } 10^4 = 10^{12} \text{ ID}_{50}$
- Assume a concentration of  $10^8$  bacterial cells per ml is possible in the fermenter so the attacker will need to produce
  - $10^{12}$  times (No. of cells equivalent to 1  $\text{ID}_{50}$ )/ $10^8$  times 1000) liters of suspension
- Given the  $\text{ID}_{50}$  for anthrax is about  $10^4$  the attacker would need about 100,000 liters which would be possible in ten runs of ten fermenters of 100 liters capacity

# 17. Other Types of BW Attack

## (i)

- Anti-Agriculture BW
  - Low-tech, high consequence bioterrorism
  - Little specialist knowledge required, highly contagious pathogens (but not to humans) and huge costs to agriculture
  - For example one study stated
    - “Pathogens that cause diseases such as FMD, rinderpest, African swine fever (ASF), soybean rust, Philippine downy mildew of maize, potato wart, and citrus greening could, if introduced into the continental United States, have serious consequences for the US economy.”

# 18. Other Types of Attack (ii)

- Terrorist attacks on people
  - US Congressional Research Service 2004 report cautions against drawing direct analogies from consideration of State programmes
    - “C/B agents that were considered high threats in other frameworks appear to present a lesser threat when viewed in the small scale attack context. Conversely, C/B agents that were considered of lesser threat when considering mass casualty attacks may be ranked more highly in the small scale context, as barriers to mass use may be missing when the agent is used on a small scale.”

# 19. Other Types of Attack (iii)

- World Health Organisation 1970 report considered a range of possible WMD and other scenarios
  - A lethal and incapacitating antibiotic-resistant biological weapon without secondary cases (tularemia)
  - A lethal and incapacitating antibiotic-sensitive biological weapon with secondary cases (pneumonic plague)
  - Contamination of the water supply with typhoid bacillus or botulinal toxin A

## 20. Other Types of Attack (iv)

- 1kg of freeze dried culture of typhoid used to attack the water supply of a city of 1 million in a hot arid developing country. The attack was without warning so no special precautions were taken by the authorities
  - Raw water consumption assumed to be two litres per person per day and so 125,000 people calculated to receive 100,000 microorganisms and many would therefore become ill
  - If no facilities were available for mass treatment some 4,500 people might die because of the attack

# Sample Questions

1. Critically evaluate the military-significant features of: Plague, Influenza, Tularemia, Botulinum Toxin and Q Fever.
2. What are the structural difficulties that make a large scale antipersonnel biological attack rather unlikely at this time?
3. Discuss some of the calculations in the open literature that suggest that under certain conditions biological weapons could be used as Weapons of Mass Destruction (WMD).
4. Anti-agriculture is the most likely form of very successful bioterrorism today. Discuss.

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