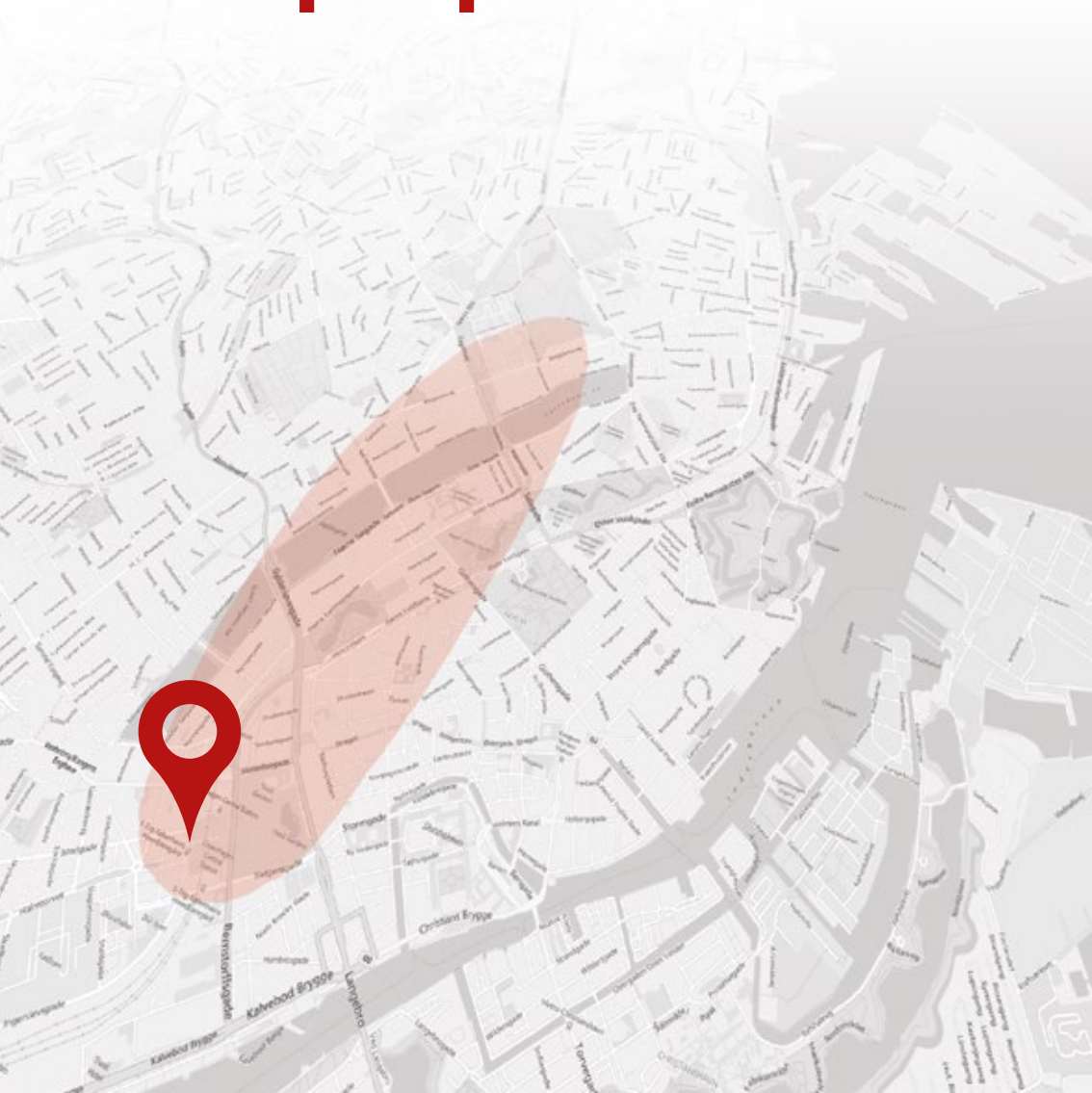
CENTRE FOR
BIOSECURITY AND
BIOPREPAREDNESS

An introduction to biopreparedness



An introduction to biopreparedness

preface

In 2015, the Danish Center for Biosecurity and Biopreparedness (CBB) published An efficient and practical approach to biosecurity, a comprehensive guide to establishing national biosecurity systems. Such systems are designed to prevent the abuse of biological substances and related materials that are intended for legitimate research and other purposes, but which could also be misused to create biological weapons.

Since its publication, our biosecurity book has been distributed worldwide, and has often been used in training and classroom settings.

The book you now are reading is intended as a companion volume to the original work. It goes beyond prevention to address in detail the issue of what to do in case of a terrorist attack or an accident involving the uncontrolled release of dangerous biological substances; it deals with biopreparedness.

The biosecurity book also addresses the issue of biopreparedness, but primarily as it relates to incidents at laboratories and other government-regulated facilities that work with dangerous biological substances and related materials.

This book takes a much broader and more complex view. It deals with how to manage and mitigate incidents and accidents in which civilian targets or entire populations are threatened.

Like the biosecurity book, this volume draws on CBB's own experience as well as a variety of other sources to suggest a comprehensive model that other countries can use – in whole or in part – to help establish or improve their own biopreparedness systems.

Additional material, resources and litterature with relation to the topics of these two books will be posted on our website, so please look us up there.

We hope you will find it useful.

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Photo: CBB

intro duction

An attack with a biological weapon or an accident with hazardous biological substances can cause death, disruption and destruction on a massive scale. This book describes an effective way to investigate and respond to incidents involving hazardous biological substances, and offers some strategies for dealing with the aftermath.

The prospect of a bioterror attack spreading deadly disease may not be the first scenario that comes to mind when considering the terrorist strikes of recent years. Vehicles, firearms and explosives have been the weapons of choice, and will probably remain so in the near future.

Even so, the use of biological weapons remains a serious threat to society. The consequences of a successful attack against an unprotected population can become catastrophic, and any comprehensive national preparedness system needs to be able to counter such attacks.

Preparedness: a rapid response and long-term plans

The purpose of this book is to suggest effective ways to prepare for and mitigate both the immediate and the longer-term consequences of a biological attack or accident. It offers strategies to quickly investigate incidents and limit the casualties and other damage. It also includes practical advice about the procedures, personnel, equipment and software that should be in place as part of a national biopreparedness system.

As part of a longer view, we discuss issues such as mass vaccination, quarantine and decontamination. An even longer-term discussion will deal with international cooperation, which may well be the most effective countermeasure against a weapon whose effects can easily spread beyond any border.

Advice for decision-makers, experts and first responders

The information we present relates to every level – tactical, opera-

tional, strategical as well as international. It reaches out to decision-makers everywhere who are responsible for public health, safety and security. It is likewise intended to inform the leaders and employees of police, public health, emergency response services, military and other institutions who do not have biological incident handling as their primary daily activity, but who do potentially have important supporting functions when such incidents do occur.

In this book, we will use the expression 'biological incident' as a general term for any occurrence involving the suspected or actual release of dangerous biological substances, whether intentional or accidental. An intentional release is by definition an act of terror or warfare.

A biological incident could, for example, consist of a traffic accident involving the legitimate transport of dangerous biological material. Or it could be an intentionally executed attack on an unprotected civilian target. Or a hoax (with fake biological material) that cannot be dismissed without expert involvement and investigation.

It should be noted that this book will deal exclusively with biological incidents, which require a markedly different approach than incidents involving chemical, radioactive or nuclear threats.

Collaboration and cross-organisational training

Biological incidents can involve a variety of public and private entities, including:

- police
- medical emergency responders
- firefighters
- public health authorities
- hospital doctors
- experts in biopreparedness
- experts in microbiology
- military forces

Collaboration strategies are therefore an important and necessary aspect of this book. Knowing exactly when the various entities should be brought into play with clearly defined roles and tasks is vital in terms of avoiding confusion and mistakes that can ultimately cost lives.

We will therefore also discuss cross-organisational training as a way of learning how to work together effectively.

Examples from real life and realistic scenarios

Whenever possible, we will draw on real-life experiences to illustrate our biopreparedness discussions. The infamous 'anthrax letter' incident of 2001 in the USA is perhaps the most vivid example of a biological attack in recent history, but we will also draw on the learnings of other real-life cases.

A disastrous biological accident at a bioweapons factory in the Soviet Union encompasses important biopreparedness learnings, for example. The same may be said of the experiences and lessons learned during certain naturally occurring epidemics.

We have also developed a fictional but realistic scenario that will appear in several chapters to illustrate how biopreparedness principles can be put into practice in a real-life setting. Discussions after each segment of the scenario will further amplify and explain the actions that take place in this storyline.

You can find exactly what you need

Like the biosecurity book published by the Danish Centre for Biosecurity and Biopreparedness in 2015, you can read this volume from cover to cover or use it as a reference tool. The text is divided into sections, chapters and smaller segments with headlines that make it easy to find exactly what you need to know.

The book can be used as inspiration for establishing an entire biopreparedness system 'from scratch'. Or it may be used to focus on possible improvements of particular aspects of an existing system.

About CBB

This book is created by the Danish Centre for Biosecurity and Biopreparedness (CBB), an agency established in 2001 to address the threat of biological attacks and accidents. The Centre administers and regulates a sophisticated and efficient national biosecurity system and maintains a 24/7 response capability to counter the effects of a biological incident, whether accidental or malicious.

The Centre also offers biosecurity and biopreparedness courses for various target groups. In addition, it arranges practical incident response training. Participants in these exercises include external entities such as the police, public health authorities and local and national emergency management agencies.

CBB also operates at an international level, offering courses on how to establish and implement national biosecurity systems. In 2014, the Centre initiated the Danish Biosecurity Partnership Programme to help countries in Eastern Africa address specific biosecurity issues and establish national biosecurity systems.

Further information on CBB activities may be found on the Centre's website at www.biosecurity.dk.

The book is divided into four major sections

Section 1 of this book explains some of the basic concepts, terms and issues involved in biopreparedness. Among other things, it describes the elements of a good biopreparedness organisation and examines the way in which a biological incident can unfold.

Section 2 provides specific advice on how to respond to each phase of an incident, from the first emergency call through the investigation and analysis to the excecution of medical countermeasures.

In Section 3, you will find discussions of such challenging topics as large-scale decontamination, mass vaccination, and enforced or voluntary quarantine.

Section 4 will present a more detailed discussion of a few specific topics related to biopreparedness. These include training exercises, public information, and international collaboration. The section concludes with some dilemma exercises designed for classroom discussion.

You will also find a glossary of biopreparedness terms and acronyms at the back of the book.

section 1

The basics of biopreparedness

Before we discuss the specific activities that take place in a biopreparedness system, it's important to know some basic concepts and concerns.

This section will therefore begin with the question of why we need a biopreparedness system at all. What is the rationale for it, and what is the threat?

We will also present some biopreparedness terms and issues that will be referred to throughout the rest of the book. This includes a description of some types of biological agents and weapons, as well as the kind of biological attacks and dangerous accidents that we must be prepared to deal with.

Finally, this section will provide an overview of the building blocks that are needed to construct an effective response.

1

what is the threat?

Do modern societies really need to prepare for the possibility of a biological attack or accident? The short answer is yes: even though the likelihood of such an event is relatively small, the consequences can be catastrophic

Of the different types of weapons of mass destruction that exist today, it may be the biological weapon that has been employed most frequently. History is filled with examples of how the deliberate spread of disease has been used to decimate armies, crops, livestock and populations.

Infected corpses and biologically contaminated materials have been used for hundreds of years as biological weapons against enemy troops. Once it became possible to isolate and cultivate specific bacteria, new and more effective biological weapons were developed and added to the arsenals of many countries.

Anthrax and glanders were thus used by Germany during WWI against transport animals. Between 1932 and 1945, Japan used plague, cholera and other disease agents against civilians during its war with China and against enemy prisoners of war during WWII.

Over the past hundred years or so, government-run biological weapons programmes are also known to have existed in the US, Canada, the UK, France, the Soviet Union, South Africa and Iraq.[1] More recently, the Syrian government admitted in 2014 to having had a facility to produce ricin, a highly toxic protein with potential for use as biological weapon.[2]

The largest anthrax assault may have happened in Africa

The anthrax letters of 2001 caused five deaths in the US and were perhaps the most highly-publicised examples of a biological attack in this century. But the letters and their powdery, poisonous content may not have been the largest assault involving the deadly *bacillus anthracis* spore.

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1 Riedel, S. Biological warfare and bioterrorism: a historical review. Proc (Bayl Univ Med Cent). 2004 Oct; 17(4): 400–406. Accessed at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1200679/

2 Corder, M./Associated Press. Syria declares it was ricin maker. Arkansas Democrat Gazette, 20 Sept 2014. Accessed at https://www.arkansasonline.com/news/2014/sep/20/syria-declares-it-was-ricin-maker-20140/?f=news

The largest recorded outbreak of anthrax in history happened in Rhodesia (now Zimbabwe), where ***bacillus anthracis*** caused some 200 human fatalities and sickened thousands of humans and cattle between 1978 and 1984. The outbreak destroyed a once thriving agricultural area, and there is strong indications that the epidemic was the result of a deliberate attack by the Rhodesian government on the country's black rural population.[3]

Biological weapons can be camouflaged

International law made the use of biological weapons illegal in 1975, when the Biological and Toxins Weapons Convention (BWC) went into force. But biological weapons are well-suited for covert operations which can avoid detection.

Biological weapons development can, for example, be camouflaged as defense research, which is legal according to the BTWC.

The biological material itself can also be camouflaged as an object of medical research, while the technologies for deploying it as a weapon can be quickly mobilised by re-purposing manufacturing equipment that was designed for legitimate uses.

These so-called 'dual-use' materials and technologies can quickly transform laboratory and production facilities from legal to lethal.

The conversation about threat has changed

The anthrax incident of 2001 was not a government-sponsored attack. According to the American FBI, it was the action of a highly placed and mentally unstable employee at a US military laboratory. And it changed the conversation about threat.

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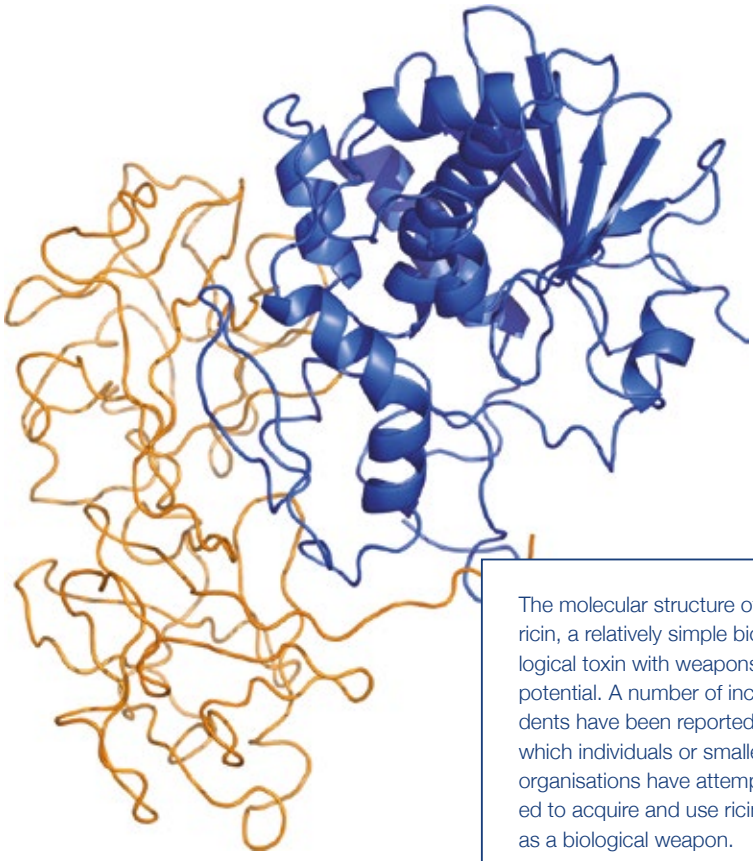
3 Wilson, J. et.al. Reanalysis of the Anthrax Epidemic in Rhodesia, 1978-84. PeerJ — the Journal of Life and Environmental Sciences. PeerJ. 2016 Nov 10;4:e2686. Accessed at https://doi.org/10.7717/peerj.2686



The molecular structure of ricin, a relatively simple biological toxin with weapons potential. A number of incidents have been reported in which individuals or smaller organisations have attempted to acquire and use ricin as a biological weapon.

Photo: AZATOTh / Wikimedia

In the aftermath of this one-man war, concerns have been raised about the potential use of biological weapons by 'insiders' and non-state entities – religious sects and terrorists, for example, as well as disturbed individuals and criminals.

Recent scientific advances also pose new threats. Today it is possible to 'resurrect' extinct microorganisms, modify existing ones or even create entirely new ones to make them more suitable for use as weapons.

These developments could open a Pandora's box of new ways to achieve destructive goals.

Biological weapons can be used covertly

Some types of biological weapons can quickly spread over huge areas, aided by wind, contagion and a mobile population and can cause long lasting contamination which can leave entire cities uninhabitable for years. Some can cause epidemics that could result in casualties as at the level of a nuclear weapon.

Moreover, biological weapons can be used covertly, which is not an option for nuclear weapons. Covert use of biological weapons can seriously delay and confuse mitigation efforts, thus greatly increasing the effectiveness of an attack – an issue that will be expanded upon later in this book.

The smallpox paradox is a special threat

Smallpox presents a special kind of threat, paradoxically because it was declared extinct in the 1980s. A quantity of the virus was kept for research purposes at two high-security sites in the US and Russia, respectively.

However, a security lapse was uncovered in 2014 at a US laboratory in Maryland, where a cardboard box containing live smallpox virus was found in an unsecured storage room. This of course raised questions as to whether there might be similar lapses and other caches of smallpox elsewhere in the world.[4]

The existence of the virus and the danger of theft, misuse and accidents is a matter of concern because smallpox vaccinations are no longer given on a routine basis. An unvaccinated population is entirely vulnerable to an accidental release or biological attack involving this agent.

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4 Reardon, S. NIH finds forgotten smallpox store. Nature. 09 July 2014. Accessed at https://www.nature.com/news/nih-finds-forgotten-smallpox-store-1.15526

Misuse of advances in biotechnology have made it possible to manipulate biological organisms to create biological weapons with enhanced destructive. potentials.

Photo: Shutterstock

Biohackers' can create new risks

Meanwhile, a new trend has developed in which advanced biological technologies have become more accessible to persons outside the traditional scientific community. As biotechnology becomes less expensive and easier to work with, an informal community of 'biohackers' and 'citizen biologists' has begun to conduct its own experiments, sometimes in improvised, garage-style laboratories.

The expressed intent of these persons is not malicious. But they may not be aware of the biosecurity laws of the country in which they work. And because they operate 'under the radar', they are not licensed and do not receive control visits to ensure compliance with safety and other regulations. [5]

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5 Baumgartner, E. As D.I.Y. Gene Editing Gains Popularity, 'Someone Is Going to Get Hurt'. New York Times, 14 May 2018. Accessed at https://www.nytimes.com/2018/05/14/science/biohackers-gene-editing-virus.html?action=click&module=RelatedLinks&pgtype=Article

Biohackers may not even be aware of the possibilities of misuse that some of their activities could involve. This in turn increases the likelihood of accidents, and could also make the biohacker community an easy target for theft, manipulation or infiltration by persons with a criminal agenda.

Accidents can and will happen

The risk of 'bio-error' may well be greater than that of bioterror – meaning that the accidental release of dangerous biological substances is probably a more likely scenario than terrorism or state-sanctioned acts of war. The total biotechnological activity of modern societies is huge and human error, technical breakdowns and other unforeseen events can and do happen in any environment, including in Biotech.

A good example of risky activity is the Gain of Function studies on H5N1 Influenza carried out by the Dutch virologist Ron Fouchier. The potential consequences of an accidental release of the modified virus – an influenza pandemic with an unnaturally high contagiousness and mortality - are unreasonably mismatched to the perceived scientific insigths obtained through the research.

Accidents can of course also happen where illegal activity takes place. Given that the potency of the involved biological substance is very high, such incidents can be exactly as dangerous as a malicious attack (see box, 'The biological Chernobyl').

Biosecurity can help mitigate the threat

Despite recent advances, the technologies for creating and deploying a biological weapon are still relatively expensive, complex and difficult for a non-state actor to obtain – especially compared to the relative ease with which firearms, explosives and other weapons can be procured.

Another point to consider in assessing the overall threat of biological

attacks is that many countries have begun to implement biosecurity measures designed to prevent dangerous biological substances and related materials from falling into the wrong hands.

The subject of biosecurity is beyond the scope of this book, but you can learn more in *An efficient and practical approach to biosecurity*. The book was published by CBB in 2015 as part of the Danish effort to address the risk of incidents involving dangerous biological substances and related materials.

The likelihood is low, but the consequences would be high

For the above-mentioned reasons, the Danish Center for Biosecurity and Biopreparedness currently sees the likelihood of a large-scale biological attack as being relatively low. However, the consequences of such attacks or accidents could potentially cause breakdown of entire societies and should thus be taken very seriously.

The biological Chernobyl

The damage that can be caused by a biological accident was illustrated with alarming clarity in 1979, when things went wrong at a secret biological weapons factory run by the military in the Soviet city of Sverdlovsk (now Yekaterinburg).

Details of the accident remain unclear, but apparently a communication breakdown resulted in the accidental release of somewhere between a few milligrams and one gram of weapons-grade anthrax into the environment. To compound the situation, technical difficulties delayed mitigation efforts.[6]

Casualty estimates differ, but according to the most conservative statistic, 77 persons outside the military base were infected, and 66 of these people died.[7]

Fortunately, the wind was blowing away from the city at the time of release – otherwise, the loss of human life could have been massive. The incident – sometimes referred to as 'the biological Chernobyl' - was kept secret until after the breakup of the Soviet Union in 1991.[8]

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6 Centre for Biosecurity and Biopreparedness, Copenhagen. Det biologiske trusselsbillede (Danish-language report on biological threats). 2016.

7 Meselson, M. et.al, 1994, The Sverdlovsk Anthrax Outbreak of 1979. Science Vol 266. Accessed at https://www.researchgate.net/publication/15224942_The_Sverdlovsk_anthrax_outbreak_of_1979

8 Det biologiske trusselsbillede, 2016

2

biological agents weapons and incidents

In this chapter, we will discuss some of the unique challenges that a biopreparedness system must deal with. Understanding the nature of a biological incident and the components of a biological weapon are key to developing an effective response

At its most basic level, the purpose of biopreparedness is to limit loss, maintain public stability and make it possible to return to normal after a biological incident as quickly as possible.

By 'loss', we mean first of all the loss of life and health. But we are also concerned with economic and productivity losses due to the disruption of public order caused by a biological incident. Closed buildings, production shutdowns, evacuations and traffic disturbances can cost time and money, even if an incident turns out to be a hoax.

To achieve the goals of biopreparedness, however, we must first understand some basic facts and concepts about biological weapons and how they are used.

Biological weapons are fundamentally different from other unconventional weapons

The central component of a biological weapon is the biologial organism or agent: the virus, bacterium, biological toxin or, to a lesser extent, fungus (see box, 'Categories of biological agents').

Biological warfare agents are harmful biological substances that are used with the intention to cause harm.

Biological warfare agents are fundamentally different in their effect from for instance chemical warfare agents. Chemical agents have been and are still used as weapons, but their impact on the human body is different from that of biological substances.

Exposure to chemical weapons has an immediate effect: almost at once, victims will begin to show very obvious symptoms; cough, wheeze, froth around the mouth, choke or loose contiousness. Mass poisoning with chemical warfare agents will therefore usually become apparent within minutes. First response efforts and medical interventions can be initiated based on these symptoms alone without much delay.

Biological warfare agents are stealthy

The effect of exposure to biological warfare agents is in some ways far more sinister, because these agents cause diseases that are not immediately visible. Each of these diseases has an *incubation period*. In practical terms, this means that a certain amount of time will pass before an illness develops in the body and is revealed in the form of symptoms. In addition to this delay comes the fact that the living bacteria or viruses of a biological weapon will replicate, thus creating more substance with time, not less.

Depending on the agent, incubation periods can range from hours to weeks (or in special cases, even months). And during this time, an attack can go unnoticed as an invisible cloud of infectious material can spread far beyond the original attack site, exposing hundreds or thousands of others to the same infection without anyone being aware of it.

The range of a biological weapon can be huge

The ability of a biological agent to disperse – that is, to spread beyond the attack site – is another fundamental difference between chemical and biological warfare agents.

Under the right circumstances, some biological warfare agents can quickly cover dozens or even hundreds of square kilometres. Weaponised anthrax, for example, can even seep through microscopic openings in walls and windows that seem impenetrable. Not to mention the fact that a very small amount of biological agent can do an almost incalculable amount of damage.

Chemical agents, on the other hand, tend to disperse over a much smaller area, unless a very large amount of agent is used and the dispersion of a chemical warfare agent is generally simpler to track and predict.

Computer-assisted modelling tools have been developed to help

predict how a cloud of biological material will behave over time. We will return to this subject in several other chapters of this book.

Contagion can enhance the effect of some biological weapons

Another important difference between biological and chemical agents is the fact that some biological agents are contagious. Victims of a covert biological attack who are unaware of their own infection can bring the disease home to their families, carry it into workplaces and shopping centers - or travel with it to other countries.

By the time the first signs of illness appear, far more drastic measures may be needed to contain the disaster in any meaningful way. And the task of treating the disease could be overwhelming.

Five principal dimensions define the weapons potential of an agent

Contagiousness is one of five dimensions used to characterise a potential biological warfare agent. The others are lethality, persistence, treatability and preventability.

- *Contagiousness* is the degree to which the disease caused by an agent can be transmitted to others.
- *Lethality* is the ability of the agent to kill those exposed and infected.
- *Persistence* describes the agent's ability to remain infectious after release into the envionment.
- *Treatability,* as the name suggests, is the extent to which medical treatment will have an effect on the disease in question.
- *Preventability* refers to the extent to which it is possible to vaccinate against the effects of the agent.

The choice of agent for use in a biological weapon will depend in part on what combination of the five traits that best serves the purpose of the attacker. See Fig. 1 for examples of agents and characteristics.

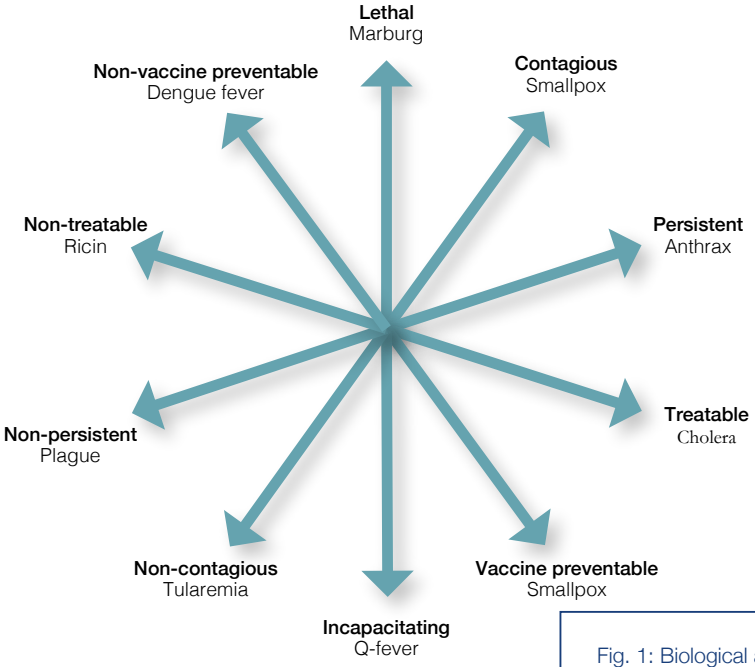

Fig. 1: Biological agents can be described by the degree to which they express five primary dimensions. Biological agents exemplifying these dimensions are indicated here in italics.

Biological warfare agents are weaponised

To function effectively as a biological warfare agent, the natural characteristics of a biological substance must be supplemented by a process called *weaponisation*. This means altering or formulating the agent to make it easier to disperse or more effective at causing disease.

Weaponisation is what can turn the anthrax bacteria into an extremely fine powder that will disperse and become invisible in an instant, float on the smallest of air currents, settle on an object and then fly into the air again at the slightest disturbance. In this form, its capacity to spread death and disease is formidable.

Weaponisation is necessary because agent production processes may result in a particle size that is too large for it to drift and spread through the air. Or the agent may not be persistent enough to survive for very long after being released into the environment.

The perpetrator of a biological attack might also want to modify the agent to make it more lethal, less treatable, or more contagious. The technological developments described in Chapter 1 make such alterations entirely possible.

A delivery device completes the weapon

A biological warfare agent must also have a *delivery device* that can effectively disperse the agent. This device could be anything from a small, improvised spraying apparatus to military-scale armaments depending on the target.

A delivery device could be constructed with materials purchased at an ordinary hardware store. Or, as mentioned in Chapter 1, it could be a piece of dual-use manufacturing equipment that has been converted so it can be used as part of a weapon.

In the case of the anthrax letters, the only necessary delivery device was the envelope in which the powder was placed and sent through the postal system. The bacteria had been weaponised to such a degree that the act of tearing open the letter was enough to disperse the agent over a very large area.

Delivery devices provide important clues

Delivery devices are important – not only because they serve as a vehicle of attack, but also because they are primary clues for investigators.

Suspicious-looking objects that turn out to be delivery devices can be the first indication of a biological attack. It is therefore extremely important that those who work with biopreparedness in the field are able to recognise a potential delivery device.

Discovering a delivery device – or any other relevant bit of physical evidence, for that matter – can pinpoint the site of a biological attack that would otherwise have gone unnoticed until much later. Moreover, samples taken from the device can reveal what type of agent was used in the attack.

Knowing both the release site and the agent at an early point in time can dramatically improve the chances of a successful intervention.

There are three basic types of incidents

For the purposes of this book, we will use the term *type 1* to describe a deliberate biological attack in which the release site (the site at which a biological warfare agent was released into the environment) has been identified. In general, such identification will be possible in connection with the discovery of a delivery device.

We will use the term *type 2* to describe a deliberate biological attack in which the release site has *not* been identified, and no delivery device has been found. Suspicion of a type 2 incident will arise due to the appearance of suspicious symptoms of particular illnesses in a given population.

This distinction between type 1 and type 2 is important, because – as you will see in Section 2 – it will fundamentally affect the way in which the incident is investigated and handled.

The accidental release of a legally possessed dangerous biological substance will be referred to as *type 3*. In these cases, the site of the accidental release will usually be obvious, and the time at which the release took place can be pinpointed more or less precisely. Most importantly, the identity of the agent itself is known, making it possible to initiate immediate countermeasures.

a.

Photo: Frederick A. Murphy / CDC
(Ebola virus virion)

b.

Photo: NIAID / Wikimedia (Escherichia coli)

c.

Photo: Gokalp Iscan / Pixabay (Castor Beans)

d.

Photo: Yale Rosen /Flickr
(Coccidioidomycosis - PAS stain)

Categories of biological agents

The four categories of dangerous biological agents that can be used in a biological weapon are:

a. **viruses**
b. **bacteria**
c. **biological toxins**
d. **fungi**

In Denmark the relevant pathogens have been placed on lists of *controlled biological substances* which must be kept under lock to prevent theft and subsequent misuse. These *control lists* are mandated by the Danish Biosecurity Law.

A special issue of definition relates to the biological toxins. The toxins differ from other biological agents in that they are not alive and are not replicating. They are classified as a biological substance because they are biological molecules and are derived from a living organism, typically a plant. Their effect in an organism, however, resembles that of chemical substances in that they cause illness very quickly compared to the viruses and bacteria with an incubation time that is generally much shorter. Hence they have been named *mid-spectrum agents.*

Control lists are used internationally and nationally with or without adaptations. The Australia Group Common Control Lists are an example of such lists used for export control purposes.

Each of these incident types will require specific courses of action, although there will also be some actions that are common to them all. We will discuss recommended methods of investigation and appropriate countermeasures in Section 2 of this book.

As an incident unfolds, some special challenges and moral dilemmas can develop. These will be discussed in Sections 3 and 4.

Hoaxes are disruptive and need an expert eye

Hoaxes are deliberately misleading attempts to spread fear and disruption using innocuous substances that are claimed to be dangerous biological substances. They are often accompanied by written threats.

Distinguishing hoaxes from dangerous incidents as quickly as possible requires the same expertise and the same systematic threat analysis procedure that establishes an actual biological attack. We will describe threat analysis procedures in Chapter 5.

The lines can be blurred between a natural outbreak of disease and a covert attack

A type 2 incident can be indistinguishable from natural outbreaks of disease, and a perpetrator can therefore avoid taking responsibility for the attack which can indeed be denied.

A biological attack which is not immediately apparent, and for which no formal responsibility has been claimed, is termed a *covert attack*. Such attacks are by definition always type 2, because they are not noticed until symptoms develop in the affected population.

The possibility to deny responsibility is particularly relevant for an attacker who wishes to disrupt and destabilise an enemy society without identifying himself. It is also highly relevant for a perpetrator who wishes to make the incident appear to have been the work of some other party, organisation or government.

Moreover, there will be no attribution efforts or criminal investigation as long as the attack is not recognised for what it is.

Outbreaks of weapons relevant diseases should therefore allways be reported to competent authorities with the ability to investigate with biopreparedness experts – even if such outbreaks appear to have 'natural' causes.

Overt attacks are publicly announced

It is well known that some terrorist attacks – biological or otherwise – are openly declared by a perpetrator who wishes to take responsibility for the incident before or after it happens. Deniability is not an issue for such an attacker. It is, however, quite possible that the person or organisation making such an announcement is simply exploiting the act of someone else.

In any case, the release of a biological agent that is preceded or followed by a public announcement of responsibility is defined as an *overt attack*. Overt attacks will at least provide a starting point for investigators – not least if the announcement takes place *prior* to the attack and includes a warning about time and place.

It should be borne in mind, however, that the concepts of deniability and responsibility can both be used to confuse an investigation. And an announcement of an imminent attack may not involve an overt action at all. It could be a hoax designed to cause panic.

Discretion should be exercised whenever possible

Any type of biological incident – including hoaxes – will cause a certain amount of public disruption. It can also increase the public's fear of terrorist activity and thus have a destabilising effect on society. As we have just noted, this may be exactly what the perpetrator wants to achieve.

In this context, the sight of field investigators in 'moon suits' and

gas masks is certainly enough to make anyone nervous. Meanwhile, police cordons and blocked roads are bound to cause irritation, and if workplaces or train stations are suddenly made inaccessible, the situation could also result in lost time and productivity.

Rumours and fake news can add to the disruption and fear, especially if the public begins to ask questions that cannot yet be answered.

For these reasons, a basic principle of biopreparedness should be to always have a competent biopreparedness authority perform an immidiate *threat analysis* of the actual situation at hand (a real time systematic analysis of the situation using all sources of information, see Chapter 5) before initiating any highly visible activity that may turn out to be unnecessary and harmful. This will enable the organisation to exercise as much discretion as possible without compromising safety, security and the public's 'need to know'.

3

A specialised response: the COMA staff

This chapter introduces what we believe should be the heart and hub of a biopreparedness system: a specialised response organisation whose expertise can bring common purpose to some very disparate players. We will also present some other key elements of a good biopreparedness system

Responding to a biological attack or accident can involve a great many different players. In addition to a biopreparedness organisation, this could include police and fire fighters, healthcare professionals, ambulance services, hospitals, medical laboratories, government and public health officials, and the military.

All these participants and more may be needed during different phases of a major biological incident. But in their everyday work, each of these many organisations has it's own tasks and priorities. The complexities of the handling of a biological incident are added to these.

For example: a police officer trained to provide immediate assistance in an emergency may unwittingly enter a contaminated building before biological experts have assessed the situation and the potentially hazardous area. Apart from possibly being exposed to contamination, the officer's movement through the building could disturb and spread a weaponised, easily airborne agent over an even greater area.

In the same manner, an investigator from a biopreparedness organisation might take samples from the scene of a biological incident with the object of identifying the substance that was released as quickly as possible – and neglect to gather other possible evidence of interest to a criminal investigation.

Entities that need to be working together can thus end up at cross purposes – a situation that can easily result in confusion and costly mistakes.

Overview and specialised competences are needed

In view of the above, it should be clear that the investigation of a biological incident is a highly complex activity that takes place under pressure of time. Necessary information will be lacking to begin with, and additional information must be secured as quickly as possible.

At the same time, however, there will be a pressing need for immedi-

Computer-assisted modelling can provide a COMA staff with extremely valuable knowledge about the area that may be contaminated after a biological attack or accident.

Photo: CBB

ate recommendations which must be based on whatever information is available at a given time. Securing this kind of information and providing qualified decision support under such circumstances cannot be done by one or two individuals; input will be needed from many people with a variety of specialised competences.

The Danish biopreparedness system upon which the recommendations in this book are modeled is therefore structured around a staff of specialised advisors known as COMA; the acronym stands for Coordination of Operative, Medical and Analytical advice.

COMA analyses information and suggests solutions

The COMA staff is led by a coordinator who, with the help of his staff, can provide overview and momentum to decision-making and response efforts - even in the face of sub-optimal conditions.

Standard operating procedures create clarity

To ensure that all the all necessary tasks in a biopreparedness organisation are performed in a uniform manner and at a consistent level of quality, a set of internal guidelines should be developed. These are the so-called *standard operating procedures*, or SOPs.

Such documents are meant to provide guidance and clarity with respect to work processes. An SOP could, for example, be the list of items to check when briefing the COMA staff, descriptions of how to use personal protective equipment or a step-by-step instruction of how to take environmental samples at the site of a biological incident.

For quick reference, some SOPs in the Danish system have been summarised in the form of *action cards.* They are designed to serve as concise reminders of how to perform specific procedures. These cards are strategically placed near relevant vehicles, pieces of equipment or locations. They provide further assurance that important processes and rules are remembered and complied with.

The subject matter and quantity of SOPs will vary according to the needs and objectives of your own biopreparedness system. The important thing is that a clearly stated SOP should ensure that no one is in doubt about what they need to do in a given situation.

The main tasks of the COMA staff are to:

- provide the coordinator with relevant and constantly updated information about the incident
- continually assess the situation as it unfolds
- suggest specific decisions and courses of action to the coordinator
- ensure that the coordinator's decisions are implemented

The staff must also maintain contact with all relevant parties during a biological incident, including any field personnel and external authorities.

The work of COMA is supported by three key activities

To accomplish these tasks, the COMA staff have three important and specialised capabilities at their disposal:

- mathematical modelling experts who can identify hazardous areas and predict the outcome of different possible scenarios, for instance the number of casualities
- field investigation teams (FIT) (which include a fully licensed medical doctor with CBRN experience) who are trained and equipped to conduct investigations in biologically hazardous areas
- PhD-level laboratory scientists who can analyse the clinical and environmental samples gathered by the FIT

These three key areas – modelling, field investigations and laboratory analyses – are essential to the investigation of a biological incident, and as such are regarded as the three supporting 'pillars' of COMA's work. We will describe these activities in further detail in Section 2.

A dual-duty system ensures an efficient organisation

The COMA staff is activated in response to a given incident and is made up by members of the available staff at the Danish Centre for Biosecurity and Biopreparedness (CBB).

During normal working hours, CBB employees are engaged in a variety of tasks related to both biosecurity and biopreparedness (administration, inspections, training exercises, education, research, etc.) Everyone has been trained to serve on a COMA staff or perform supporting duties that match their professional profile and qualifications in the event of a biological incident,

CBB has found this dual-duty system to be an efficient way of organising its employees.

COMA staff functions

In their capacity as advisors to the coordinator, the COMA staffers in the Danish system have specialised modelling, medical and laboratory competences. This enables the COMA staff to provide the best possible assessments of the information provided by their colleagues in the field during a biological incident.

The COMA staff includes the following positions:

- An operative advisor
- A medical advisor/analyst
- A laboratory advisor/analyst
- A modelling advisor/analyst
- A log-keeper
- A secretarial/administrative assistant
- An information/press officer

The operative advisor on a COMA staff is experienced in the area of field investigations. The medical advisor, like the physician on a field investigation team, is a PhD-level medical doctor. The laboratory advisor has the same training and education as the scientist who analyses material provided by field investigators. The laboratory advisor is familiar with the practicalities of the laboratory analysis and the modelling advisor is an IT expert who can perform highly specialised biopreparedness modelling tasks as needed.

The evalutation of an incident is summarised in a flow chart

To illustrate the process by which an unfolding incident is evaluated and a COMA staff is created, we have created a fold-out flow chart which has been placed at the back of this book. As you continue to read about the various phases of a biological incident response in this and other chapters, it may be useful to refer back to the chart, which provides a concise overview of the entire process.

All of the above-mentioned activities and more will be discussed in greater detail throughout Section 2. But we will begin here with a few more words about the three key activities, and the ways in which biological incidents may result in the activation of a COMA staff.

Computer-assisted modelling has several uses

In the event of a biological incident, mathematical modelling expertise using specialised software is initially employed to estimate the extent of the contamination that can appear in the wake of the incident. This type of computer-assisted calculation activity is called *dispersion modelling.*

Among other things, dispersion modelling is used to generate a *dispersion map*, which shows the likely surface contamination in a specific geographical area. Such maps can be used by police to cordon off and/or evacuate the contaminated area – referred to in this book as the *hazard area*.

We will discuss dispersion modelling and hazard areas in greater detail in Chapter 6.

Dispersion modelling may also be used in connection with the decontamination of areas affected by a biological incident. We will discuss this usage in Chapter 10.

Intervention modelling helps predict countermeasure outcomes

During the course of a biological incident response, computer-assisted modelling can also be used to predict the outcomes of various possible countermeasures and mitigation efforts – vaccination and medical treatments, for example. This type of calculation activity is known as *intervention modelling*.

Intervention modelling may be defined as computer-assisted mathematical modelling with a view to measuring the effect of the interventions that are possible in a given situation involving a specific biological agent.

In the context of intervention modelling, a hazardous, three-dimensional area referred to in this book as the *area of exposure* may also be modelled. We will return to the subject of intervention modelling in Chapter 9.

Computer-assisted dispersion and intervention modelling are complex activities that require a high level of education and experience.

Field investigators are the 'eyes and ears' of a COMA staff

Field investigation teams in the Danish biopreparedness system consist of two persons: a senior-level medical doctor and a biopreparedness specialist who can also perform basic computer-assisted modelling. Most of their work takes place directly at the site of a biological incident, and they are therefore regarded as the 'eyes and ears' of the COMA staff.

Together, the field investigators must:

- provide COMA with continuously updated on-site situation reports and assessments
- find and render safe any delivery device that may still be releasing a hazardous biological substance
- perform environmental and clinical sampling in accordance with a prepared strategy

Laboratory scientists are an indispensable part of a biopreparedness response.

Photo: CBB

- help verify the predicted hazard area
- provide – in cooperation with COMA – immediate medical and safety advice to authorities and others at the site of the incident

While performing these duties, FIT will remain in radio contact with COMA colleagues who are based at the biopreparedness centre.

In Chapters 6 and 7, we will demonstrate more fully how field investigations contribute to response activities after a biological incident.

Lab analyses provide the answers

To answer the question as to what has taken place at the site of a biological incident, laboratory scientists and a well-equipped laboratory are necessities. Laboratory analysis will identify any specific biological

agents that may be present in the samples taken by FIT. Knowing the identity of the agent is an absolute prerequisite for initiating effective medical treatments and other countermeasures.

Laboratory analysis is also the basis for confirmation of the hazard area predicted via computer-assisted modelling. Later in the response process, a laboratory scientist may also be needed to analyse the effectiveness of decontamination activities (see Chapter 10).

Analysis of samples form the field also reveal important microbiological clues that can be of assistance in a criminal investigation of a biological attack. This kind of scientific evidence can, for example, help establish where the substance was manufactured, and in some cases even point to the identity of the perpetrator of the attack.

For some types of analyses, COMA's laboratory will need assistance from other laboratories that are specially equipped to analyse extremely dangerous biological materials.

In Chapter 8 we will provide more detailed information about specific laboratory techniques and procedures as they relate to biopreparedness.

Round-the-clock work may be needed during an incident

It should be noted that a COMA staff and the persons involved in the three key biopreparedness activities may be needed around the clock during a biological incident. This means that additional teams or individual experts may be needed to continue the work initiated by others.

In other words, a biopreparedness organisation must have a fairly large number of available and trained personnel at its disposal.

Expertise must be available 24/7

CBB has a emergency number which is answered 24/7 by competent personnel. All suspicions of uncontrolled presence of dangerous biological materiale can be reported to this number. Such calls could be made due to the discovery of a suspected delivery device, an accidental release of a hazardous biological agent, or suspicions related to the possibility of a covert biological attack

Calls to the emergency number will often come from the police, who of course tend to be the first to receive reports of suspected crimes. But a call could also be made by a public health officer, a biosecurity officer, a hospital doctor, or an ordinary citizen.

All calls are handled by a specially trained duty officer who is a senior-level medical doctor with specialised knowledge of biological threats. The duty officer secures detailed answers to a set of prepared questions that will help decide very quickly whether an incident response needs to be mounted and a COMA staff needs to be formed.

Field teams can also be summoned 24/7. This ensures that necessary response activities can be initiated at any hour.

Police and fire fighters needs to know when and how to contact biological experts

The system described above is intended as an emergency service with respect to biological hazards. Every organisation or person who works with first response or who could get in contact with hazardous biological substances should be familiar with the biopreparedness organisation, the emergency number and the necessity of reporting any biological incident or suspicion of an incident.

In the Danish biosecurity system, the biosecurity officers mentioned earlier automatically receive the necessary information and training

for reporting a biological incident. Biosecurity officers are appointed at all relevant facilities throughout Denmark, both public and private.

The personnel of other emergency services such as police and fire departments should be trained to recognise indications that a biological incident is unfolding and the need to call a biopreparedness organisation.

Recognition of covert attacks is a large challenge

Familiarity with a biopreparedness organisation is no less important when it comes to recognising and reporting suspicions of a covert biological attack.

As noted in Chapter 2, such incidents are by definition not recognised until after symptoms of illness begin to appear, because there has been no discernible event (the discovery of a delivery device, or an accident involving a hazardous biological substance) that could raise an immediate alarm.

Here it is important that everyone in the healthcare system is aware that a biopreparedness organisation exists, and that it can provide expert advice and assistance in interpreting the signs of a covert attack. All relevant persons (public health officers, healthcare professionals, clinical laboratory specialists, etc.) should be familiar with the organisation and feel comfortable about reporting any suspicious circumstances.

In our next chapter, we will discuss the challenge of recognising a covert biological attack – preferably at a point in time where countermeasures have a good chance of mitigating its effects.

section 2

Biopreparedness in action

We are now ready to examine how the principles of biopreparedness can be implemented in practice.

The chapters of this section will follow the basic chronology of a biological incident, beginning with the daily monitoring of trends and events that have relevance to biological threats, and continuing through the phases of attack, response and mitigation.

We will also take a closer look at the work of field investigators, mathematical modelling experts, laboratory specialists, health authorities, police and first responders, and the decision-supporting role of a biopreparedness organisation.

To illustrate this chronology, we will in Chapter 5 introduce a fictional attack scenario that will be presented as a series of episodes and follow-up discussions.

The scenario will continue throughout the remaining chapters of this section.

4

recognising a covert biological attack

Rapid recognition of a type 2 (covert) biological attack can make a life-and-death difference to victims. Goal oriented and flexible collaboration between organisations, coupled with routine monitoring procedures and an awareness of specific attack indicators and risk factors, can help make this possible

One of the greatest challenges facing a biopreparedness organisation is the recognition of an unfolding attack. Early recognition of a biological attack enables timely action that can vastly improve the prognosis for anyone who was exposed to a dangerous biological agent.

Ideally, prophylactic treatment of victims should take place before symptoms get the chance to appear. It is during the incubation period – the time between exposure and the appearance of symptoms – that treatment has the best chance of stopping the disease in its tracks. This is a window of opportunity that should be put to good use if possible.

The challenge lies in the fact that a biological attack is so well-suited to covert use. The agent itself is invisible, and the victims who are exposed to it without their knowledge will not feel its effects until the end of an incubation period that can be anywhere from a few hours to several weeks.

By the time the first signs of illness appear, the window of opportunity will at best be only partly open.

Some types of incidents can be recognised early

The likelihood of a timely recognition is highest in cases involving the accidental release of a legitimately possessed hazardous biological substance (type 3 incident). This is because the trained staff at legitimate facilities consists of professionals who have emergency procedures in place and who can be expected to report the accident to a biopreparedness organisation as quickly as possible with the intention of full cooperation. At the same time the identity of the agent is known, as are the release site and time of release. In addition it is possible that a release can be contained at the premises without causing danger to citizens.

This means that police and biopreparedness entities can immediately begin working together to identify and cordon off the potential hazard area, help contain the agent if needed and, if possible, make

sure that those who were exposed to it receive prophylactic treatment.

A biological attack in which the release site is known due to the discovery of a delivery device or suspected substance (a type 1 incident), also has a chance of being recognised prior to the occurrence of disease. As described in Chapter 2, such findings anchor the location of the attack and the release site geographically. This means that there is a starting point for a Field Investigation and for the modelling of the hazardous area. These circumstances can facilitate successful countermeasures before symptoms of illness begin to appear.

Type 2 incidents use the element of surprise

A biological attack in which the release site has *not* been identified (a type 2 incident) is a different matter. In such cases, the attack will not be noticed until its victims begin to present in hospitals and medical clinics.

Even so, early treatment of post-symptomatic patients is more likely to be successful than it would be at a later time. And it is highly likely that there will be other victims who have not yet begun to show signs of illness, and who can thus gain the full benefit of early treatment.

If the disease in question turns out to be contagious, timely action after the appearance of symptoms is even more important. Mass vaccination (which we will discuss in Chapter 11) and other measures can and must be initiated while it is still possible to prevent an uncontrolled epidemic.

In short: regardless of the incident type, it is critical to initiate countermeasures as soon as possible. If not before, then immediately after the first symptoms of illness appear.

A biopreparedness organisation will need external 'allies'

Recognising the earliest signs of a type 2 incident can, however, be a

challenge because of the element of surprise. Even after symptoms begin to appear, suspicions may not be raised to begin with. Many diseases present with unspecifc symptoms initally including some of the biological warfare agents – anthrax, for example – can cause symptoms that initially resemble those of influenza. This can delay recognition, reporting and an appropriate response.

To ensure that a type 2 attack is recognised at the earliest possible moment, there should be clear criteria and procedures for healthcare workers to report suspicions to a biopreparedness organisation, there should be clear and testet lines of communication and a continual and close coordination between biopreparedness organisations, healthcare organisations, police and intelligence communities.

Disease outbreaks must be carefully evaluated

Because the first indication of a type 2 incident is an accumulation of sick individuals, the first persons to notice anything out of the ordinary are likely to be employees in the healthcare sector – doctors and nurses - in coordination with public health authorities who monitor outbreaks and epidemics of specific serious diseases.

Public health authorities conduct continual surveillance to detect unusual disease patterns that could indicate the emergence of a new epidemic or the appearance of a new type of disease. Such monitoring of disease outbreaks should of course also include looking for signs of a covert biological attack. Most countries have procedures in place whereby a diagnosis of certain serious infectious diseases must be reported to a central pubic health authority. Measures should be taken to make sure that a biopreparedness organisation also recieves such reporting since this could give a critical early warning.

General awareness of bioterror issues should also be encouraged among employees in the hospitals, clinics, medical laboratories and other institutions that are in direct or indirect contact with patients. Their suspicions should be reported to a biopreparedness organisation as well as to public health authorities.

Descriminating between natual outbreaks and attacks

There are a rather large number of epidemiological or clinical indications – referred to as *attack indicators* – that could bear the 'signature' of a covert type 2 attack. Surveillance should be in place so that these indicators will be noticed, analysed and reported to the relevant authority.

Attack indicators include, but are not limited to:

- a compressed epidemiological curve (i.e. a rapid rise in cases of illness over a short period of time), that peaks within hours or days (a possible indication of food poisoning)
- a large number of patients appearing within a period of 48-72 hours (illness due to microorganisms) or within just a few hours (illness due to biological toxins)
- a steadily increasing flow of patients
- a vector-borne illness which appears in an environment that does not suit the vector
- an outbreak of disease that is unusual for a given area
- simultaneous disease outbreaks in geographical areas that are not linked to each other (possibly indicating multiple attacks)
- unusually high rates of pulmonary involvement in a disease which, in its natural form, is non-pulmonary (possibly signifying an aerosol attack with a biologically altered agent)
- a geographical distribution of cases that seems to align with a prevailing wind direction
- fewer fatalities among patients who work indoors, especially in locations with closed ventilation systems or air filtering systems (possibly signifying an outdoor attack)
- increased fatalities among patients who work indoors, especially in locations with the above-mentioned ventilation or filtering systems (possibly signifying an indoor attack)
- unusually large numbers of sick or dead animals (some biological weapons affect animals as well as humans)
- a large number of cases with few symptoms and rapidly developing fatalities (indicating that a large number of people may

have been exposed to lethal bioweapon dosages near a covert attack site).[1]

Any one of the above indicators should be flagged and reported to the biopreparedness organisation.

An initial suspicion is necessary to trigger an outbreak investigation

Once the first suspicion has been reported, a biopreparedness organisation can apply its own expertise to the information and, with the help of its external partners, further evaluate the possible threat.

An evaluation of this kind will be referred to in this book as an *outbreak investigation*. Its initial purpose is to help determine whether a given disease outbreak is due to natural causes or could have been caused by a deliberate biological attack.

In a biopreparedness context, an outbreak investigation can begin when occurrence of relevant disease without a known cause is reported. Occurrence of one or more attack indicators will raise the initial suspicion and further investigations will be initiated to clarify the situation. An investigation requires the formation of a COMA staff that will probably need to will function for a prolonged period of time. A highly prioritised task will be to locate the release site og sites so that a response can be initialled on site (see also the box in Chapter 6, 'Outbreak investigations may reveal a covert attack site').

Some cases will be irrelevant to the investigation

When conducting an outbreak investigation, a clear *case definition* should be established to distinguish between clinical cases that are relevant to the disease outbreak in question and those that are not. A case definition provides a set of criteria which must be fulfilled in

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1 NATO handbook on the medical aspects of NBC defensive operations (biological), AmedP-6(C) Vol II, p.2-3.

order to identify an ill person as a victim of the disease outbreak in question (rather than having a different, unrelated illness).

These criteria should include such information as the individual patient's age, sex, occupation and residence, as well as information about that person's presence in specific areas or facilities at a time that is relevant to the disease outbreak. Clinical and laboratory findings should also be included, once these become available.

Ambulance dispatch patterns can give an early warning

The Danish Center for Biosecurity and Biopreparedness has developed a surveillance tool called BioAlarm that monitors the Danish ambulance dispatch data with the purpose of detecting a possible outbreak of bioterror relevant disease.

Relevant ambulance dispatch data may provide an early indication of a possible biological incident

Photo: Colourbox

A primary alert is automatically activated if there is an increase in demand for relevant ambulance transport that exceed statistically predefined thresholds. A call can then be made to public health authorities in the relevant region to discuss the possibility of a suspicious incident. If necessary, a COMA staff will then be activated to conduct further investigations.

Other automatic surveillance systems have been developed to detect outbreaks of specific diseases. However, because they are disease-specific and dependent on the results of laboratory analyses, they are not very well suited to early detection of diseases caused by an unknown biological agent.

Biomedical intelligence provides background knowledge

In a biopreparedness context, the term *biomedical intelligence* is used to denote intelligence resulting from an analysis of relevant medical, bioscientific and environmental information from domestic and international sources.

For example, general information about emerging biological or bioweapons related technologies in a relevant country or institution could, upon further analysis by a biopreparedness organisation, become useful biomedical intelligence in connection with a specific biological incident.

This type of information is essential to assessments of capabilities and intentions of a potential adversary. It is also necessary in order to be able to competently assess any incident suspected of being a biological attack.

Media and website monitoring may be useful

Relevant information related to the likelihood of a biological attack can also come from domestic and foreign television and radio broadcasts, as well as from various websites. The main purpose of monitoring these sources is to acquire knowledge of any real time occur-

rences of disease outbreaks, terrorist activity or other trends around the world with relevance to biopreparedness.

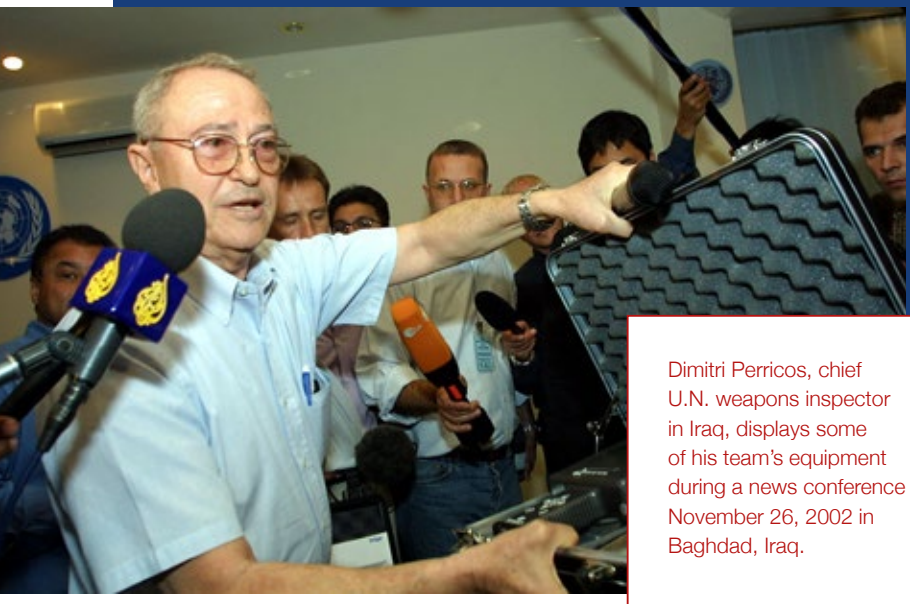
News of serious disease outbreaks, possible biological attack sites and/or biological threats around the world can be found on several websites, including:

- The World Health Organisation (search the website for “disease outbreak news”)
- The Centers for Disease Control and Prevention (search the website for “CDC Health Alert Network”)
- Healthmap.org
- Outbreaks global incident map: outbreaks.globalincidentmap.com
- Center for Infectious Disease Research and Policy: cidrap.umn.edu
- Global Biodefense: globalbiodefense.com
- Outbreak News today: outbreaknewstoday.com
- Outbreak News: outbreak.news
- Food Safety News: foodsafetynews.com

Monitoring sources such as those mentioned above should be a regular routine in a biopreparedness organisation.

The next step: responding to an attack

In the next few chapters, we will take a closer look at a type 1 incident scenario, and show how the knowledge, education and skills of a COMA staff, modelling experts, field investigators, police, emergency services and public health authorities can be used to initiate an appropriate response.



Dimitri Perricos, chief U.N. weapons inspector in Iraq, displays some of his team's equipment during a news conference November 26, 2002 in Baghdad, Iraq.

Photo: Getty Images

A case of smoke and mirrors

The fact that the development of biological weapons can be easily concealed (for instance as legal defense research) has led to some remarkable intelligence failures with respect to biopreparedness and biological warfare.

Western agencies thus failed to notice the buildup of an extensive Iraqi biological weapons arsenal in the 1980s; its presence was not revealed until the Iraqi dictator Saddam Hussein threatened to use it in 1990, just before the first Gulf War in 1991.

After losing the war, Hussein had to agree to destroy these weapons, but he blocked the inspection efforts needed to prove compliance. This led to the suspicion that the arsenal still existed – a suspicion backed up by misinformation from an Iraqi refugee in Germany, who claimed insider knowledge about the continued presence of biological weapons in Iraq.

After the second Gulf War in 2003 – which was fought precisely because of this flawed intelligence – it became clear that the arsenal had in fact been destroyed a decade earlier. But Saddam Hussein had apparently found it useful to keep up the illusion of having biological weapons at his disposal.

And so, the world failed to see these weapons when they were present – and then thought they were present when they weren't.[2]

2 Centre for Biosecurity and Biopreparedness, Copenhagen. Det biologiske trusselsbillede (Danish-language report on biological threats). 2016.

5

Responding to an emergency call

In this chapter, we introduce a fictional but not unrealistic type 1 scenario to help illustrate how the principles of biopreparedness are used in practice. We will return to the story several times over the next few chapters as we discuss the events, responses and collaborations that can take place during the investigation of a biological incident.

Day 1: 06:00
The powder hits the fan

Imagine a busy, urban train station during an early-morning rush hour. The time is 6 a.m., and hundreds of passengers are arriving and leaving, hurrying past a forgotten briefcase that stands unnoticed under a bench. What also goes unnoticed is the fact that this particular briefcase has an odd hole in it.

The first to spot the briefcase is a train conductor who is always suspicious of abandoned luggage. He takes a closer look, discovers the hole and sees an odd, powdery residue around the opening. A whirring noise seems to be coming from somewhere inside the case.

The conductor gets a little of the mysterious residue on his fingers and rubs it off on his pants. Then he decides to leave the case exactly where it is and call the police.

Meanwhile, an unseen substance is emerging from the briefcase – invisible except for the residue it has left behind. It has already covered the entire train station with an imperceptible layer of dust and is now spreading into the surrounding neighborhood, where it drifts up and down the streets and begins to seep through the doors and windows of buildings and cars.

Discussion:
Quick countermeasures could contain this incident

A story that begins in the manner described above points to a classic type 1 biological incident: a suspicious object has been discovered that may indicate the possibility of a biological attack. No illness has been reported, so any infection caused by such an attack will still be in the incubation stage.

As discussed in Chapter 4, preventive medical treatment in connection with type 1 incidents has a good chance of stopping the disease before symptoms develop. And if the train station has indeed become the site of an attack, it will be possible to perform dispersion modelling, define the hazard area and cordon it off, thus preventing contamination of persons who might wander into the area.

A critical point at this time is the actions of the train conductor. It is very important that he reports his findings to the police which in turn can make the connection to the biopreparedness experts.

06:10
Telephones begin to ring

At the police station, the inspector who takes the call from the railway station has been trained to recognise possible signs of terrorist activity. He also has some knowledge of bioterrorism – enough to know that the incident described by the conductor is probably not a chemical attack, which would have resulted in immediate symptoms of illness and distress.

The police inspector makes a quick call to a police intelligence source to see if there have been any specific threats against the train station, but there are none. Then he calls the emergency biopreparedness number to discuss whether there is a need for further investigation.

His early-morning call is automatically routed to the medical duty officer who takes biopreparedness inquiries. The medical officer immediately sees the danger of contamination and the possibility of terrorist involvement. He therefore decides that a threat analysis is immidiatedly necessary.

Discussion:
A threat analysis is an important biopreparedness tool

The threat analysis initiated by the medical duty officer is a systematic analysis of the immidiate situation at hand. All the available information about a newly reported biological incident is gathered and analysed quickly with the intention of making a sound decision about a possible response operation. It can involve input from a variety of sources including, for example, witnesses, police and other emergency responders, health authorities and intelligence sources. The result of the analysis is discussed with the reporting police inspector and a common understanding about the situation and what needs to be done is reached.

With respect to type 2 incidents, a threat analysis will be more protracted in time and will involve multiple authorities and their inputs including information that could relate to one or more of the attack indicators listed in Chapter 4.

A type 3 incident (accidental release) will not involve a threat analysis, because no terrorist activity is involved. To denote the difference the Danish Centre for Biosecurity and Biopreparedness (CBB) uses the term *risk analysis*, which does not contain questions related to the possible perpetrators of terrorism, but addresses the same biological dangers as a threat analysis. In the event that a release would show to be caused by sabotage the incident would change into a type 1 or 2 incident.

Threat and risk analyses are used by CBB to quickly gain an overview of the case, discover whether it involves a biological hazard, and determine whether a COMA staff should be activated. The analysis will also determine whether the incident requires a *full response* or a simpler *flexible response.*

Some incidents require more activity than others

A full response involves most or all of the investigative procedures and tools at the disposal of a biopreparedness organisation, including COMA staff, computer-assisted modelling, cordoning off hazardous areas and a complete field investigation.

If necessary, a full response will also include mitigation efforts performed by a variety of external organisations and emergency responders.

A flexible response requires less activity, equipment and personnel. It is used in situations where a threat or risk analysis has made it apparent to the biopreparedness experts that the incident does not involve any dangeorus biological substances, but where there may be a need for guidance and reassurance of persons on site or other types of counselling from the biopreparedness organisation.

The decision as to the required level of response - full or flexible - must always be based on a threat or risk analysis, and that the decision to take any kind of action requires medical and biopreparedness expertise.

Important questions must now be asked

To ensure that a threat analysis properly illuminates every aspect of the case, the standard operating procedure at CBB is to use a prepared form with a set of central questions that must be addressed. This includes both basic who-what-where data, as well as specific and technical information that can help determine whether there is a biological threat to life and health.

Of primary importance to a threat analysis is off course the issue of whether a dangerous biological substance is involved in the incident. Other critical concerns include the question of whether the substance has been released into the environment or is contained at the site, and whether a possible release was intentional (criminal or terrorist involvement) or caused by accident.

A biological attack in the middle of a crowded train station could ultimately affect thousands of people.

Photo: Pixabay

Questions should be phrased in a neutral manner

To gain accurate information, it is important that persons who are interviewed in the course of a threat analysis are allowed to provide input in their own words with as much detail as possible.

Leading questions that could prompt someone to answer in a certain way must therefore be avoided. Instead, questions should be phrased as neutrally as possible, and in a way that encourages more than a yes-no answer. Questions to ask the police inspector in our scenario might include, for example:

- What has happened?
- Why do you suspect biological danger?
- Who reported to you and can you connect me directly with this person?
- Do you have any information about this from other sources?
- What did they tell you?
- Are there persons with symptoms of disease, pain, discomfort?

The above types of questions can reveal information about the circumstances surrounding the incident and the possible presence of a biological substance - without putting words into the mouth of the person being questioned. In many instances they can also help to quickly refute the suspicion of biological danger. This is very important in order to avoid the highly disruptive effect on the public order of an unnecessary field investigation.

Standard safety precautions should be observed

If the medical duty officer who takes the initial call has any suspicion of a biological danger, he should provide the caller with some immidiate standard safety rules that should be observed until more information about the incident becomes available and – crucially – until a hazard area can be pointed out.

The main precaution at this point is to stay at least 200 metres up-

wind of the suspected source of contamination. This precaution will later be changed and refined after the hazard area has been modelled, and it will probably change again after laboratory analyses have been performed.

06:20
The police receive some preliminary advice

Because the possibility of a harmful release cannot immediately be ruled out, the medical duty officer tells the police inspector that everyone at the scene of the incident should stay upwind of the briefcase until further notice, adding that they should keep themselves at a distance of at least 200 metres from it.

The two men also agree it would be a good idea for the inspector to get in touch with railway authorities and stop all train traffic in and out of the station. In addition, the platform where the briefcase was discovered should be cleared of all passengers, and further access to the platform should be blocked.

The medical duty officer then promises to call back as soon as possible with more detailed information about the possible hazard area, and advises the police to refrain from taking any further action until then.

After this conversation, the medical duty officer notifies the on-duty field investigation team that will examine the site of the incident, if a full response is deemed necessary.

06:30
The train conductor tells his story

The medical duty officer then gets in touch with the train conductor, filling out the threat analysis form with new information as the telephone interview progresses. He is par-

ticularly struck by the conductor's description of the whirring sound and the powdery residue around the hole in the briefcase.

Discussion: Eyewitnesses can provide highly useful details

As evidenced by our scenario, the medical officer was able to gain some highly descriptive and useful details from his interview with the train conductor. Questions that can elicit this kind of information might include:

- Can you tell me exactly what you saw and heard?
- Why did you report the briefcase?
- Describe the briefcase
- Was there anything out of the ordinary about the briefcase?

Supplementary questions – asked in a neutral way - can encourage witnesses to amplify their initial replies. If possible, it would also be helpful to have the witnesses photograph any suspicious objects and transmit the photo via mobile phone to the biopreparedness agency.

A flexible response is enough for many incidents

Many biological incidents will not require a full response. In a traffic or laboratory accident involving a dangerous biological substance, for example, the substance might still be safely contained after the accident.

In cases where no dangerous biological agent has been released, the primary biopreparedness job is to provide guidance to ensure that the receptacle containing the agent is safely conveyed to a place where it can be securely stored. This can be accomplished with a flexible response and a minimum of fuss and public disturbance.

It is important to understand, however, that a flexible response will only be used if the preceding threat or risk analysis has positively ruled out any type of biological danger.

A full response will always cause some disruption

In Chapter 2, we noted that avoiding unnecessary disruption of public order - if there is no credible threat - is one of the priorities of the Danish biopreparedness organisation. But if a full response is needed - because a threat can not be ruled out - disturbances will be unavoidable and are a part of the price to be paid for an effective response.

Again, it is important to highlight the importance of the threat or risk analysis that is made by the biopreparedness organisation at the time a report is received.

If a threat analysis of an incident involving powdery material in a letter gives rise to a credible suspicion of a terrorist anthrax attack, for example, the incident will require a full-response investigation, including a laboratory analysis. Such incidents will also require full-response safety precautions such as police cordons and evacuations.

If the investigation later proves that the substance in the letter is harmless, the biopreparedness response can quickly be terminated and the hoax can be investigated by the police, who will seek out the perpetrator.

COMA is activated when a full response is needed

So far in our scenario, however, the evidence does not point to a hoax - and it is obviously not an accident, harmless or otherwise. On the contrary, everything at this juncture indicates the deliberate release of an unidentified substance that could be harmful.

06:50
A COMA staff is formed

It doesn't take long for the medical officer to decide that a harmful biological substance may indeed have been released at the train station. He decides that a COMA staff must be

activated right away, and that the on-duty Field Investigation Team should immediately prepare to conduct a field investigation as part of a full response.

6
Managing an incident investigation – COMA

Once the response activities begin, the COMA coordinator must keep track of developments that involve his own organisation as well as the police and other authorities and agencies. Overview, smooth collaboration and constant updates are essential.

Day 1: 08:00
The COMA staff prepares for action

A plan has been set in motion: a COMA staff is being formed, a full response is about to begin, and a field investigation team consisting of a medical duty officer and the biopreparedness specialist will soon be dispatched to the site of the incident at the train station.

The appointed COMA coordinator has already drawn up a list of the persons that will perform the various functions on the COMA staff at the biopreparedness centre. His first order of business is to call them all together for a briefing.

At this initial meeting, he instructs the information officer to check all pertinent websites for news that could be relevant to this incident. The coordinator also instructs the staff to draft a series of requests for information that are to be relayed to police and intelligence sources.

The coordinator also alerts the on-duty laboratory scientists, who must be prepared to receive and analyse the material that FIT will bring back from the incident site. Going forward, he will remain in close contact with the laboratory, the field investigators and any external source that can update the situation and enable effective collaboration and decision support.

Discussion:
COMA is at the centre of a critical flow of information

The COMA staff play a pivotal role in a biological incident response, during which a great deal of information will be flowing in and out of the biopreparedness centre.

Squarely in the middle of these information streams is the COMA coordinator, who must keep track of all incoming and outgoing threads

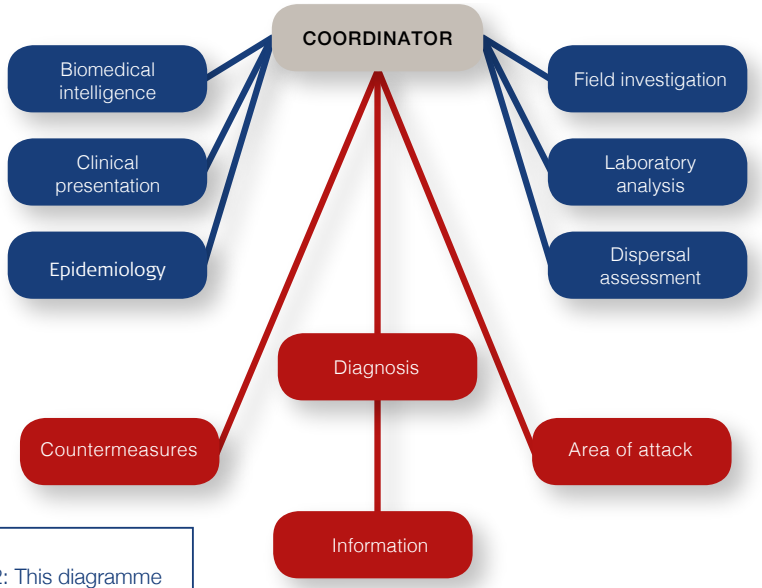


Fig. 2: This diagramme shows where a COMA coordinator gets his information and how this information is processed into specific 'outputs'.

of communication, and who is ultimately responsible for providing information, situational updates and decision support to authorities.

Fig. 2 illustrates how this flow of information places the coordinator in the 'eye' of the action.

Input to COMA comes from internal and external sources

Inward-flowing information (the blue boxes to the left and right of the coordinator in Fig. 2) comes from the internal and external sources noted in Chapters 3 and 4, respectively.

To recapitulate, internal sources of input include the three key activities mentioned in Chapter 3: field investigations, modelling activities, and laboratory analyses. The information generated by these ac-

tivities includes dispersion maps, outcome predictions, clinical and environmental samples from the incident site, and laboratory analysis that identify and characterise specific biological agents.

Externally derived data includes input to biomedical intelligence analysis and information about attack indicators (unusual clinical presentations or epidemiological patterns) noted in our discussion of covert attacks (Chapter 4). External input could also come from observations reported by police, emergency services personnel, eyewitnesses, external laboratories and more.

COMA output includes specific recommendations

These incoming data from internal and external sources are assessed and analysed by the COMA coordinator and his staff and transformed into some important outputs (the red boxes in Fig. 2) for use either by COMA itself or by external authorities.

The COMA staff must provide answers to some important questions very quickly that fall in three categories:

- Situation - what is going on?
- Prognosis - what is going to happen?
- Recommendations - what can be done about it?

Specific questions that must be answered include:

- diagnosis - the identity of the biological agent
- information about the area of attack - location of the hazard area and area of exposure
- countermeasure recommendations - police cordons, medical treatments, evacuations etc.

The reporting mentioned above could take place via briefings given by liaison officers, written reports, website updates and statements to the press issued in response to a given situation.

We will discuss the above outputs in more detail throughout the rest of this book.

07:00
The first dispersion map is generated

Immidiatedly after being notified by the medical duty officer the field investigation team on duty starts a computer-assisted dispersion analysis using all the information that is currently available. The results of this analysis are visualized in the form of a dispersion map that police can use as a guide for setting up cordons around the hazard area.

The dispersion map is relayed to the police station and the police incident commander, who will coordinate the on site operations including the cordoning off of the hazard area.

The incident commander recieves a copy of the hazard area map on his laptop as he drives onward toward the train station. By telephone he is briefly instructed by a COMA staff advisor as to how the map must be used as a guide for cordoning off the hazard area.

The advisor also counsels the incident commander about a safe route that will prevent him from crossing through the hazard area on his way to the station.

Police will need help with the cordons

The incident commander has also been advised to stay at least 200 metres upwind of the train station and the suspected delivery device, so when he reaches the train station area, he parks at an appropriate distance, opens his laptop and takes a look at the dispersion map.

Even at a glance, he can see that the hazard area is huge, and he realises that the police will need help to cordon it off.

Discussion:
It can take days to cordon off a hazard area

Fig 3 shows an example of a dispersion map as it might appear in our train station scenario. The elongated, plume-shaped zone represents the hazard area, which extends outwards from the presumed release site (the narrowest end of the plume) in the direction of the wind. The shape of the hazard area reflects the effect of the wind direction on an aerosol agent.

As the incident commander in our scenario has already discovered – and as you can see in Fig. 3 – a biological hazard area can be extremely large especially in the context of urban neighbourhoods. Cordoning off such areas effectively is a task that can take days to complete, and the orderly evacuation of a hazard area is an even greater challenge.

Less than optimal decisions may have to be made about which areas should be cordoned off and evacuated first, and COMA must provide informed support for such decisions.

Many factors can affect the size of the hazard area

The size and shape of a hazard area will be affected by a number of factors, including

- the exact identity of the agent
- the time of its release
- the mode, speed, duration and efficiency of its release
- the amount of agent released
- the nature of the delivery device
- meteorological conditions

Accurate mapping of the area requires detailed weather information, including the speed and direction of the wind, as well as data about temperature, humidity, barometric pressure and precipitation.

Fig. 3: This dispersion map of the hazard area described in our train station scenario shows how far a biological agent can spread across an urban area in a relatively short period of time.

Outbreak investigations are needed to reveal a covert attack site

As you have seen, the dispersion map generated in our type 1 scenario is an indispensable tool for the response efforts we have described in this chapter. Such maps are based in large part on the location of a suspected delivery device.

A covert (type 2) incident in which symptoms of illness have begun to appear, and in which no delivery device has been found, is a far more complex matter. Identifying a hazard area in such cases will require an extensive outbreak investigation which must focus on identifying an unknown source of contamination that is causing an unexplained illness.

Such investigations are based on disease knowledge, biomedical intelligence, patient interviews, and sampling procedures that focus on anything the patients may have in common: their residences or workplaces, for example, or their activities on specific days during the incubation period.

The Danish Centre for Biosecurity and Biopreparedness has done some initial work to supplement these epidemiological techniques with computer-assisted modelling. During a naturally occurring outbreak of Legionnaire's disease in Denmark in 2015, the above-mentioned types of data were processed by an experimental software that ultimately focused suspicions to particular geographical locations as the source of contamination.

A dispersion map may be updated periodically

In the early hours of an investigation such as the one described in our scenario, the initial dispersion map must be based on the information that is available at the time, plus some qualified assumptions about missing information and the nature of the incident. As more information becomes available, primarily through on-site investigations, the modelling process is repeated, which in turn can have consequences for the physical organisation of the indicent site. Updated modelling and dispersion maps are necessary to ensure that COMA can provide the best possible situation assessments and decision support for response efforts.

07:30
Emergency responders assemble at the incident site

Recognising that the logistical task ahead will require a great deal of manpower and materials, the police incident commander requests additional police forces and assistance from the fire brigade. The setting up of cordons and other logistical tasks at the incident site will demand man power. Via the biopreparedness center he also ensures that the public health authorities are notified. Their presence will be needed in connection with the evacuation of the hazard area and the particular instructions to the exposed citizens (see also the box, 'Who are the emergency responders?', ed.).

All personnel is instructed to meet at a safe staging area which the incident commander has identified in cooperation with the biopreparedness center and demarcated with barrier tape. At the staging area – an empty quay at the nearby municipal harbor – the first respondes will receive briefings and tasks.

The incident commander also repeats the safety warning given to him by the COMA staff: on their way to the staging area, response crews must be wary of the wind direction and

make sure to use a route that will not take them through the hazard area.

The field investigators are also in the loop

At this point, the incident commander gets a call from the field investigation team that will soon be arriving to investigate the hazard area. They will meet at the staging area and present a hard copy of the dispersion map for briefing and clarification regarding the area to be cordoned off.

Discussion:
Hard-copy dispersion maps are reliable

To ensure that the dispersion map is available to police as soon as possible, the Danish biopreparedness organisation (CBB) always transmits the map electronically to the senior policeofficer on duty at the police station and to the police incident commander at the site.

In our experience, however, the reading and interpreting of a dispersion map by non-specialists must be accompanied by a detailed explanation by a specialist – preferably without having to depend on the use of electronic equipment that adds complexity to field work. For field use hard copies are more reliable and written notes can be added to the map during briefings.

Hard copies of the map are therefore given to the police incident commander and the firebrigade incident commander. These commanders will in turn be responsible for communicating the necessary information to their respective pesonnel, and must also impress upon them the importance of taking the proper safety precautions with respect to the hazard area.

Any disturbance in the hazard area is dangerous

The formal definition of a hazard area is the area over which an aerosol (airborne) cloud of a hazardous biological agent has caused

a surface contamination that exceeds a pre-defined threshold set by the relevant competent authority i.e. the government biopreparedness organisation.

The hazard is primarily created whenever the agent that has been deposited on the ground or other surfaces is disturbed, either by the wind, an air current or any type of physical activity. This can cause particles of the substance to whirl back into the air *(re-aerosolisation)*, where they can easily be inhaled and cause infection.

At this point, it should be noted that there is still no positive proof that a hazardous biological substance is present at the train station in our scenario. However, the threat analysis conducted at the biopreparedness centre has established the likelihood of such a danger.

In other words, as soon as a threat analysis indicates that an area may be biologically hazardous, it must be treated as a hazard area until investigated further. As any activity in the area risks causing re-aerosolisation of dangerous particles only the Field Investigation Team should enter the hazard area defined by the dispersion map and of course only with the use of full *personal protective equipment* (PPE).

This equipment includes a protective suit, boots, gloves and headgear, plus a breathing apparatus with a filtrator or a self-sufficient air supply.

Decontamination will also be necessary

Safe entry into a hazard area is assured by the use of PPE, but it is imperative that response personnel are also able to safely *leave* the area. This happens through decontamination.

After spending time in a hazard area, the outside surface of protective clothing will be heavily contaminated; removing these suits and handling them without precautionary measures would put the personnel using them at risk of infection. It would also risk spreading contamination outside the hazard area. For these reasons the hazard

area can only by left after decontamination of the personnel in their protective suits.

The surface of any item or piece of evidence that is brought out of a hazard area must also be decontaminated. In this context, we will explain decontamination procedures in Chapter 7.

An incident site should be divided into three areas

The diagramme shown in Fig. 4 illustrates how emergency activities at the site of a biological incident can be organised to protect both the public and emergency responders from contamination and infection. The diagramme (which does not necessarily reflect actual distances or shapes) divides the incident site into three areas:

- a hazard area, which is contaminated. Entry only for FIT wearing PPE.
- a safety area which contains the hazard area and buffers the surroundings from it. Entry requires PPE.
- a working area that surrounds the safety area and ensures working space for responders undisturbed by the general public. The working area is uncontaminated, so responders can work here without PPE.

The outer edge of the working area should be demarcated by a police cordon. This barrier – the outer cordon shown in the diagramme – marks the 'border' that the general public should not be allowed to cross.

The hazard area should be clearly demarcated by an inner cordon.

The working area puts distance between the public and the biological hazard, and enables response personnel to work freely without the need for PPE. An incident command post (ICP on the diagramme) would be placed in the working area, where it will serve as the headquarters for response at the tactical level. The holding area shown in the diagramme is also placed in the contamination-free zone; this is where evacuees can be received and registered (see Chapter 7).

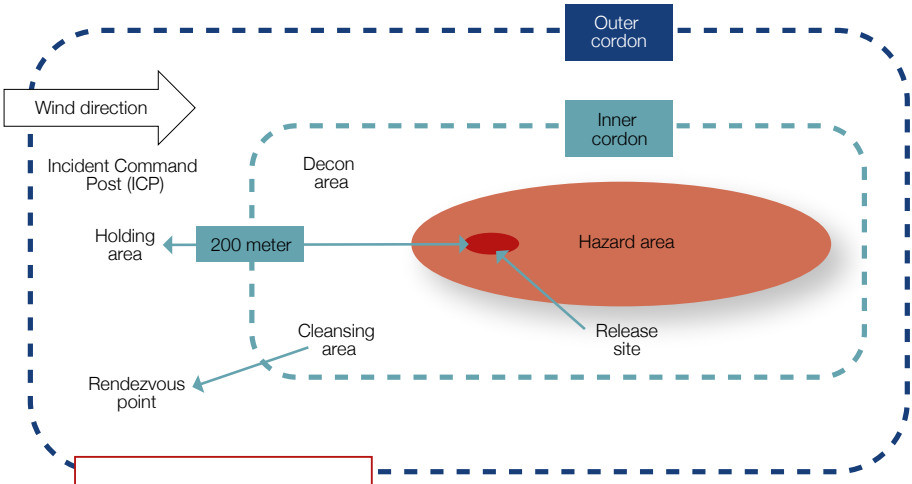


Fig. 4: A biological incident site should be organised in such a way as to protect both the public and response workers from contamination and infection.

FIT will perform its work in the hazard area

The safety area (defined in Fig. 4 by an inner cordon) is where decontamination and cleansing activities take place (see Chapter 7). This area is not safe in the respect that it is absolutely free of contamination. It is rather to be understood as an area where some contamination can occur in connection with unclean activites i.e. where the transition from contaminated to decontaminated occurs. Contaminated equipment can be left temporarily in this area. Work in this area requires PPE.

The orange, oval-shaped area in the diagramme represents the hazard area shown on a dispersion map i.e. the area where contamination is deposited at levels exceeding the pre-defined threshold. This is the area where field investigators wearing full protective gear will conduct their investigations. This area contains the release site where a delivery device can possibly be found.

In Chapter 7, we will show how all the above areas are brought into play during a biological incident response, transforming the incident site into a hive of activity.

08:30
FIT leaves for the incident site

Back at the biopreparedness centre, the field investigators are ready for departure. Just before leaving on their mission, they plan a safe route to the train station and test their communication gear, making sure that the proper channels are open to COMA and to the police incident commander.

A van containing the necessary equipment for a field investigation (see box, ed.) is ready to roll, and as the investigators pull out of their parking garage, they call the incident commander once again – this time to let him know their estimated time of arrival at the staging area.

Who are the ‘emergency responders’?

The terms ‘emergency responders’, ‘emergency response personnel’ or ‘first responders’ are used to describe persons from different emergency services that can vary from country to county. Depending on the situation, these words could mean anything from police, fire fighters, ambulance drivers and paramedics to SWAT teams and bomb squads.

In the context of this book, ‘emergency responders’ are either the field personnel of CBB or personnel from other services who can who can perform practical and supportive actions during a biological incident.

Such personnel can be police and other general preparedness workers who might be organised as part of a municipal fire department, a civil defense organisation or the military. Some of these have units with protective clothing and breathing apparatus as part of their standard equipment.

Emergency responders also include persons from public health authorities that are equipped to deal with large-scale medical emergencies.

In Denmark, a police division of the Home Guard is also trained to provide practical assistance during large-scale emergencies.

7

Operations at the incident site

Barriers must be set up, samples must be taken, and people must be evacuated – all under pressure of time while observing meticulous safety precautions and criminal investigation procedures. National crisis management will become necessary.

Day 1:09:00
Field investigators meet with the incident commander

Vehicles filled with emergency responders, barrier materials and other supplies have begun to pull into the staging area as the two field investigators arrive to meet with the police incident commander. They immediately show and explain the dispersion map.

It is decided that work on the outer cordon and other demarcations will begin around the train station near the staging area. The first visible barriers and lines will thus serve to make response crews immediately aware of the zones in which they can safely begin their work, as well as the areas in which PPE will be needed.

It is also agreed that the outer cordon must allow for a wide, contamination-free working area inside the cordon, where

Field investigators must always use protective clothing and equipment when working in a hazard area.

Photo: CBB

the incident commander will establish a command post (ICP on the diagramme in Chapter 6, ed.). The command post will serve as headquarters for response efforts at the tactical level.

Mine tape will be used to demarcate the safety area, where decontamination and other activities will take place. This tape will likewise be used to define the hazard area.

Evacuation will have to take place in stages

It quickly becomes clear that the outer cordon will ultimately have to encircle an extremely large neighbourhood, and that evacuation activities cannot wait until the barrier is completed.

Moreover, they realise that the enormous logistical challenge of this operation means that not everyone can be evacuated at the same time. Establishing the cordon and evacuating everyone inside the hazard area will have to take place in stages, and prioritisation and clear guidance will be needed.

COMA is consulted

At this point, the FIT medical officer makes a call to COMA to discuss the evacuation issue. This is one of many situational updates that will be made during the FIT mission.

Realising the magnitude of the task at hand the COMA coordinator notifies the relevant higher authorites and recommends to the police that evacuation should commence with the people inside the train station, where the danger of contamination is greatest. He then advises the public health authority that a decision about evacuating the rest of the huge hazard area should await preliminary laboratory analyses which can provide a much clearer picture and either refute or confirm a biological attack.

Discussion:
National crisis management will be needed

The situation in our scenario has now reached a point where a higher level of crisis management will be needed.

For one thing, decisions about evacuating a huge area of the city will require higher-level participation at a national and political level. Moreover, an operation of this magnitude will require help from a variety of regional or national response units which must be centrally organised.

The precise organisation of the national crisis management system in Denmark is beond the scope of this book but a system of police Situation and Operations Centers (SIOC's) has been implemented in recent years at national and regional levels in addition to the existing National Operational Staff (NOST). The NOST is the coordinating arm of the Danish National Crisis Management System. NOST is activated by the Danish government during large-scale emergencies, and it communicates with on-the-ground response leaders as well as with national decision-makers.

This entity includes government representatives as well as police, public health and emergency service leaders at the national level. NOST can therefore activate national plans that will release the necessary resources for the logistical and medical challenges that lie ahead.

10:00
Cleansing facilities for exposed citizens will soon be set up

Immediately after the meeting with FIT, the incident commander contacts the local police station with a situation report, and asks that steps be taken by police to inform and involve the country's national crisis management authorities.

The incident commander also reports that work on the cordon will continue 24/7 and that it will probably take several

days to complete. Meanwhile, emergency service personnel will soon start setting up cleansing facilities for train station evacuees.

Discussion: Cleansing will prevent cross contamination

The cleansing process mentioned above is intended for unprotected evacuees. It consists of a thorough soap-and-water shower, which must take place in the safety area before these persons enter an uncontaminated neighbourhood. New clothing (inexpensive sweat suits, for example) is given to the persons who are cleansed, while the original clothing is taken away and safely destroyed.

It must be stressed that *cleansing* cannot prevent illness in unprotected persons. Biological agents cause illness primarily through inhalation; their potential effects can therefore not be washed away. The cleansing process is only meant to prevent unprotected persons from cross contaminating others with biological residue that may still be on their clothing or skin.

Cross contamination – either from person to person or via a contaminated object – is a serious matter. During the anthrax episode in the US in 2001, two of the five persons who died of anthrax inhalation had been nowhere near any of the contaminated areas, but it is believed that they may have received mail that had been cross contaminated by one of the anthrax-tainted letters during postal processing.[1]

Not everyone will be cleansed

If possible, all evacuees from the site of a biological incident should be cleansed. However, in situations involving large crowds and limited cleansing resources, the Danish biopreparedness organisation

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1 Thompson, M. The Killer Strain: Anthrax and a Government Exposed, p. 164. 2003, HarperCollins Publishers Inc, New York, NY.

advices a practical distinction between *contaminated persons* and *exposed persons*.

- Contaminated persons are defined as people who have been so close to the source of contamination that they have actually seen it and/or have visible residue on their clothing. This is likely to be a small group.
- Exposed persons have not been close enough to the source to see it, and do not have visible residue on their clothing.

Only contaminated persons are cleansed.

Emergency services should take care of the triage

The cleansing process takes place in the safety area, where response personnel must wear protective clothing. The facilities for this (tents containing portable outdoor showers) must therefore be set up and manned by emergency responders who have PPE at their disposal (firebrigade).

To accomplish the necessary triage, these emergency service personnel must briefly speak with and divide evacuees into two streams: one for exposed persons and one for contaminated persons. Exposed persons will bypass the cleansing process and be taken straight to the holding area (which we will discuss later). Contaminated persons will be cleansed before moving on to the holding area.

Persons who have been cleansed in the safety area should afterwards be able to step directly into the contamination-free working area.

09:30
Another call is made to COMA

After the meeting with the incident commander, the field investigators put on their protective clothing, take the gear they will need out of the van, and approach the train station building on foot.

Personnel in front of the station are just beginning their work on the outer cordon as the two investigators pass through to the safety area and set up their decontamination tent.

The biopreparedness specialist then contacts the COMA coordinator to verify their strategy for taking samples in the hazard area.

Discussion:
Sampling activity must be carefully planned

Field investigators should be able to take any kind of relevant sample from a hazard area, including a variety of environmental samples (air, water, surface swabs, etc.) as well as clinical samples from humans, animals, corpses or carcasses. Prior to beginning these investigations, FIT should prepare a *sampling strategy* which can, if necessary, be adjusted or changed in consultation with COMA.

In general, the strategy should rest on the following principles:

- proceed from lowest to highest concentration of agent (reducing the risk of cross contamination)
- obtain enough samples to allow for a second laboratory to confirm and/or repeat initial analyses
- obtain control samples outside and inside the predicted hazard area as a safeguard against false positive laboratory results and to validate the hazard area prediction
- prioritise the types of samples to be taken and the order in which they will be taken

It should be noted that sampling to validate the precise contours of an entire hazard area (which could be several kilometres long) is not practical at this point. Initial efforts should focus on taking a few samples to confirm or refute the presence of dangerous biological material and that the predicted hazard area is plausible.

The team should also bear in mind its duty to:

- render safe any delivery device or other hazard
- look for evidence that could help identify a perpetrator
- use their training and experience to deduce anything else they can about what happened

The 'incubation clock' is always ticking

As a general rule of thumb, it should take about four hours for field investigators to complete their on-site mission. In addition to collecting samples, this includes the time spent setting up their equipment, communicating with COMA, taking photographs, meeting and conferring with other on-site response personnel and conducting decontamination activities.

While all this is going on, the 'incubation clock' will be ticking loudly, reminding FIT that the biological warfare agent, if any, must be identified, and medical countermeasures initiated, before the incubation period is over.

09:30
COMA asks for a change of plan

The two FIT members have prepared a sampling strategy based on the principle of investigating what they assume to be the least-contaminated areas first. The COMA coordinator, however, requests a different priority in this case.

Due to the amount of time that has already passed since the first report of the incident, and because this incident appears to involve a delivery device that could still be dispersing a biological warfare agent, he tells the team to minimise their sampling from lower areas of concentration, and to seek out the briefcase as quickly as possible.

If the briefcase appears to be a delivery device, they are to render it safe, take samples from it, and bring the samples di-

rectly back to analysis. This will ensure the quickest possible identification of the agent.

As per COMA's instructions, the field investigators therefore take just a few environmental samples from areas which, according to the dispersion map, should be uncontaminated. The investigators then shoulder their equipment and walk into the hazard area.

Discussion:
Investigators must travel light

Field investigators must always bear in mind that they will have to carry all necessary equipment themselves whenever they enter an area that requires protective clothing. In practical terms, this means that they will need to prioritise and limit their 'baggage' to items that are absolutely essential.

For the mission at hand, essential items in the hazard area will include

- sampling and packaging materials
- a waterproof camera that can withstand decontamination procedures
- hand-held communication devices
- a laptop computer
- a portable x-ray machine

For their decontamination work in the safety area (where PPE is also required), they will, in addition, need:

- decontamination fluid and a hand-pumped spraying apparatus
- a lightweight tent in which the two investigators will decontaminate each other after their mission
- a basin in which waterproofed items can be submerged in decon fluid

Hazard area samples: handle with care

To withstand decontamination, samples from a biological hazard area must be placed in a vial with a leak-proof stopper that can withstand being submerged in a decontamination fluid for a period of 20 minutes.

After decontamination, the vials must be further wrapped and packaged to ensure safe transport in compliance with relevant international regulations - for example, the European ADR treaty (for transport by road), IATA dangerous goods regulations (for transport by air) or the IMDG code (for transport by sea).

The primary containers (the stoppered vials) should be placed together in a rigid, secondary leak-proof container; each vial should be separated from the others by absorbent material in order to prevent breakage.

Finally, the secondary container should be placed inside an outer packaging that is clearly marked with the relevant UN dangerous goods code to indicate the biological hazard level of its contents.

An x-ray machine is a valuable examination tool

The x-ray machine enables investigators to examine the inside of a suspected delivery device or other large item without opening it up or taking it apart – an activity which could involve some danger. For example, the briefcase in our scenario might be boobytrapped to hamper render-safe operations.

The briefcase could, on the other hand, contain valuable clues that would make an x-ray examination worthwhile – clues about the nature of the delivery device, the amount of biological agent that has been released, or even clues about the identity of the perpetrator.

X-ray devices such as the one that will be used in our scenario are designed to be connected to a laptop, allowing x-ray images to be shown on the computer screen. Via the laptop, these images can also be transmitted out of the hazard area to COMA and the police.

10:00
Train station personnel provide valuable assistance

Approaching the train station, the investigators see that uniformed train station personnel (who themselves are among the potentially exposed persons) are preventing newcomers from entering the station building.

Inside the station, however, the building is still teeming with people who were stranded after the trains were stopped an hour earlier. The investigators can now see that a stairway leading down to one of the platforms has been blocked with an improvised barrier and a sign with the words 'closed for maintenance'.

As requested by the medical duty officer when the incident was first reported to the biopreparedness centre, station personnel have also cleared the platform where the briefcase was found. This action has probably prevented many passers-by from becoming contaminated.

Investigation and evacuation begin

Looking down the blocked stairway, the investigators quickly catch sight of the briefcase under a bench. Thanks to the empty platform, they can now approach the presumed delivery device and perform sampling activities.

As they begin their work, the investigators hear an announcement coming through the train station loudspeaker system: everyone inside the station is informed that an incident may have occurred that makes it necessary to evacuate the building.

Immediately afterwards, FIT makes another call to the COMA staff to let them know that they have found the presumed delivery device and are about to begin their investigations.

Discussion: Sampling standards must not be compromised

Despite the need for speed, sampling activities must be conducted according to rigorous standards. Mistakes at this stage can lead to false laboratory results, which could be disastrous with respect to the investigation, the ensuing mitigation efforts, and any court case that relies on the samples as evidence.

Standard operating procedures based on rigorous scientific expertise should therefore be developed as part of the response guidance for biopreparedness entities. FIT personnel should be intimately familiar with every detail of these procedures, and they must also be highly experienced with the use of their equipment and other practicalities.

A primary concern with respect to sampling is to avoid contaminating the samples with substances that can later disturb the laboratory analysis. For this reason, single-use, sterile sampling utensils and sterile handling techniques must always be employed. Utensils that have been used for sampling should afterwards be left behind in the hazard area and later destroyed.

The samples themselves must be kept cool throughout the mission to prevent degradation and should be refrigerated under transport.

A chain of custody must be meticulously recorded

Each sample must be properly labelled, packaged and registered according to the principles of a crime scene investigation. Among other things, this means that the entire *chain of custody* must be documented for each sample.

A chain of custody document is a chronological list that identifies every person who has handled a given object or specimen. The purpose of this is to prevent any tampering, contamination or unexplained loss of the evidence.

Chain of custody recording begins with the initial sampling, continuing through the transport chain to the laboratory and the analytical, investigational and judicial process until the sample is destroyed or is no longer needed for any purpose related to the case. New information is added to the form every time the evidence in question changes hands.

Photographic evidence is essential to an investigation

The waterproof camera that the field investigators have brought with them is extremely important. Photographic evidence will often be the only way to present important pieces of evidence that cannot withstand decontamination, and which therefore cannot be taken out of the hazard area.

Delivery devices such as the briefcase in our scenario will be so heavily contaminated that they should not under any circumstances be removed from the hazard area. Such items must therefore be thoroughly photographed, along with anything else that seems relevant to the case. The camera should show the date and time of each photograph.

Hand-written notes from a hazard area investigation should likewise be photographed and thus digitally stored in the camera; the x-ray pictures, meanwhile, can be digitally transmitted out of the hazard area via the laptop.

Before any photography or sampling begins, however, field investigators must perform initial 'render safe' procedures. This includes making sure that any delivery device at the incident site is deactivated.

10:15
The source of the whirring noise is revealed

As they approach the briefcase to take a closer look, the investigators begin to hear the whirring sound described by the train conductor. Peering through the hole in the briefcase, they can just make out the contours of a little, busily spinning fan.

They immediately realise that the fan could be a battery-driven delivery mechanism that is still blowing a biological agent through the hole in the briefcase. A visible, powdery residue around the hole on the exterior of the case is further evidence of this.

The biopreparedness specialist grabs the camera and photographs the briefcase as it is before proceeding to rendering it safe.

Photos and x-ray pictures are taken

The briefcase and its immediate surroundings are now photographed from every side, securing a full 360-degree view of the spot at which the presumed delivery device was found.

They two men then set up the x-ray machine and connect it to their laptop. On the screen of the computer, they can now see the contents of the briefcase: the fan, its battery, and a little box that is attached to the front end of the fan. The box seems to be empty.

The specialist draws some preliminary conclusions

The team once again calls COMA, describing all the visual evidence. It now seems likely that the box had originally

Danish field investigators bring their own, lightweight decontamination tents to the site of a biological incident. These tents are quick and easy to set up, saving both time and effort.

Photo: CBB

contained the biological agent that was used in the attack, and they suggest to the coordinator that the COMA staff estimate the amount of agent that could have been released.

The investigators are becoming increasingly convinced that a biological attack has in fact taken place. And now, having deactivated the delivery device, it is time for FIT to start taking samples from it.

Discussion: Sample-taking activity must also be photographed

To ensure that the samples taken from a hazard area are admissible in a court of law, the process of sample-taking and any other activity or movement/manipulation of objects in a hazard area should be photographed while these activities are actually taking place.

Care must also be taken to properly identify each sample. The standard CBB procedure is as follows:

Each sample is placed in a pre-numbered vial (the number is etched into the glass or written on the vial with indelible ink to withstand decontamination). Samples that are to be inactivated are placed in vials that are prefilled with deactivation fluid; live samples, which will be analysed by an external laboratory, will of course not require this fluid.

The number on the vial in which the sample was placed is then written at the top of a sampling form into which details about the sample are entered. In addition to the identifying number, these details include the date, time and place at which the sample was taken, as well as the type of sample (e.g. surface swab, air sample, etc.), plus relevant remarks or other details.

A photo provides chain of custody information

As a final step, the vial, the completed sampling form, and the person who took the sample are photographed *together* – creating, in effect, a digitalised record of the sampling. This photograph will provide the information that will be needed later for the first entry in a chain of custody document.

The vials must then be properly packaged to ensure that they are leakproof and can be safely transported (see the box, 'Hazard area samples: handle with care').

The above procedure should be repeated for every sample that is taken. Field investigators must make sure that both the number on the vial and everything on the form are visible and legible in the photograph.

11:30
Some samples are inactivated – others are not

Some of the samples taken by FIT are immediately inactivated by placing them in a vial filled with inactivation fluid.

These samples are intended for analysis at the biopreparedness centre's own laboratory, which is not equipped to handle live samples of substances that could be extremely hazardous.

Other samples are not inactivated. These live samples will be sent directly to a high-security laboratory (BSL4) for independent and confirmatory testing. This laboratory is equipped to safely handle live samples of even the most dangerous biological substances. Live samples will, moreover, provide the BSL4 lab with greater freedom to plan their analysis activity.

When the sampling work is finished, the investigators carefully wrap and seal the briefcase. This is not because they plan to take the device out of the hazard area; it is a containment procedure to prevent further aerosolisation from this object.

The team is convinced that an attack has occurred

Via their communication channel to COMA, the field investigators have provided a running account of their activities. And now they inform the COMA coordinator that they will soon begin the process of decontaminating themselves, their samples and the camera.

They also inform the coordinator that, based on their visual assessments of the briefcase, its contents and the scene in general, they are now convinced that a biological attack has taken place at the train station.

After this report, the team walks out of the hazard area and into the safety area, where they will begin decontamination procedures. Everything that cannot be decontaminated is left behind in the hazard area, which will remain cordoned off until further notice.

Discussion:
Many items may have to be sacrificed

We have previously noted that nothing should leave a hazard area unless it has been decontaminated. As you have seen, this applies to written material as well as objects and personnel.

The problem with this rule is that, with the exception of the sealed vials and the waterproofed camera, most items – including expensive, sensitive equipment - will be ruined by the decon fluid. If worst comes to worst, this means that such equipment must be left in the hazard area and later destroyed for reasons of safety.

This is why the FIT vehicle, as noted in Chapter 6, must be equipped with extra communication devices (which of course are kept out of the hazard area).

Equipment can possibly be retrieved later

Further investigation and analysis may reveal that the incident does not involve a harmful biological substance (and fortunately, hoaxes and harmless episodes are more common than attacks or dangerous accidents). If the danger is disproven through sampling and analysis, valuable items that were left behind can be retrieved once an all-clear notification has been given.

On the other hand, if suspicions of biological contamination turn out to be correct, the items in question should be destroyed as part of the larger decontamination operations that will take place at a later point in time (see Chapter 10).

12:00
The evacuation is now in full swing

Much has happened while FIT was conducting their investigations inside the train station building. Now, as they leave the station, the two investigators can see police officers standing in

the working area with bullhorns, instructing the people leaving the station to gather behind the cleansing facilities.

Firemen wearing PPE are standing by in the safety area to receive and triage the evacuees. A few of the people in the crowd – the train conductor who touched the delivery device, for example – will require cleansing before they can be taken to the holding area.

The rest are immediately guided onward to the holding area (which has been set up in a nearby warehouse), where they will receive more information about the incident and about what they must do.

Discussion:
Every evacuee should be informed and registered

At the holding area, medical personnel should be standing by to inform evacuees - individually or in small groups - that they may have been exposed to a substance that could be dangerous. They should also be told when and where to seek medical attention.

Information to evacuees should also include instructions to listen for further media announcements that will at some point confirm or dismiss current suspicions and provide further guidance.

In addition, each person in the crowd should be registered by name, address and cell phone number so that they can be contacted individually by public health authorities if the suspicion of a biological attack is confirmed. Issues related to medical treatment, vaccination and other forms of mitigation will be discussed in Chapters 9, 11 and 12.

Large-scale evacuation will be even more challenging

Later, if and when a larger evacuation must take place, and more of the cordon is in place, additional holding area facilities should be established along the lines of an updated dispersion map.

Shelters and other provisions for large numbers of evacuees will also have to be organised. This will be a task that would involve the national level crisis management organisations and staffs due to the very large number of evacuees.

Volunteer help will probably also be needed, and should be effectively organised when the time comes. Mobilising the public for this type of action is among the subjects related to public communication that we will discuss in Chapter 14.

12:30
The investigators prepare to leave

On returning to their decon tent, the two FIT members decontaminate their camera and the safely packaged samples by submerging them in decontamination fluid. Then, still wearing their protective gear, they take turns spraying each other with decon fluid. The inside of the tent is then also sprayed.

The investigators can now step out of their decontaminated outer clothing, taking care not to get any residual decontamination fluid on their unprotected skin, after which they can cross from the safety area into the working area.

Before they leave, the team has a quick word with the police incident commander, telling him that the suspicion of a biological attack has been strengthened, and letting him know when to expect the preliminary results of their sampling mission. Until further notice from the COMA staff, the commander is to continue work on the cordon and keep the hazard area sealed off as much as possible.

The biopreparedness specialist then makes a final call to let COMA know that their mission has been completed, asking that this information be relayed to the local police inspector and other relevant parties.

The investigators then quickly proceed to their vehicle and head for the biopreparedness centre together with the all-important samples.

8

Laboratories and analysis

During a biopreparedness response, it is the laboratory that provides conclusive proof of what has happened. Results of laboratory analyses will also inform efforts to counter the attack, and may even help find the perpetrator of the incident.

Day 1: 13:30
The laboratory goes to work

The COMA staff is ready for action as the two field investigators arrive with their samples and photographs. The centre's on-duty laboratory scientist (who was alerted in the early morning hours by the COMA coordinator) is standing by together with all the other personnel who will be working on this case.

The inactivated samples from FIT are immediately turned over to the laboratory for analysis, while a COMA staff assistant takes the camera and begins to download the photographs. The COMA coordinator has just been in contact with the military, which has agreed to transport the live samples to a BSL4 laboratory abroad. To this end, a military helicopter is about to land in a nearby parking lot.

The COMA communications officer is also in full swing preparing a statement about the incident for publication on the centre's website.

An analysis strategy has been prepared

While the two FIT members are debriefed by the COMA coordinator, the laboratory scientists begins analysis of the samples.

Thanks to the sampling strategy provided to COMA by the field investigators, the laboratory scientists know the type and amounts of samples that have been taken. They have therefore been able to set up the necessary equipment and prepare a systematic strategy for the analysis which can now be implemented immediately.

The strategy is designed to quickly and efficiently discover which biological agent, if any, is present in the samples. The

first step is an initial screening to determine whether the sample contains any relevant biological substance at all.

Discussion:
The scientists must quickly narrow the search

Unfortunately, there is no universal test that can be used to immediately identify an unknown biological agent. A variety of procedures may have to be tried before a positive result is obtained, so one of the challenges for the laboratory scientists is to develop a strategy that can quickly exclude as many agents as possible from a long list of 'suspects'.

Investigators of a biological incident may sometimes have a strong suspicion that a specific biological substance has been released into the environment. This could, for example, be the case after an accident involving a known agent.

In this type of situation, the scientist may choose a strategy that begins with a specific test to prove the presence or absence of that particular agent, instead of casting a wider net that could be a waste of time.

A screening for biological content may be useful

In our scenario, however, there is still no concrete evidence or information that points to a specific agent. In such cases, the quickest way to begin (and possibly end) the laboratory analysis may well be a quick screening to see if there is *any* kind of biological substance in a given sample. This is best done on a sample that is presumed to have a high concentration of agent; a sample taken from a suspected delivery device would be ideal.

If the initial screening of such a sample shows no biological content, and if there are no other unusual circumstances in the case, the case can be closed regarding biological danger. It can then be turned over to police for further investigation.

Screening begins with a microscope

Initial screening for biological content begins with a visual examination through a microscope. This is a relatively quick and easy procedure, and if enough agent is present in the sample, it may be possible to actually see biological entities such as bacteria, spores or fungi.

A microscope examination can sometimes also indicate whether a given substance was professionally manufactured or prepared by an 'amateur'. Indications pointing to the latter might include a large amount of impurities in the sample.

If no relevant biological entities are immediately visible in the microscope, the sample can be tested for the presence of proteins by running an SDS PAGE analysis – a longer and more complex procedure which is routinely used in molecular and microbiological laboratories. A laboratory scientist will recognise the absence or presence of biological matter when the analysis has run its course, although this will not necessarily be enough to identify a specific agent. It will, however, tell the scientist that further tests are needed.

14:30
The view through the microscope shows suspicious particles

The initial microscope screening reveals many different particles, including spore-like structures that point to spore-forming bacteria. The next step is to check for the presence of proteins by running several dilutions of the sample on an SDS-PAGE gel.

While waiting for the SDS-PAGE to complete its run (this will take about an hour), the scientists document the proces thus far, and then begins to test for the presence of specific biological agents. A prioritised list of biological agents helps decide where to begin.

Discussion:
Agent-specific tests begin with the likeliest 'suspects'

In a laboratory context, a *prioritised list of agents* is a 'short list' list of hazardous biological substances that are believed to be at particularly high risk of deliberate misuse. This list is prepared by the laboratory to help focus its analyses, and is based on local assessments of prevailing threats. It is regularly reviewed and, if necessary, updated.

At the top of such a list are substances which

- pose the greatest danger to human life and health
- have been used before in other terrorist attacks
- are least difficult to obtain
- are least difficult to produce and/or weaponise

If there are no suspicions or evidence to indicate a different testing sequence, the first agent-specific testing should target the substances at the top of a prioritised list.

Prioritised lists may vary from country to country, but *B.anthracis* will almost always be at the top of such lists.

PCR and ELISA assays may be used at this point

A variety of PCR assays can be employed to confirm or rule out the presence of specific bacteria, virus or fungus. If the targeted agent is present in a given sample, a chain reaction will occur which rapidly and exponentially amplifies the amount of that agent in the sample, making it easy to detect.

PCR technology has the advantage of being fast, specific and highly sensitive. On the other hand, it can only confirm or rule out the presence of the targeted agent and will thus not provide information about the presence of an agent that is not included in the PCR assay. Moreover, the presence of inhibitors (impurities from a variety of sources) can compromise the results of this test.

As the investigation gets under way DNA-based methods of analysis such as Polymerase Chain Reaction (PCR) become central.

Photo: CBB

Even so, PCR assays are widely used in clinical diagnostics; a laboratory scientist will typically run several PCR analyses at the same time, thus targeting several substances at once. The technology can be a powerful tool if properly handled, and if the results are interpreted correctly.

Another kind of agent-specific testing called an may be used to investigate the presence of specific biological toxins. This type of assay takes advantage of certain antigens that are present on the surface of toxin molecules, and which will react with matching antibodies that are present in the assay.

Like the PCR assay, an ELISA assay is very sensitive, and can only confirm or rule out the presence of the targeted agent. Both technologies require careful control procedures to ensure a correct conclusion.

Biomarkers must be carefully chosen

Testing for specific agents – regardless of the method – relies on seeking out certain *biomarkers* that are specific for the agent in question. Such biomarkers include, for example, unique nucleic acid (DNA) sequences, antigenic epitopes, microscopic characteristics or certain growth properties.

Careful selection of biomarkers for use in identification is necessary in order to avoid false positive or false negative test results.

19:00
A preliminary result is achieved

The laboratory scientists sets up several different PCR and ELISA assays that will run simultaneously, thus enabling targetting several of the substances on the laboratory's prioritised list.

Later SDS-PAGE analysis is checked and it shows a positive result, confirming that the sample has a biological (protein) content.

Minutes later, one of the PCR assays confirms the presence of *Bacillus*, a genus of bacteria which, among others, includes the *B. anthracis* bacteria. PCR analyses for all the other selected bacteria are negative, while the ELISA assays indicate that none of the selected toxins are present in the samples from the train station.

This is an important result which the laboratory scientists immediately communicate to the COMA coordinator. More tests will be needed, however, to determine whether the specific bacterium is in fact *B. anthracis* – and if so, whether it is a disease-causing strain or a non-pathogenic sibling.

Further tests focus on three specific biomarkers

The next step for the scientists is to perform an even more specific PCR assay which targets a specific DNA sequence and two specific plasmids (pX01 and pX02), all of which are biomarkers that indicate the presence of an unspecified but pathogenic *B. anthracis* strain. In less than an hour, the answer is ready, and the scientist once again contacts the COMA coordinator.

The message this time is more straightforward: the biological agent in the train station samples is indeed a disease-causing strain of *B. anthracis*. Further testing will determine exactly which pathogenic strain is involved.

20:00
A new dispersion map is sent to the police

The latest laboratory results have made it clear to the COMA staff that the train station incident was a deliberate attack, and that a range of countermeasures – logistical as well as medical – must be rolled out as quickly as possible.

Now that the field investigation has given detailed and specific informations and the agent has been identified, the COMA modelling experts generate an updated dispersion map which also reflects a rough estimate of the amount of agent that was dispersed and uses the latest meteorological data.

Copies of the new map are quickly dispatched to the police incident commander at the train station.

Because the area is practically unchanged COMA advises the police not to spend time adjusting the barriers that have already been set up, but to use the new map as a guide for the barriers that are not yet in place.

Discussion:
The agent in question may not be viable

Terrorists – biological or otherwise – can sometimes make mistakes that thwart their own intentions. Such was the case in 1993, when members of the Japanese cult Aum Shinrikyo dispersed aerosolised *B. anthracis* spores from the roof of a building in the Japanese city of Kameido. No one was harmed.

As it turned out, the cult had mistakenly used the non-virulent Sterne strain of the *B. anthracis* bacteria for its attack.[1] This strain is widely available around the world for use in veterinary vaccinations.

In the context of our scenario, mistakes may have been made by the perpetrator – an ineffective attempt at weaponisation, for example – that could inadvertently have killed the bacteria before it was released at the train station. Other factors such as exposure to sunlight or a problem with the dispersion process could also affect the viability of a given agent.

Conclusive proof that the agent really is alive and therefore capable of causing harm will require tests on samples that have not been inactivated - testing that can only be performed at a BSL4 facility. For the same reason, a BSL4 laboratory is also the only facility that can test whether genetic alterations (such as making an agent more resistant to treatment) are functioning correctly.

To wait, or not to wait? COMA must decide

For COMA staff in our scenario, this means that the staff must now decide whether to recommend initiating medical countermeasures and large-scale evacuation based on the laboratory analysis so far or await further information from analysis at the BSL-4 LAB, which can take days.

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1 Keim, P. et.al. Molecular Investigation of the Aum Shinrikyo Anthrax Release in Kameido, Japan. Journal of Clinical Microbiology Dec 2001, 39 (12) 4566-4567; DOI: 10.1128/JCM.39.12.4566-4567.2001. Accessed at https://jcm.asm.org/content/39/12/4566

20:00
The 'incubation clock' is still ticking

13 hours have passed since the first alert was received from the conductor at the train station. No evidence has yet been discovered to suggest exactly when the delivery device was left under the train station bench, but it could have been in place for hours before it was discovered.

COMA's medical advisor reminds the other staff members that the average incubation period for an anthrax infection is 2-5 days, which means that the first symptoms of illness could begin appearing within the next 24 hours.

Before then, the necessary medical supplies must be ready, and facilities must be established where prophylactic treatment can be administered to thousands of people in order to prevent a massive outbreak of disease.

Medical countermeasures cannot be postponed

COMA decides very quickly to recommend that evacuation of the rest of the hazard area continues, and that immediate steps be taken to ensure prophylactic medication for the exposed population.

At this point, the situation has escalated to a level where political decision-making and national crisis management is involved. The COMA recommendation is therefore presented to the government's national crisis management staff wich has the coordinating role at the government level.

Discussion:
The laboratory work must continue

Plans for mass medication and a broader evacuation are important consequences of the laboratory work that has been done thus far in our scenario. But the laboratory effort is far from finished.

A deeper investigation of the agent can provide important information about the specific strain of *B. anthracis* that was used in the attack, as well as information about possible genetic alterations that could affect the treatability and other characteristics of the agent (see the five dimensions described in Chapter 2).

Antimicrobial resistance or other genetic alterations could have a huge, negative impact on the outcome of the treatment that will be provided to the exposed population.

DNA sequencing is the next step

This type of investigation begins with DNA sequencing – the process of identifying the sequence of nucleic acids in a strand of DNA. The process can be used to describe some or all of the genetic information that is stored in the DNA of a *B. anthracis* bacterium, for example.

DNA sequencing is a computer-assisted technology in which the laboratory scientists extracts and purifies a DNA sample from a biological substance and then runs it through a DNA sequencer – a scientific instrument which essentially digitises the biological DNA information. Among other things, this process makes it possible to compare the entire genome of a specific strain of agent with the genome of the same strain in an expert-verified database.

Difference between the nucleic acid sequences in the database sample and those of the targeted sample could indicate that the latter has been genetically modified in a specific and identifiable way that could affect treatment outcomes. It could also point to other types

of changes that could be significant to a police investigation (see the sections below on microbial forensics).

At the time of this writing, New Generation Sequencing (NGS) was the fastest and most accurate technology for detecting alterations to a nucleic acid sequence. It can deliver results within just a few hours.

Day 2: 01:00
DNA sequencing yields some disturbing information

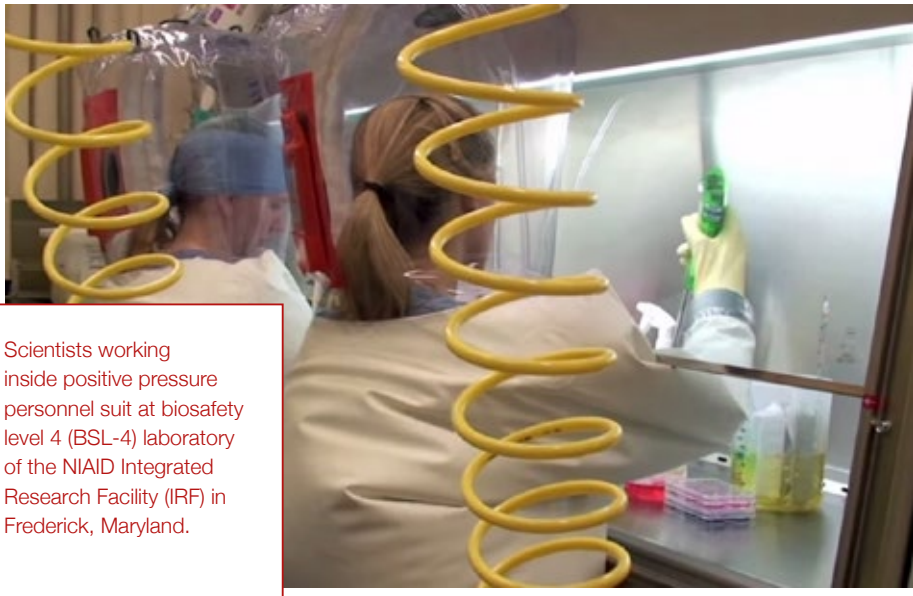
Having provided an initial identification of the *B.anthracis* bacteria, the laboratory scientists now begin a DNA sequence analysis to learn more about the agent. A few hours later, the genetic information provided by the analysis reveals that the strain in question is the notorious Ames strain – the same one that was used in the US anthrax attack in 2001.

Fortunately, the sequence analysis does *not* reveal any unusual antimicrobial resistance patterns compared to the database sample. This means that the substance has not evolved or been genetically altered in a way that could make it particularly resistant to treatment.

This information is immediately passed on to the COMA coordinator. The coordinator, in turn, informs the public health authorities who will oversee the rollout of medical countermeasures.

The BSL4 lab must now perform a pivotal task

While this is taking place, the BSL4 laboratory is performing the pivotal task of determining whether the samples it has received from the biopreparedness centre are in fact alive. Viability is tested by culturing a sample in an appro-



Scientists working inside positive pressure personnel suit at biosafety level 4 (BSL-4) laboratory of the NIAID Integrated Research Facility (IRF) in Frederick, Maryland.

Photo: NIAID / Wikimedia

priate growth medium; final proof that the sample is alive is achieved if and when germination and growth are observed.

The laboratory is also working to corroborate that the agent in hand is the Ames strain of *B. anthracis*, and that it shows no unusual antimicrobial patterns. If the BSL4 lab should independently discover any such genetic alterations to the agent, it will also test to see whether these changes work as intended.

Uncertainties must be accepted

It will be three days before any growth in the *B. anthracis* samples can be expected; by that time, the rollout of evacuation and medical countermeasures will already be well underway. If the samples turn out to be non-viable (i.e. harmless), the entire activity will be called off.

Based on all their experience and expertise, the COMA staff

finds it highly likely that the anthrax spores in question are both alive and dangerous, but they cannot be certain until the BSL4 results are received.

Meanwhile, the laboratory scientists at the biopreparedness centre will begin to look for microbial forensic evidence that could be of assistance to the police.

Discussion: Microbial forensics can generate solid evidence

DNA sequencing is a key capability in the field of *microbial forensics*, a form of criminal investigation in which laboratory findings at the molecular level can generate important clues for use in a police inquiry.

As indicated earlier, small alterations to nucleic acid sequences can be caused by deliberate genetic manipulations with criminal intent. But these changes may also be caused by a naturally evolving response by the agent to culturing conditions, for example.

Such changes can sometimes be so specific that they can be used to trace an agent back to the laboratory at which an agent was produced.

In addition to studying these types of genetic identity changes, a laboratory method called *stable isotope analysis* can identify microscopic traces of chemicals that were present in the solid or liquid growth medium used during the production of a given bioweapon. This can link the agent to a specific growth medium or production batch, thus bringing investigators even closer to the actual perpetrator.

External help may be needed

Finding the culprit in this way can be a painstaking and time-consuming process that can involve a variety of external organisations. In addition to partnering with criminal investigators, it could be neces-

sary for a biopreparedness organisation to enlist the help of chemical expertise when conducting the stable isotope analysis, for example.

Microbial forensic investigations could also involve identifying laboratories around the world with the capacity to investigate the type of biological weapon used in a specific attack.

Microbial forensics solved the Amerithrax case

Despite its challenges, microbial forensic investigations can, if properly performed according to strict scientific and legal protocols, generate new investigative leads for police and ultimately help link a biological attack to a specific perpetrator.

A pioneering use of microbial forensics took place after the Amerithrax attack in the US, where researchers from the Institute for Genome Sciences at the University of Maryland School of Medicine combined their expertise with that of FBI investigators and ultimately identified both the source of the weapon and perpetrator of the attacks.[2]

Next: a look at medical countermeasures

In our next chapter, we will show how the mass distribution of appropriate medication can help beat the 'incubation clock' after a biological attack.

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2 Science Daily. University of Maryland Medical Center. Microbial forensics used to solve the case of the 2001 anthrax attacks. 8 March 2011. Accessed at https://www.sciencedaily.com/releases/2011/03/110307151913.htm

9 Medical countermeasures and intervention modelling

Good decision support and fast rollout are key to a successful mass medication campaign during a biological incident. Intervention modelling can facilitate this process, but procuring enough medicine and establishing distribution centres for a large population can be a challenge.

Day 1: 21:00
Decision support is urgently needed

Having established the fact that a biological attack has in fact taken place, COMA must now provide advice about the medical countermeasures that will be needed to mitigate its effects. Implementing these countermeasures will be a huge challenge that must be met at a point in time where evacuation of an enormous area of the city around the train station is also just getting underway.

The specific challenge for COMA will be to provide actionable decision support to public health, government and/or crisis management authorities. This support must be based on informed outcome predictions and the best possible medical advice.

Discussion:
Medical countermeasures can both prevent and treat

Medical countermeasures may be defined as life-saving medicine and medical products that are used to diagnose, treat or protect against illness caused by exposure to a hazardous biological agent. Examples of medical countermeasures include the use of vaccines, diagnostic tests, antibiotics (against bacteria and viruses), and antiserum (against toxins).

Medical countermeasures may be administered prophylactically to persons who are not ill or have not yet begun to present symptoms. They may also be used post-symptomatically to treat persons who have reached the end of an incubation period and have begun to show signs of illness.

Antibiotics, vaccinations and serum are used

There are two types of prophylactic (preventive) countermeasures: *chemoprophylaxis* and *immunoprophylaxis*.

Chemoprophylaxis in a bioweapons context consists of preventive treatment with antibiotics that target bacteria, viruses and certain fungi. Chemoprophylaxis must always be initiated as quickly as possible after a potential exposure, as this will increase the likelihood of preventing illness.

Immunoprophylaxis in a bioweapons context can be either active or passive; active immunoprophylaxis refers to the process of vaccination, while passive immunoprophylaxis involves preventive treatment with an antiserum.

Widespread vaccination would seem to be an obvious choice for the protection of healthcare workers, rescue personnel and ordinary citizens. There are, however, some important restrictions and drawbacks to this approach which we will discuss in the chapter on mass vaccinations (Chapter 11).

Specific treatment advice should be readily accessible

Prophylactic or post-symptomatic treatments after a biological attack will of course involve a wide variety of medications and treatment regimens, depending on the agent in question. To save time in an emergency, a biopreparedness organisation may consider publishing detailed treatment instructions for a variety of hazardous biological substances on its website, where these guidelines can be quickly accessed.

The Danish Centre for Biosecurity and Biopreparedness website includes detailed disease descriptions and treatment guidelines for a number of agents which, based on a threat analyses, have been prioritised due to a particular risk of misuse. By way of example, we have translated an excerpt from the recommendations for treatment of persons who have been exposed to aerosol *B. anthracis* in the box ‘Treatment of inhalation anthrax’.

Intervention modelling clarifies the consequences of tough decisions

The intervention modelling activities mentioned in Chapter 3 can provide the type of information that a COMA staff will need to support its medical countermeasure recommendations. To recapitulate, intervention modelling is defined as computer-assisted mathematical modelling to measure the effect of possible interventions in a given situation involving a specific biological agent.

Intervention modelling is performed with the help of software that can simulate the effects and outcomes of various countermeasures, both medical and logistical. For example, the information generated through intervention modelling makes it possible to

- compare projected casualty figures with or without medical treatment
- compare projected casualty figures resulting from early treatment as opposed to later treatment
- predict the effect of cohort isolation in a given population
- predict the effect of quarantine in a given population

Who has been exposed: The area of exposure

To ensure that all persons who may have been exposed to the agent are included in these or any other intervention calculation, computer-assisted modelling to identify the area of exposure (also mentioned in Chapter 3) must first be performed. This area includes the original hazard area but is much larger (see Fig. 5).

Whereas the danger in the hazard area is caused by surface contamination, the area of exposure is defined as a geographical area over which the release of an aerosol biological agent has created a concentration of agent *in the air* that exceeds a predefined threshold.

Fig. 5: This dispersion map – created by CBB as a hypothetical illustration – shows how the size of a hazard area (the inner ring, red colour) might compare to the size of the area of exposure (the outer ring, light blue colour) after an attack in an urban area.

Treatment of inhalation anthrax

If the number of persons infected with inhalation anthrax is limited, ciprofloxacin 400 mg IV or doxycycline 100 mg IV may be administered twice daily. Multi-combination treatment using 1-2 other types of antibiotics is also recommended – for example, vancomycin, penicillin, ampicillin, chloramphenicol, imipenem, klindamycin or clarithromycin. Depending on the overall state of health, a transition to peroral treatment may be made. The total duration of treatment is 60 days.

If the number of cases is massive, IV treatment may have to be omitted due to resource constraints. It may instead be treated with a tablet regimen.

Cutaneous anthrax treatment consists of a 60-day regimen using either ciprofloxacin 500 mg tablets twice daily, doxycycline 100 mg tablets twice daily, or amoxicillin 500 mg tablets three times a day.

Prophylactic treatment

Denmark has no supply of anthrax vaccine. In the US, a cell-free filtrate of an avirulent, non-capsulated strain of *B. anthracis* is used as a vaccine (BioThrax). It is administered in a series of 6 doses at intervals of 0, 2, and 4 weeks plus 6, 12 and 18 months. A yearly booster is also necessary.

This airborne cloud of agent will spread on the wind after being released by the delivery device, and it will eventually dilute to non-hazardous levels. But anyone who happened to be in its path during the release is at risk of inhaling a dose of agent. This cloud can swiftly travel many kilometres before it dissipates, thus endangering persons far from the release site.

Evacuation is not an option in the area of exposure

It should be noted that cordoning off and evacuating the area of exposure is impossible.

This is because of the speed at which the aerosol cloud spreads and dissipates. The cloud will have done its damage and diluted itself into oblivion before anyone realises what has happened. Evacuating an area in which the danger has already come and gone is of course pointless especially because people will have moved far and wide in a short time, many will have left the area and the only way to reach them is through mass and social media.

Countermeasures in the area of exposure should therefore consist of mapping the total area as accurately as possible, identifying and tracking those persons who were present in the area immediately after the attack, and offering them whatever prophylactic (or post-symptomatic) treatment is appropriate and feasible.

Available intervention options must be identified quickly

Modelling the hazard area and the area of exposure can provide the COMA staff with important information about the number of persons who may have been exposed to a hazardous biological substance.

Once the total number of potentially exposed persons has been identified, the COMA staff should also identify the possible intervention options. Typical interventions include medical treatment, vaccination, cohort isolation and quarantine.[1]

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1 The isolation and quarantine options are used to limit the spread of a contagious disease. Since anthrax infections are not contagious, these options are not relevant in our scenario, but in Chapter 12 we will explore these types of intervention in other contexts.

Within the relevant types of intervention, different levels of intervention can also be identified. For example, if critical ressources are limited it may be considered to give certain groups priority over others, for instance prioritising the vaccination of first responders, police, healthcare professionals and other emergency personnel who ensure public order and without whom society might sink into civic unrest (see also the prioritisation discussion later in this chapter).

Intervention modelling can help pinpoint the dilemmas

Intervention options that are relevant for a given situation must then be weighed up against each other in terms of their relative costs and effects, particularly with respect to the number of casualties and/or deaths associated with each option.

Intervention modelling can provide these types of assessments, which can then be used by COMA to support its recommendations to relevant authorities.

22:00
Nearly 140,000 persons were exposed to the hazard

To assist the COMA staff with the deliberations that are now underway, the necessary modelling tasks are initiated.

The results show that the size of the area of exposure, combined with the originally modelled hazard area, covers a total area of about 18.3 square kilometres. Within this elliptically shaped zone, the model shows that nearly 140,000 persons were exposed to anthrax spores.

The modelling results also show that the area of exposure reached its maximum size just 20 minutes after the time of release.

Without medical intervention, 1,443 people will die

After modelling the area of exposure, the casulaty numbers without medical countermeasures are calculated. The results show that a total of 1,443 persons in the hazard area and the area of exposure will die of anthrax inhalation.

The death rate will be highest (38.8%) among persons who were infected by large doses of agent in the hazard area at the train station, and will drop sharply thereafter to a low of .01% at the outer edge of the area of exposure.[2]

Casualties cannot be completely avoided

The modelling advisor then focuses on a series of possible medical countermeasures (interventions) and outcomes. These calculations generate an overview of the illness, deaths and resource demands (medication, personnel, hospital facilities, etc.) associated with each of the countermeasure options that COMA wishes to consider.

Some of these options look more attractive than others. But none of them predict an outcome that is completely free of casualties.

Discussion: Every option must be carefully considered

The pros and cons of each intervention option must be thoroughly explored and considered before COMA makes its recommendations. This is of course especially important in situations which, due to their complexity and magnitude, can limit the options, necessitate tough choices and result in ethical dilemmas.

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2 The numerical calculations and predictions in this chapter relate to a hypothetical anthrax attack on an urban center. The modelling was performed for use in this book.

In our scenario, it is unrealistic to assume that a group of 140,000 people can be completely protected from the effects of a biological attack with weaponised anthrax. The 'advantage' here is on the side of the attacker, whose covert operation at a time and place of his own choosing has taken authorities and response units by surprise.

A realistic goal in such a situation could be to ensure that as many people as possible among the exposed population are given chemoprophylactic treatment before symptoms begin to appear.

Strategic planning is necessary to avoid medication shortages

Shortages may arise in cases involving a very large number of exposed persons and the resulting need for extraordinarily large amounts of chemoprophylactic medication.

Strategic planning is key to dealing with such situations. Specifically, a strategic threat analysis should be conducted in order to prioritise the size of various medication stockpiles, based on an overall balancing of cost, efficacy and the risk of attack with a given biological agent. At the same time, plans should be made for how additional medication might be procured at a short notice.

If shortages occur despite such planning, the option of using veterinary medications may also be considered. Countries such as Denmark with a large agricultural sector and large-scale animal husbandry activities will often have large amounts of veterinary antibiotics at their disposal which, in an emergency, could be used for human consumption.

Beforehand strategic analyses can clarify the amounts and types of veterinary antibiotics that might be available, the places in which they are stored, which types of human antibiotics that might be substituted by which type of veterinary medicine and the dosages that would be needed. At the same time, detailed plans can be made for how these reserves could, if necessary, be mobilised.

Treatment may have to be prioritised

Despite every effort, critical medication shortages may still occur, and the persons needing treatment will have to be prioritised in some way.

To maintain public order, decision-makers may want to assign top treatment priority to persons who perform essential services. Essential persons could include police, ambulance personnel, doctors and nurses, firemen, soldiers or persons who maintain critical infrastructures such as electricity, water and heat.

On the other hand, priority might be given to the most vulnerable populations - the elderly or the very young, for example. Or it might be decided that treatment will only be offered to persons who were present in the most contaminated portion of the hazard area.

Regardless of any cost/benefit analysis that intervention modelling might support, these and other prioritisation issues will obviously result in ethical dilemmas for which there are no standard solutions.

23:00
Important calls are made

While the intervention modelling process takes place, the COMA coordinator informs the police and the national government's crisis management authority that the biological attack has been confirmed, and that COMA is now in the process of preparing information to support the difficult decisions which must soon be made. The inspector at the police station will relay this information to his own senior management and all the personnel on-site, who is still directing the work of setting up cordons and managing the crowds.

The COMA medical advisor, meanwhile, gets in touch with the regional public health officer, who will be responsible for implementing medical countermeasures to the anthrax attack.

Discussion: Countermeasure issues

Whoever makes the final, difficult decisions about medical countermeasures will need to take many issues into account. Apart from the considerations already mentioned in this chapter, other issues include:

- the likelihood of a second attack, which could make it necessary to withhold a certain amount of medication for later use
- the total amount of available medication
- the likelihood of procuring or manufacturing more
- the extent to which medication will be effective in a given population
- the risk of dangerous side effects (adverse events or development of resistance to medication)
- the time it would take to secure additional medication
- the time it will take to reach and treat those who should receive medication

Time is an unyielding factor in these deliberations. If a decision about medical countermeasures is not made quickly enough, the question of preventive treatment can become moot for those who were among the first to be exposed.

Day 1-2: 23:30 – 02:00
Deliberation and planning continue all night

Night has fallen, and an emergency meeting has been called by the crisis management authority. Participants in this meeting include representatives from the government, police, public health, emergency services and other relevant parties. Biopreparedness experts deliver a briefing.

After reviewing the situation – including an assessment of treatment options and current medical supplies – a government-approved decision is made to immediately arrange

chemoprophylactic treatment (antibiotics) for all emergency and medical personnel in the city, as well as for everyone who has been present in the hazard area defined by the most recent dispersion map.

Vulnerable persons receive special consideration

Treatment will also be offered to those who were present in about half of the area of exposure on the day of the attack. Beyond this area, consideration will also be given to persons defined as vulnerable (children, people with immune deficiencies, the elderly, etc.)

In addition, all hospitals in the city will work together with the local public health authority to implement emergency plans to establish medicine distribution centres and to expand hospital capacity (calling in extra staff, postponing non-acute activities, etc.).

Work to mobilise the necessary human, medical and facility resources continues throughout the rest of the night, and emergency medication plans are ready for rollout by morning.

Discussion:
Outreach efforts must begin immediately

Once a decision has been made about who to treat, the challenge remains of very quickly seeking out and informing everyone who will be offered prophylactic medication. Evacuation shelters are an obvious place to begin the distribution of antibiotics, as the persons staying there have by definition spent time in the hazard area.

Registration such as that which took place after the attack in our scenario can be an extremely useful tool for finding persons who may not live in the hazard area, but who were evacuated from it after the attack. The cell phone numbers and/or home addresses provided as part of this registration can be used to contact them directly.

Other outreach possibilities could include media broadcasts, online alerts via social media and other channels, and direct contact to vulnerable groups.

Distribution of medication will be a challenge

To ensure the efficient distribution of medication to a very large number of persons, *points of distribution* (PODs) must be quickly set up, staffed and provided with the necessary medicines and supplies. This will involve some logistical challenges, especially in densely populated urban areas where the hazard area and the area of exposure are very large.

It must be assumed that some people will not be able to make their own way to a POD due to age or infirmity. Each of these persons will require assistance from response personnel or volunteers who are recruited for this purpose. Many helpers may be needed.

Good planning can minimise conflicts

Friction may arise due to the physical placement of the PODs. They should therefore be logically placed so that citizens can quickly be channeled to the appropriate distribution site without running into traffic jams caused by crisscrossing routes. The distribution process itself should be well organised and efficient; this will of course minimise the risk of unpleasant scenes among those who are waiting to receive medication.

To ensure that everyone fully understands the required treatment regimen, the POD personnel should also be able to provide citizens with the necessary medication instructions.

Plans for how to set up PODs (or emergency vaccination centres, which will face many of the same challenges) may be incorporated into national disaster preparedness plans. Some very large cities may, however, find it more expedient to make their own plans (see box, ‘Major cities face extra challenges’).

Day 30: 10:00
The medical crisis seems to be over

One month after the train station attack, the medical crisis has apparently tapered off.

Results from the BSL4 laboratory ultimately confirmed that the *B. anthracis* used in the attack was indeed alive and fully functional, and cases of illness began to appear on Day 3. For the past week, however, there have been no new reports of inhalation anthrax, and thanks to an impressive level of preparedness, the city has for the most part been able to manage the logistical challenge of procuring and distributing medication and caring for the ill.

At a morning meeting of the preparedness and public health authorities who for the past 30 days have cooperated across organisational boundaries to counter the biological attack, the casualty count is reviewed: 533 persons across the city have been hospitalised due to anthrax inhalation, but there have been only 14 deaths. This, compared to the predicted death toll of 1,443 without medication, is viewed as a success.

The criminal investigation continues; no perpetrator has been found so far, but police investigators and the biopreparedness centre are cooperating to follow up on some microbial evidence generated by laboratory analyses.

Apart from the ongoing investigation, there is one more huge, remaining challenge: that of trying to make the contaminated and evacuated areas of the city habitable again.

Discussion:
Decontamination is perhaps the greatest challenge

We now conclude our fictional scenario, leaving its players at a point where they have overcome a great many obstacles under pressure of

time. Fast, accurate assessments of the danger, mass evacuations and a well-prepared and executed mass medication programme have saved hundreds of lives.

Any incident of this magnitude is bound to have an aftermath that will require continued attention from a biopreparedness organisation. A COMA staff will continue to monitor the situation and be prepared to re-convene if the need for further support should arise.

Necessary aftermath support will vary, depending on the complexity and duration of the incident, the type of agent involved, the number of casualties and other factors such as geography and weather.

Perhaps the greatest aftermath challenge of all relates to the long-term problem of decontamination, particularly with respect to large urban landscapes. It is one of three special challenges that we will discuss in Section 3.

Major cities face extra challenges

Large cities may have special logistical challenges which, in a biopreparedness context, warrant extra attention.

The City of New York, for example, has recognised that its size and importance make it a high-profile terrorist target. With a population that is larger than some countries, the sheer magnitude of the city and

its heavy urban traffic can be especially problematic, not least during a major emergency. For this and other reasons, New York has developed its own biological response plan, which includes special provisions for the distribution of relevant medical materials.

Among other things, the city has its own stockpiling warehouse, and thousands of city employees have been trained to set up and run pre-defined points of distribution (PODs) to which materials from the stockpile can be delivered.

PODs are located throughout the city and are placed in such a way that the personnel who will man them live nearby, thus ensuring that transportation issues will not prevent them from quickly reaching their assigned stations.

Training exercises with respect to biological incidents are also arranged by the city. During a surprise bioterror drill in 2014, for example, an impressive 30 PODs were set up throughout the city in less than eight hours.[3]

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3 Troy, T. Is Gotham Ready for Bioterror? City Journal, Spring, 2017. Accessed at https://www.city-journal.org/html/gotham-ready-bioterror-15129.html

section 3

Special challenges

In this section, we will take a look at some of the large-scale challenges that society and preparedness organisations could face in the aftermath of a biological attack.

These include the daunting task of decontaminating an area that has been made unfit for human habitation. Depending on the warfare agent that was used and the size of the area over which it has spread, this job could take far more time, effort and resources than dealing with the attack itself. The economic consequences could be enormous.

Two major health-related challenges with relevance to a biological attack will also be discussed: mass vaccination and the use of isolation and quarantine to prevent the spread of disease. In order to succeed, these measures will require good planning and a high degree of compliance from the public.

10

Large-scale decontamination

Direct experience with the complex process of biologically decontaminating large, outdoor areas is limited. However, a biopreparedness organisation can use its expertise to assist in the decontamination process and to help close any major knowledge gaps.

As part of a 1942 biowarfare experiment, British scientists working amid fears of a German biological attack released airborne spores of *Bacillus anthrasis* over a tiny, uninhabited island called Gruinard off the coast of Scotland. A flock of sheep was used to test the effectiveness of the agent; the animals died within days of exposure.

The agent was never used against Germany, but Gruinard Island had to be quarantined. It was still anthrax-tainted when a decontamination project was finally launched in 1986.

The effort began by killing all plant life with an herbicide. The dead vegetation was then burned away, after which the ground was drenched in a solution of formaldehyde and sea water. Follow-up work was needed to remove some remaining contamination. The island was then fertilised and re-seeded, and by 1990, sheep were once again able to graze on Gruinard.

The decontamination was declared a success.[1, 2]

Large-scale decontamination is a huge project

It is hard to imagine a project like the one on Gruinard Island in a densely populated urban area. Or perhaps more precisely: large-scale decontamination seems hard to imagine at all.

The cost of decontamination in the wake of the Amerithrax attack has been estimated in the hundreds of millions of dollars, and some of the affected buildings had to be closed for over two years. Yet this is considered a relatively small event. A major biological attack aimed at a large city would contaminate not only buildings, but streets, parks, vehicles and everything in between.

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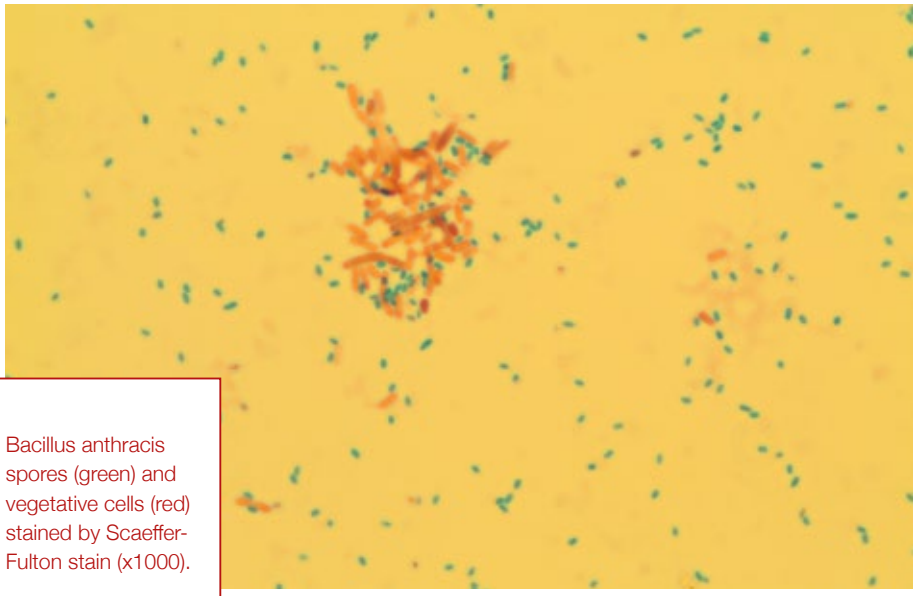
1 Manchee, R. J., Broster, M. G., Stagg, A. J., and Hibbs, S.E.: Formaldehyde Solution Effectively Inactivates Spores of Bacillus anthracis on the Scottish Island of Gruinard. Applied and Environmental Microbiology, Vol 60 No. 11, 1994 p.4167-4171. Accessed at https://aem.asm.org/content/aem/60/11/4167.full.pdf

2 Britain's 'Anthrax Island'. BBC News, UK: Scotland. 25 July 2001. Accessed at http://news.bbc.co.uk/2/hi/uk_news/scotland/1457035.stm



Bacillus anthracis spores (green) and vegetative cells (red) stained by Scaeffer-Fulton stain (x1000).

Photo: CBB

According to one estimate, a full decontamination after a successful anthrax attack in New York City could take more than 300 years.[3]

Whether this estimate holds true for New York or any other city will at least to some extent depend on how well we are prepared to deal with such a catastrophe.

There is no universal recipe for effective decontamination

A full *decontamination*, in the context of a major biological attack, can be defined as the process of removing or killing pathogenic organisms from any and all surfaces and substances in the contaminated environment. This includes air, water, vegetation and earth, as well as buildings, vehicles, clothing and skin.

There is no single method or universal cleansing product that can fix every decontamination problem. The methods and materials used

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3 Miller, J.: Bioterrorism's deadly math, City Journal, Autumn 2008. Accessed at https://www.city-journal.org/html/bioterrorism's-deadly-math-13123.html

Anthrax experiments on the uninhabited Gruinard Island required massive decontamination efforts.

Photo: Getty Images

will depend on the nature of the agent and the type of environment in which it is present. They will also depend on definitions: When is something suffciently decontaminated? How is 'safe' defined?

The Gruinard decontamination project, for example, took several years to develop and complete, and scientists were careful to note that their success did not necessarily mean that the same techniques could be used elsewhere. Their article about the decontamination effort concludes with the following words:

"Each site is unique, and laboratory or pilot-scale tests are essential to devise a successful decontamination method."[4]

Some agents are easier to destroy than others

Not all biological agents are equally challenging to eradicate; in some cases, decontamination efforts can receive significant help from Mother Nature. The Ebola virus, for example, tends to degrade rather

4 Manchee, R. et.al., 1994.

quickly after being released into the environment. Decontamination would therefore probably not be an insurmountable task after an incident involving this agent.

Anthrax spores, on the other hand – even in a non-weaponised state – have been known to survive for decades before finding their way into a living host and causing infection. Anthrax decontamination will therefore have to be exceptionally thorough.

Certain agents are stable in some environments, but not in others. For example, *Yersinia pestis* (which causes plague) is unstable in outdoor air but can remain stable for years in soil and live tissues. *Coxiella burnetti* (Q fever) will remain stable for months on wood and sand. Ricin is stable in the environment, but is heat sensitive.

Weaponisation can make decon more difficult

The above characterisations, along with several others, appeared in a 2010 analysis which was supported by US Commission on the Prevention of Weapons of Mass Destruction Proliferation and Terrorism. In describing the relative stability of various agents, the authors also point out that weaponisation could enhance the stability of a given agent and thereby make decontamination more challenging.[5]

The analysis addresses several other important decontamination issues which we will discuss later in this chapter.

Bacterial spores have dangerously good survival skills

B. Anthracis belongs to a group of bacteria that transforms into a spore in response to lack of nutrients, and it can remain alive in this dormant state for a very long time. Bacterial spores are surrounded

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5 Franco, C. and Bouri, N. Environmental Decontamination Following a Large-Scale Bioterrorism Attack: Federal Progress and Remaining Gaps. Biosecurity and Bioterrorism: Biodefense Strategy, Practice and Science, Vol. 8 No 2. 2010. Accessed at https://www.liebertpub.com/doi/pdf/10.1089/bsp.2010.0009

by several layers of protection that make them highly resistant to degradation or eradication.[6]

A dormant spore can therefore survive all sorts of assaults, including high extremes of temperature, irradiation and chemicals, until the presence of nutrients in a living host causes it to germinate and return to what is called its vegetative state.[7]

The agent must be identified and mapped

The first step toward effective decontamination is the same as for effective medical countermeasures: the biological agent must be identified, and the area over which it has spread must be mapped. Without this initial step, it will not be possible to choose the most appropriate decontamination agents and methods, nor will it be possible to apply them to the correct area.

We have already described the above identification and mapping processes in our discussions of dispersion modelling and field investigations. The information gained in the initial phases of a biological incident should therefore already be at hand when large-scale decontamination begins.

It will, however, be necessary to repeat the modelling process due to changes in wind, weather or other conditions, and new sampling and laboratory analyses will be needed to verify modelling results.

At this point it may also be prudent to validate the entire hazard area with exhaustive environmental sampling from points both inside and outside the predicted area.

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6 Sinai, L. et.al. The molecular Timeline of a Reviving Bacterial Spore. Molecular Cell, 9 Feb 2014. Accessed at https://www.ncbi.nlm.nih.gov/pmc/<articles/PMC4339302/

7 Ibid.

Agents used for decontamination can in themselves be both harsh and harmful.

Photo: CBB

There are many decon agents and methods

The decontamination process itself can involve a variety of agents and methods, depending on the specific circumstances of the case.

A solution of formaldehyde and sea water, as previously mentioned, was infused into the soil to decontaminate Gruinard Island. After the Amerithrax attack, several methods and agents were used to decontaminate anthrax-tainted buildings. These include:

- removal and disposal of contaminated materials
- surface cleaning with bleach, liquid chlorine dioxide and various hydrogen peroxide products
- fumigation with chlorine dioxide, hydrogen peroxide, or paraformaldehyde[8]

The Danish biopreparedness organisation has tested and used a sprayed solution of benzalkonium chloride and hydrogen peroxide (trade name: EasyDECON®) and found it to be effective. We have also found that a combination of two or more products can sometimes be more effective than one.

Decon agents must be carefully chosen and used

Each of the above decon agents and methods, however, are merely examples that cannot be regarded as standard treatments. To determine the right agent, amount, and method for a given decontamination task, expert advice from a dedicated biopreparedness organisation or other relevant entity should always be sought.

Lack of knowledge – also among experts – can still be a major stumbling block, however. Decon efficacy can sometimes vary, and more

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8 Blair, G. et.al. 2 November 2005. The Field Perspective on B. anthracis Decontaminations and EPA R&D Program to Evaluate Decontamination Technologies. Accessed at https://www.hsdl.org/?view&did=478949

research is needed in this and other areas related to decontamination. We will return to the subject of research later in this chapter.

Finally it should be noted that unprotected persons cannot be exposed to decontamination fluids. Only personnel wearing full personal protection equipment can be decontaminated. Unprotected persons are cleansed instead (given et water and soap bath).

Standards for success must be established

A highly sensitive question when discussing decontamination is the problem of how much decon is 'enough'. Does a successful decontamination project always have to eradicate every trace of a given agent in order to render an environment safe for humans, animals and plant life?

In view of the formidable costs and time frame of a 'zero contamination' standard, political leaders and/or taxpayers may ask whether this is an appropriate criterion for success. On the other hand, even if scientific evidence can prove that a low-level presence of a particular agent is harmless, the public may be not be willing to accept such evidence.

Another possibility for disagreement on this issue might emerge from evacuees who are eager to return to their homes (which of course will bear no visible evidence of damage or danger). If a lower standard could ensure a quicker return to 'normal' life, these stakeholders could conceivably begin to exert pressure to lower decontamination criteria to an unacceptable level – or even begin to illegally re-occupy their homes, as was the case after the nuclear disaster at Chernobyl [9].

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9 Morris, H. The women living in Chernobyl's toxic wasteland. 2012 08 November. The Daily Telegraph. Accessed at https://www.telegraph.co.uk/news/earth/environment/9646437/The-women-living-in-Chernobyls-toxic-wasteland.html

Masses of debris must be destroyed

Treatment of bio-contaminated furniture, clothing and other objects after a major biological attack is likely to be a logistical challenge. During a 2018 incident in Denmark in which a man had been illegally working with ricin in his home, it was necessary to drench the interior of his apartment and all its contents with a decontaminant. This destroyed the agent – and everything else.

After this soaking, every item in the apartment was removed to an authorised facility that could dispose of the debris. Fortunately, ricin is an agent that does not have the same ability for wide dispersion as weaponised anthrax, so the rest of the neighbourhood was spared a similar treatment.

In our anthrax scenario, disposing of the objects left behind at the train station would only be the prelude to an unprecedented effort that would give new meaning to the term 'mass destruction.' Plans must therefore made for the removal and safe destruction of a huge amount of decontaminant-soaked debris.

Methyl bromide could hold some promise

Fumigation experiments in 2015 using methyl bromide – an agent once commonly used for termite control – achieved success in anthrax decontamination of building contents as well as the building structure itself. However, methyl bromide has been shown to be an ozone-depleting agent, for which reason its use as an insect fumigant has been largely discontin-

ued. For the same reason, methyl bromide was not used as a fumigant after the Amerithrax attack.[10]

The fumigation study suggested further research to investigate ways of minimising both the necessary amount of agent and the amount of damage it causes to the earth's ozone layer.[11]

Defficacy must be verified

Assuming that a success standard has been set, the final decontamination step is to verify that the effort has been succesfull. Ongoing environmental sampling and laboratory analyses will be needed to measure the effect of the decon process and ultimately prove that the degree of contamination has been reduced to the chosen level.

Both the sampling and the laboratory analysis require an organisation with these capabilities.

The aftermath may be hard to accept

This leaves the question of how the decontamination agent itself will affect the area in which it is used. Sheep may be willing to graze on a decontaminated island. But will human beings be willing to live in a neighborhood, eat vegetables from a field or let their children play in a park that has been soaked in formaldehyde?

And how much is it possible to rescue? Can the contents

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10 Serre, S. et.al. Whole-building decontamination of Bacillus anthracis Sterne spores by methyl bromide fumigation. Journal of Applied Microbiology. Published online 2015 Dec 8. doi: 10.1111/jam.12974

11 Ibid.

of a house or apartment filled with objects, clothing and furniture be decontaminated without being destroyed? Or will it all have to be incinerated in some environmentally safe manner? (See the box, 'Masses of debris must be destroyed.')

So far, the world has had very little experience with these types of questions. But they do need to be asked and answered – preferably at a point in time *before* a large-scale attack makes such questions unavoidable.

Real-life decon experience is limited

There are only a few real-life incidents that have done much to prepare societies for dealing with large-scale biological decontamination in a densely populated urban area.

The decontamination of Gruinard Island demonstrated the importance of careful planning and rigorously controlled results. But the island was uninhabited, making it possible to burn everything to the ground before effectively decontaminating the earth.

The Amerithrax attack took place in a complex urban setting, and the decontamination efforts that followed have been extensively described and discussed. But the experience gained from the event, albeit valuable, was limited to a relatively small number of indoor settings.

Some outdoor cleansing took place at Sverdlovsk

The 1979 anthrax accident in the Soviet city of Sverdlovsk (mentioned in Chapter 1) resulted in both indoor and outdoor cleansing efforts, according to an independent team of scientists who were allowed to investigate the incident after the dissolution of the Soviet Union.[12]

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12 Meselson, M. et.al, 1994, The Sverdlovsk Anthrax Outbreak of 1979, Science Vol 266, accessed at https://www.researchgate.net/publication/15224942_The_Sverdlovsk_anthrax_outbreak_of_1979

In an article about the investigation that appeared in *Science* in 1994, the team described how they pieced together the story despite the fact that many original records of the incident had been confiscated by the KGB. Some of these documents were ultimately unearthed, and a great many witnesses and survivors of the incident were interviewed.

With respect to decontamination, the investigators were told that indoor treatments consisted of disinfecting kitchens and sick rooms in the homes of the victims affected by the anthrax release. In the area of the city where most of the victims lived, trees and the exteriors of buildings were washed down by local fire brigades, and some unpaved streets were asphalted.[13]

There is no indication in the article as to whether the results of these operations were verified through testing, but the investigators reported that "to the best of our knowledge, no human anthrax has occurred in the Sverdlovsk region since 1979."[14]

Today, the city (now called Yekaterinburg) is a bustling provincial capital with some 1.5 million inhabitants.[15]

Several biopreparedness gaps need to be addressed

Improved decontamination policies are needed, along with more knowledge about the decontamination process itself, according to the 2010 analysis mentioned earlier in this chapter.

The analysis identified several gaps in US decontamination policy and practices, and recommendations were made for how to address them.[16] It specifically targeted conditions in the US, but the issues raised are likely to be relevant to communities worldwide.

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13 Ibid.
14 Ibid.
15 Official portal of Ekaterinburg [Web], 2018, accessed at http://www.ekburg.ru/aboutcity/population/
16 Franco, C. and Bouri, N., 2010

The following major decontamination issues, all of which were discussed in the analysis, are examples of problems that the rest of the world may also need to address:

- **Leadership issues**
  Roles and responsibilities for decontamination may be distributed among a variety of local, regional and national entities with overlapping responsibilities and little or no overriding leadership. A leading agency for decontamination should be identified.

- **Decision support**
  Adequate scientific decision support to provide assessments of health risks, decontamination costs and a time frame for the decontamination process must be ensured.

- **Sampling and analysis capabilities**
  Sampling, testing and laboratory analysis capabilities may not be sufficient to deal with a large-scale, outdoor attack. Techniques for outdoor sampling need to be developed, and adequate human resources and laboratory facilities must be ensured.

- **Standards for decontamination**
  Widely recognised standards for an appropriate level of decontamination need to be established.

- **Decontamination research**
  More knowledge of effective decontamination technologies and methods is urgently needed, especially with respect to large, outdoor biological attacks. Research is underfunded, and tends to focus on small, indoor incidents.

The health risks of re-aerosolisation need more study

The US analysis specifically highlights the health effects of re-aerosolisation as a subject that needs more study, because the real-life experience in this area is inconclusive.

After the Sverdlovsk accident, the risk of infection due to re-aerosolisation of anthrax spores appeared to be negligible. But in the US postal facilities contaminated by the Amerithrax attack, infection caused by re-aerosolisation was a major issue – possibly due to the high level of physical activity in the building.[17]

Also highlighted in the analysis, is the need to address knowledge gaps and unresolved issues in areas such as risk assessment, weaponisation, previous decontamination efforts, and various biological agent properties such as infectious dosages. The relative effectiveness of various decontamination strategies also needs further study, the analysis states.[18]

Innovative decontamination methods have been suggested

In recent years, some interesting new decontamination strategies have been studied – including one which is based on the fact that anthrax spores lose much of their resistance to external assaults if germination can be induced while the spore is still in the environment – that is, *outside* a living host.

Once germinated, the biological agent can be destroyed with milder remedies that are less hazardous to the surrounding environment.[19]

Another interesting area of study relates to the use of *bacteriophages* – a group of viruses that attack and destroy bacteria. Phage technology is not new; at the beginning of the 20th century, it was studied as a possible cure for bacterial infections, but it was soon eclipsed by the advent of antibiotics.[20]

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17 Ibid
18 Ibid
19 Omotade, T. et.al. The impact of inducing germination of Bacillus anthracis and Bacillus thuringiensis spores on potential secondary decontamination strategies. Journal of Applied Microbiology. 3 Sept 2014. Accessed at https://onlinelibrary.wiley.com/doi/pdf/10.1111/jam.12644
20 Cisek, A.et.al. Phage Therapy in Bacterial Infections Treatment: One Hundred Years After the Discovery of Bacteriophage. Current Microbiology 28 Nov 2016. Accessed at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5243869/

Today, the appearance of antibiotic-resistant bacteria has caused a revival of scientific interest in phages which, among other things, are now being studied for possible use against the anthrax spore. A number of anthrax-attacking phages have already been discovered[21], and studies have suggested the possible use of phages as an environmentally friendly decontaminant for anthrax spores in which germination has been induced.[22, 23]

There is at least some hope for the future

In 2018, another environmentally friendly approach was suggested by researchers who had achieved success in decontaminating anthrax-tainted soil with a combination of germinant and ordinary nematode worms. Among other things, their study pointed out that nematodes (like anthrax-specific phages, *ed.*) are natural predators of the anthrax bacteria.

In the context of a biological attack and its aftermath, the authors of the study were hopeful about the future for this type of decontamination. At the same time, they were careful to point out that follow-up research is needed in this area.[24]

The above-mentioned studies of course represent just a glimpse of the ongoing decontamination research that is taking place around the world. But the examples we have shown do at least hold some hope for a future in which decontamination workers will not have to poison an environment in order to purify it.

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21 Jończyk-Matysiak, E. et.al: Possible Use of Bacteriophages Active against Bacillus anthracis and Other B. cereus Group Members in the Face of a Bioterrorism. 28 Aug 2014. Accessed at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4163355/

22 The Rockefeller University. Natural-Born Killers Enlisted To Fight Anthrax. ScienceDaily. ScienceDaily, 22 August 2002. Accessed at https://www.sciencedaily.com/releases/2002/08/020822070131.htm

23 Jończyk-Matysiak, E. et.al. 2014.

24 Schelkle, B. et.al. Caenorhabditis elegans Predation on Bacillus anthracis: Decontamination of Spore Contaminated Soil with Germinants and Nematodes. Frontiers in Microbiology. 05 Jan 2018. doi: 10.3389/fmicb.2017.02601

11

Mass vaccination

Mass vaccination in response to a biological attack can involve a complex interplay of logistical, training and security issues. Futhermore it is necessary to address the need for speed, the risk of side effects, public distrust of immunisation – and in some cases, the emergency use of unlicensed vaccines.

Mass vaccination is a highly relevant medical countermeasure to an attack with a communicable pathogen – not least the smallpox virus, against which routine vaccination is no longer given. Without widespread immunisation, a deadly infection in an unprotected and mobile population could spread out of control and beyond any border.

Mass vaccination could also be relevant in special situations for instance in a situation where a biological attack is known to be imminent. It could likewise be relevant in cases where a neighbouring country has an outbreak that could spread across the border.

A decision about mass vaccination after a biological attack – like the decision about mass medication described in our anthrax scenario – should be made at a government level, and the decision should be based on expert assessments and medical recommendations from a biopreparedness organisation.

As with the other types of medication for emergency use, stockpiles of relevant vaccines and related materials will help assure availability, and will thus facilitate rapid deployment of a mass vaccination campaign. Plans should also be in place for dealing with shortages including shortages on the free markets due to simultaneous high demands in different countries (see also the section on strategic planning in Chapter 9).

Important vaccination issues must be considered

Like many other emergency activities described in this book, mass vaccination in the context of a biological attack is a complex challenge that should be integrated into biopreparedness and public health preparedness plans and also into an overall national disaster preparedness programme.

Planning regarding vaccination should include consideration of the following points:

- Vaccines are not available to counter the effects of every weapons-relevant biological agent.
- Vaccines are agent-specific. In other words, each biological agent requires its own, specific vaccination.
- Some vaccines are merely experimental, and are therefore not approved for widespread use; protection may be sub-optimal.
- Some vaccines have serious side effects.
- Vaccines do not provide immediate protection. They must therefore be administered before exposure and outbreaks of illness (although with certain agents – anthrax, for example – the vaccine may be administered simultaneously with chemoprophylaxis).
- Some vaccines cannot be administered simultaneously with other vaccines, as this could result in a lack of effect or an undesirable effect.

We will discuss some of these issues in more detail below.

A threat analysis will be needed

Bearing all the above issues in mind, an effective vaccination programme should be preceded by a strategic threat analysis. This will ensure that relevant agents are prioritised, and that there is a suitable balance between the perceived threat from these agents and the cost and effect of the corresponding vaccination programme – including the expected side effects, which could be serious.

A cost-benefit assessment of this kind will enable an informed decision with respect to targeted vaccinations against prioritised agents prior to exposure.

Anthrax vaccination may or may not be useful

When dealing with anthrax, as in our scenario, vaccination prior to exposure may of course be used to prevent infection. Anthrax vaccination can, however, also be given *after* exposure if administered together with antibiotics.

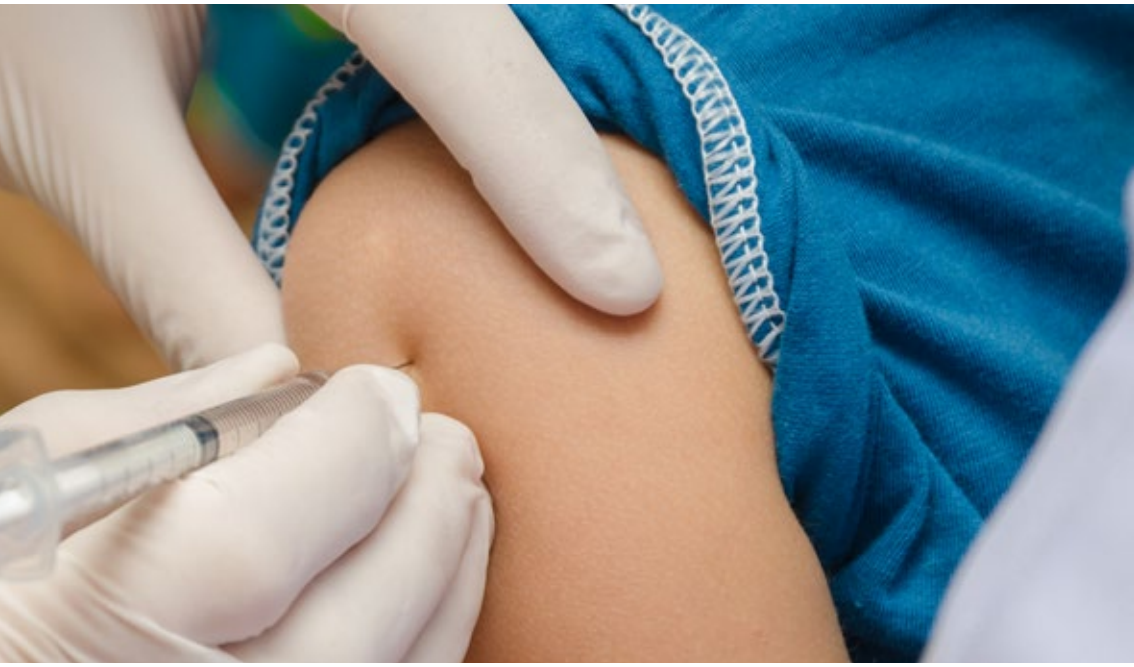
A rapidly deployed mass vaccination campaign can present many logistical challenges.

Photo: Colourbox

The antibiotic medication will suppress an infection that is still in the incubation phase while the vaccination will protect against re-infection from dormant anthrax spores that can hibernate in the lungs for months, and then germinate and cause disease after the antibiotics treatment is finished.

However, the vaccine consists of a series of injections that must be given over a relatively long period of time. Vaccination may therefore not be very practical in situations where rapid and easily implemented protection is needed for a large population.

It may, however, be useful as a measure for response personnel who will be working in a hazard area over a long period of time. Pre-attack mass vaccination might also be considered in special situations, for instance where there is forewarning about an imminent attack with anthrax.



Decision makers should also bear in mind, however, that certain types of anthrax vaccine can cause some relatively serious side effects.

An approved vaccine may not exist

Approved and licensed vaccines are available for some, but not all, of the pathogens that are commonly regarded as potential bioweapons. The smallpox and anthrax vaccines are among the approved preparations.

Other vaccines or medications may be relevant for emergency use, however. This will require special considerations that we will discuss later in this chapter.

Vaccination plans should be scalable

A vaccination campaign should be dimensioned in accordance with the nature and the level of the threat. It can thus begin with the vaccination of a few key types of persons during times of low risk, and later be broadened if the level of threat increases.

If intelligence sources, overt threats or other indications suggest that a biological attack with a specific agent is likely, vaccination should be considered for field investigation teams (FIT) as well as for selected medical professionals, policemen and emergency services personnel. Persons who may later be vaccinating others should also be among the first to be immunised.

A verified biological attack outside the borders of one's own country could escalate vaccination preparedness to include a wider range of healthcare professionals and persons in key positions. Preparation of isolation and quarantine facilities (see Chapter 12) could also begin at this point.

Mass vaccination of a large population segment (or an entire population) becomes relevant as soon as a domestic biological attack or relevant disease outbreak has been verified.

It could be argued that mass vaccination would be most relevant *before* an attack has taken place. This is a question that must be weighed up against the possibility that the attack never materialises. In such a case, the expense and effort of a mass vaccination campaign – not to mention the risk of side effects and adverse events – might seem difficult to justify.

Vaccinations may be prioritised – or not

In case of ample supplies of the relevant vaccine mass vaccination after (or before) a biological attack could be based on the principle of first come, first served, with no priority being given to anyone in particular. Logistically, however, this may cause bottlenecks at vacci-

nation centres if everyone arrives at once. Particularly in view of the fact that the vaccination process itself is more time-consuming than, for example, mass distribution of antibiotics. An alternative strategy could be to assign vaccination times and places to everyone, thus ensuring an orderly flow of vaccinations.

In the likely case of logistical restraints, including maybe limited supplies of vaccine, decision-makers might consider prioritising certain populations which are then vaccinated first.

This type of prioritisation was used to some extent in our fictional anthrax scenario, where antibiotic treatment was offered first to responder personnel and other groups with critically important functions in maintaining societal order and second to certain vulnerable groups of citizens.

Vaccinators must be properly trained

Despite the pressure of time, care must be taken to ensure an efficient procedure. This will require each exposed person to have a brief conversation with a vaccinator who is trained to ask the right questions and give the right instructions.

During a large-scale vaccination campaign, it would most likely be necessary to train additional healthcare staff who do not normally perform immunisations. Plans for mass vaccination should therefore ensure that an appropriate number of trained vaccinators are available to teach the procedure to others. Instructional materials can be prepared to supplement hands-on training.

Apart from knowing proper vaccination techniques, vaccinators should be able to explain the procedure to the people they vaccinate. They should also know how to address in a respectful way any fears and reservations a person might have about possible side effects and adverse events.

Ring vaccination could be an alternative strategy

If the disease outbreak begins with just a few, isolated cases, a so-called *ring vaccination* strategy may be tried before making the decision to mass vaccinate a larger population.

Ring vaccination is a painstaking and diligent public health effort that involves quickly tracking down and vaccinating everyone who may have had direct contact with a patient suffering from a serious, contagious disease. Contacts to the primary contacts are also immunised. Persons thus vaccinated will not spread the infection further, and will become, in effect, a ring of protection around the source of contagion.

Ring vaccination strategies were successfully used as part of the effort to eradicate smallpox during the last half of the 20th century.[1]

Vaccination centres have special requirements

Generally speaking, vaccination is a process that requires more time and activity than the simple distribution of oral antibiotics described in our anthrax scenario. Apart from the injection itself, the buildings in which vaccination takes place will need space for waiting areas and the distribution of information about the vaccine. It may also be necessary to allow space and time for the signing of 'informed consent' documents – an issue which we will discuss later in this chapter.

If re-vaccination, booster injections, or follow-up work due to side effects or adverse events are relevant for a given vaccine, the vaccination centre must also be able to accommodate this.

When planning a vaccination campaign, intervention modelling can help calculation of the number of vaccination centres, the amount of vaccine, personnel and equipment that will be needed to effectively protect the population of a given area.

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1 F. Fenner et al., Smallpox and its Eradication, WHO, Geneva, 1988. Accessed at https://www.who.int/features/2010/smallpox/en/

Lack of licensed vaccines may be a problem

As indicated earlier, approved and licensed vaccines are not available for all the agents associated with biological weapons. Vaccine development is at best a slow process that can take more than a decade to complete.

Another reason for the lack of certain vaccines is the fact that the efficacy of a preparation can not be tested on humans. Only during a naturally occurring outbreak of relevant disease, where no other safe treatment is available would it be ethically permissible to dispense experimental vaccines. Fortunately such circumstances do not occur often as many of the agents relevant to biological warfare do not cause large 'natural' outbreaks with casulaties.

Pharmaceutical companies, moreover, have little financial motivation for developing vaccines for which there is no 'natural' market.

Emergency use of unlicensed vaccines is feasible

In emergency situations, regulatory agencies that control the licensing of new vaccines and treatments may offer shorter approval pathways or emergency authorisation to use unlicensed products.[2]

In 2018, for example, the government of the Democratic Republic of the Congo (also referred to as DR Congo) was able to implement ring vaccinations using an unlicensed Ebola vaccine under a so-called 'compassionate use' protocol. The product was used during two naturally occurring outbreaks in the provinces of Equateur and North Kivu, respectively. The most recent of these vaccination campaigns was still taking place at the time of this writing.[3]

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2 The College of Physicians of Philadelphia. Biological Weapons, Bioterrorism, and Vaccines. Last updated 10 January 2018. Accessed at https://www.historyofvaccines.org/content/articles/biological-weapons-bioterrorism-and-vaccines

3 World Health Organization (website). Compassionate use of Ebola vaccine in the context of the Ebola outbreak in North Kivu, Democratic Republic of the Congo. Updated 30 October 2018. Accessed at https://www.who.int/ebola/drc-2018/faq-vaccine/en/

The vaccine in question had already been utilised on an emergency basis during previous outbreaks in Africa but was still unlicensed when it was sent to DR Congo. This meant that participants in the two Congolese vaccination programmes were required to sign 'informed consent' documents, and translators had to be recruited who could explain the form to the persons being vaccinated.[4]

Vaccination campaigns can face serious challenges

Apart from the above challenges, the ring vaccinations in DR Congo also illustrate some of the logistical problems that can accompany mass or ring vaccinations in remote areas. In this hot, humid, densely forested country with little healthcare or other infrastructures, storage facilities had to be set up that could keep the Ebola vaccine at subzero temperatures.[5]

Suspicion of Western medicines has also been an issue. And because the effort in DR Congo is a ring vaccination programme, it has also been necessary to explain why specific persons must be found and vaccinated while others are not being offered the vaccine.[6]

Sadly, the latest ring vaccination programme in DR Congo has also been disrupted by civil unrest. According to an online news report in *The Guardian*, rebel activities have included threats and assaults against Ebola response teams, and two response workers have been killed.[7]

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4 Kelland, K. In Congo outbreak, Ebola vaccine faces reality tests. Reuters (website), 18 May 2018. Accessed at https://www.reuters.com/article/us-health-ebola-vaccine-analysis/in-congo-outbreak-ebola-vaccine-faces-reality-tests-idUSKCN1IJ121

5 Ibid.

6 Ibid.

7 The Guardian (international edition). Ebola outbreak: Death toll tops 200 in Democratic Republic of the Congo. 11 Nov 2018. Accessed at https://www.theguardian.com/world/2018/nov/11/ebola-outbreak-death-toll-tops-200-in-democratic-republic-of-the-congo

A situation report issued by the World Health Organization on 28 December 2018 expressed concern that security issues in DR Congo could hurt efforts to control the disease outbreak.[8]

Vaccination requires a good communication strategy

Suspicion of vaccines, resistance to vaccination programmes and mistrust of health authorities can be an issue in almost any society. During the Amerithrax attacks, for example, many postal workers who may have been exposed to the bacteria refused vaccination which was offered to them under an unlicensed post-exposure protocol.[9]

Many reasons for this resistance have been identified, including the perception that the informed consent form which they were required to sign made them 'guinea pigs' in an experiment, and that they had no right to additional care or help if the experiment went wrong.[10]

Lack of information – and what is worse, poor and conflicting information – was a major factor with respect to this resistance.[11] Strategies for effective, respectful and honest communication must therefore be part of any mass vaccination campaign.

Mistrust of vaccines has also been an issue in Denmark (see box, 'HPV vaccination: rebuilding eroded trust').

Forced vaccination is a last-resort possibility

Forced vaccination could be a last-resort measure that most people – authorities as well as patients – would probably prefer to avoid.

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8 World Health Organization (website). Disease outbreak news: Update. 28 December 2018. Accessed at https://www.who.int/csr/don/28-december-2018-ebola-drc/en/

9 Quinn, S.C., et al. The Anthrax Vaccine and Research: Reactions from Postal Workers and Public Health Professionals. Biosecur Bioterror. 2008 Dec; 6(4): 321–333. doi: 10.1089/bsp.2007.0064

10 Ibid.

11 Ibid.

A successful Danish campaign to vaccinate young girls against the human papilloma virus (HPV), which causes cervical cancer, was very nearly undermined, due to media reports and Facebook debates about safety concerns that have since been called into question.

HPV vaccination was added to the Danish child vaccination programme in 2009. By 2014, however, HVP vaccination coverage had dropped from about 90 percent to less than 40 percent. An analysis conducted by the Danish Health Authority revealed that nearly all the parents who had doubts about HVP vaccination had heard stories about suspected side effects.

An increasing number of studies have found no connection between the vaccine and the reported symptoms. But confidence in the vaccine had eroded, so in 2017 the Danish Health Authority, the Danish Cancer Society and the Danish Medical Association launched the campaign 'Stop HPV, Stop Cervical Cancer.'

Using the same type of media as those in which the anti-vaccination stories had appeared, the campaign pitched articles about how to prevent cervical cancer

to a variety of publications, and a Facebook page was introduced where parents could ask questions and get reliable information.[12]

The campaign appears to have succeeded: by the end of 2017, the number of girls who had begun the HPV vaccination series was twice that of 2016.[13]

The World Health Organization recommends HPV vaccination for all girls aged 9-14 years.[14]

12 World Health Organization (WHO). Denmark campaign rebuilds confidence in HPV vaccination. February 2018. Accessed at https://www.who.int/features/2018/hpv-vaccination-denmark/en/

13 Statens Serum Institut. Annual Report for 2017 (Danish-language only). Accessed at https://www.ssi.dk/vaccinationer/boernevaccination/vaccinationsdaekning-og-aarsraporter/arsrapporter-om-bornevaccinationsprogrammet

14 WHO, February 2018.

In Denmark, the law permits forced vaccination to prevent the spread of dangerous, contagious diseases, and a comprehensive Danish smallpox preparedness plan also mentions forced vaccination as a possibility. However, it is the judgement of the Danish Health Authority that voluntary vaccination, good information and informed consent can get the job done.[15]

Even if some individuals refuse to be immunised, the smallpox plan assumes that an epidemic can be prevented if 70-80 percent of the population is vaccinated.[16]

The smallpox plan thus relies on the principle of *herd immunity*. Herd immunity occurs if a large percentage of a population is immunised against a given infection. An unvaccinated individual will in such a situation be surrounded by others who cannot be infected, and will thereby achieve 'free' protection.

Next: Removing the agent from society

Vaccination is one way to prevent the spread of disease after a biological attack. In our next chapter, we will discuss two other methods: quarantine and isolation, both of which involve separating some people from the rest of society. Like vaccination, these measures present several challenges.

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15 The Danish Health Authority. Operationel plan ved trussel om eller forekomst af koppeudbrud i eller uden for Danmark (Danish-language smallpox preparedness plan), p.111. 2004.Accessed at http://sundhedsstyrelsen.dk/~/media/6F91DEB24C1548648B-279C8EAFB42089.ashx

16 Ibid, p. 73.

12

Isolation and quarantine

A biological attack with a contagious agent presents wide range of challenges. To counter the epidemic that could result from such an attack, the SARS outbreak of 2003 provides some useful learnings.

As mentioned in Chapter 11, vaccines are not available for all the diseases that could be caused by a biological attack. Moreover, it is impossible to predict what sort of complications might arise with diseases caused by genetically altered bioweapons.

But when it comes to infectious diseases, there are two counter-measures that have been used for centuries, and which will always be relevant additions to a biopreparedness toolbox: isolation and quarantine.

Newcomers to Constantinople were 'cleansed'

Throughout history, some form of isolation and/or quarantine has been used as a way of limiting the spread of contagious diseases. Lepers were shunned in biblical times, and the Emperor Justinian of the Eastern Roman Empire is said to have established special facilities in Constantinople where persons arriving from 'contaminated localities' could be 'cleansed'.

Restriction of movement to prevent disease transmission was also used in seventh-century Asia and medieval Europe to guard coastal cities from incoming epidemics of plague and other diseases. More recent examples of keeping contagion away from healthy individuals include the isolation and quarantine measures employed during the influenza pandemic of 1918 and the worldwide outbreak of SARS (Severe Acute Respiratory Syndrome) in 2003.[1]

To understand how best to use isolation and quarantine in a bio-preparedness context, it is first necessary to understand a bit more about how and why these measures are used. Isolation and quarantine are related concepts, but they serve somewhat different purposes.

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1 Rothstein, J.D. (editor). Quarantine and Isolation: Lessons Learned from SARS. University of Louisville, Institute for Bioethics, Health Policy and Law. November 2003. Accessed at https://biotech.law.lsu.edu/blaw/cdc/SARS_REPORT.pdf

Symptom-free persons may be quarantined

Quarantine is used to restrict the movements of people who are believed to have been exposed to a dangerous, communicable disease but who are not yet ill. Its purpose is to keep these persons away from others and thus eliminate the possibility of disease transmission during the incubation period. It is important to remember that quarantined persons are symptom-free, and they may not be ill at all.

Individuals who have been placed in quarantine must remain in their homes or in special quarantine facilities for a specified period – usually the incubation period for the disease in question. Quarantine may be voluntary, but it may also be enforced.

In much the same way as with ring vaccinations, quarantine involves *contact tracing* – that is, tracking down people who have had contact with a person diagnosed with a communicable disease. This activity will help identify persons who should be quarantined, and it can require a great deal of time and human resources.

Isolation keeps ill persons away from others

The purpose *of isolation* is to prevent people with a dangerous, communicable disease from giving it to anyone else, including the healthcare workers who treat or take care of them.

Ideally, isolation should take place in a hospital unit that is specially designed to keep the disease-causing pathogen from escaping the room in which the patient is staying. The patient must remain in this unit until there is no further danger of disease transmission, and healthcare staff must wear protective clothing while caring for the patient.

The response to SARS contains biopreparedness learnings

Isolation and quarantine were both widely used during the SARS epidemic, and the experience thus gained offers some valuable lessons

– not only in the context of a naturally occurring epidemic, but also with respect to biopreparedness.

The appearance of SARS was not unlike a surprise attack with an unidentified biological warfare agent whose properties are unknown, and whose symptoms can be confused with those of other diseases. When SARS was first observed in the Guangdong province of southern China, the illness did not have a name; it was an emerging disease that no one had ever seen before.

Lack of reporting allowed the disease to spread

Doctors baffled by this 'atypical pneumonia' made a report to local health authorities in January, 2003. But instead of relaying this information to national and international health agencies, authorities labelled the report 'top secret'.

As a result, precious time was lost because of delays and hesitation within the hierarchical Chinese government and public health bureaucracies.[2]

Meanwhile, the mysterious infection spread from China to Hong Kong, which had received no alert that could have helped the city prepare a response. And from Hong Kong, unsuspecting air travelers gave the pathogen a free trip around the world.[3]

Vigilance and information-sharing are vital

From a biopreparedness standpoint, the above scenario underscores the importance of disease vigilance – that is, actively watching for and quickly acting on the appearance of unusual symptoms and disease patterns. As noted in Chapter 4, this type of awareness is an essential

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2 Huang, Y. et.al. The SARS Epidemic and its Aftermath in China: A Political Perspective (chapter in the book Learning from SARS: Preparing for the Next Disease Outbreak: Workshop Summary. National Academies Press (US); 2004). Accessed at https://www.ncbi.nlm.nih.gov/books/NBK92479/

3 Ibid.

element of biopreparedness, because the emergence of a 'strange' disease could be the first indication of a covert biological attack.

The emergence of SARS also demonstrates what can happen in the absence of effective reporting procedures, another basic principle of biopreparedness discussed in Chapter 4. Well-established contacts and cooperation between biopreparedness, public health and other entities, both national and international, can on the other hand ensure that information about suspicious medical events is quickly shared with others who can help stop the spread of epidemic disease.

Patients were not always isolated quickly enough

China later made a dramatic turnaround: in April of 2003, a sweeping government-sponsored crusade was launched against SARS, and the country's health minister and the mayor of Beijing were fired for their mismanagement of the crisis.[4]

By then the disease had gone global, and authorities and hospitals around the world were also struggling to deal with it.

Lacking an effective cure, isolation and supportive treatment was mainstays for SARS patients seeking help at hospitals and emergency rooms. But the disease was not always recognised at the time of admission, and isolation was therefore delayed.

Hospitals became a major source of infection

A review of SARS outbreaks in which detailed descriptions were available shows a median delay of 4.5 days between the time of admission of the first SARS patient and the time at which that patient was placed in isolation.[5]

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4 Ibid.

5 Cheng, V.C.C. et.al. Clinical management and infection control of SARS: Lessons learned. Antiviral Research, vol. 100 Issue 2, Nov 2013 p. 407-419. Accessed at https://doi.org/10.1016/j.antiviral.2013.08.016

Instead of containing the spread of disease, many hospitals thus became a major source of disease transmission to other patients, hospital staff and visitors. Healthcare workers were especially vulnerable, accounting for one-fifth of all SARS infections worldwide.[6] This was only an average; In Toronto alone, the rate of infection in this group was more than 40%.[7]

At a time when healthcare workers were urgently needed, they themselves were becoming patients.

Another problem that initially contributed to the spread of SARS in hospitals was inadequate precaution against infection - inconsistent use of protective clothing, for example. Participation in certain high-risk medical procedures for SARS patients was also an issue, even for personnel who were correctly protected.[8]

Unfamiliar diseases require extra vigilance

The lesson here is that during an epidemic of an unfamiliar, infectious disease – whether naturally-occurring or caused by a biological attack – medical staff who evaluate new hospital admissions need to be highly vigilant with respect to symptoms of the disease and the need to isolate the patient.

Extra in-patient surveillance may also be needed; in Canada, for example, it was found that patients admitted for reasons unrelated to the epidemic were sometimes also incubating a case of SARS, a fact which initially went unnoticed.[9]

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6 Chan-Yeung, M. Severe Acute Respiratory Syndrome (SARS) and Healthcare Workers (2004). International Journal of Occupational and Environmental Health, 10:4, 421-427. DOI: 10.1179/oeh.2004.10.4.421

7 Rothstein, 2003.

8 Cheng, 2013.

9 Svoboda, T et.al. Public Health Measures to Control the Spread of the Severe Acute Respiratory Syndrome during the Outbreak in Toronto. N Engl J Med 2004; 350:2352-2361. Accessed at: https://www.nejm.org/doi/full/10.1056/NEJMoa032111

Isolation can take place in a variety of settings

Ideally, isolation facilities should consist of single-person, negative air pressure units equipped with an airlock to separate the inner chamber from the outer hallway of the hospital. Ventilation that is separated from the rest of the hospital ventilation system should ensure a constant supply of fresh air.

Isolation facilities such as the above are generally in short supply and very likely totally insufficient during a large-scale epidemic after a biological attack. As the scope of the SARS epidemic grew, many patients were ultimately isolated in dedicated SARS hospitals. Countries in which such hospitals were established include China, Hong Kong, Singapore, Taiwan, Vietnam and Canada.[10]

Isolation wards were also used. A Vietnamese hospital in Hanoi experienced no in-hospital disease transmission at all from SARS patients who were placed in "designated isolation wards of large spacious rooms with high ceilings and ceiling fans that were kept running while the large windows were kept open for natural ventilation".[11]

Quarantine requires compliance – or 'persuasion'

Isolation and quarantine both involve some measure of internment and can therefore be controversial. The need for isolation of demonstrably ill persons should be fairly easy to understand, however.

Quarantine is likely to be viewed as far more intrusive, inasmuch as it prevents people who show no sign of illness from going about their business for a relatively long time (the incubation period for smallpox, for example, is 7-17 days). This can make compliance with quarantine restrictions a major issue.

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10 Ahmad, A. Controlling SARS: a review on China's response compared with other SARS-affected countries. Tropical Medicine & International Health. 7 October 2009. Accessed at: https://doi.org/10.1111/j.1365-3156.2008.02146.x

11 Cheng, 2013.

Isolation facilities must be designed to prevent patients from spreading disease throughout the hospital. Caregivers in isolation wards must wear protective clothing.

Photo: Hvidovre Hospital

A basic principle of quarantine is that it must be respected. Voluntary quarantine was widely relied on during the SARS epidemic, but there were also instances of 'persuasion'

Examples of SARS quarantine enforcement include compulsory quarantine orders, isolation in guarded rooms, fines and even jail sentences for non-compliance. In Singapore, video cameras connected to telephones were sometimes used to ensure that home-quarantined persons really were at home.[12]

Compensation for lost wages may be necessary

Even in the face of sanctions, there can be compelling social reasons for breaking quarantine. For example, quarantine will prevent people who feel healthy from going to work. This can in some cases mean lost wages, unpaid bills and perhaps even the loss of the job itself.

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12 Cetron, M et.al. Isolation and Quarantine: Containment Strategies for SARS 2003 (chapter in the book Learning from SARS: Preparing for the Next Disease Outbreak: Workshop Summary. National Academies Press (US), 2004. Accessed at: https://www.ncbi.nlm.nih.gov/books/NBK92450/

Issues like this can threaten quarantine compliance and must therefore (if for no other reason) be addressed as part of the quarantine planning process. A study of the SARS epidemic in the six most-affected countries (China, Canada, Hong Kong, Singapore, Taiwan and Vietnam) shows that steps were taken in all six countries to provide some form of wage replacement and job security for quarantined persons.[13]

Quarantine can take many forms

A broad range of quarantine methods were employed in the countries affected by SARS. In-home, voluntary quarantine was common in Canada, which also had a system of 'work quarantine' for badly-needed healthcare workers who had been exposed to SARS in the line of duty.

Work quarantine allowed symptom-free healthcare workers to drive directly to and from the workplace, without stopping and without taking passengers. When not at work, these persons were quarantined at home and had to observe all home quarantine rules.

In China, some people were quarantined in their homes, while others were relocated to hospitals, hotels, holiday camps and the like. Over 12,000 persons were 'collectively quarantined' by completely sealing off entire hospitals, residential buildings, universities, construction sites and, in rural areas, whole villages.[14]

Laws might need to be changed

Legal issues can also affect the use of quarantine. In some countries hit by SARS, the law only permitted quarantine with respect to specifically named diseases. Laws had to be quickly amended to accommodate a disease that no one had ever heard of before.[15]

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13 Ibid.
14 Ibid
15 Rothstein, 2003

In view of the wellknown risk of new, emerging diseases – or the risk of a biological attack with new, genetically modified agents – modern quarantine laws should of course be made flexible enough to accommodate contagious diseases that are not specified by name.

Decisions will be needed despite incomplete knowledge

The use of quarantine – with or without force – requires more than planning. For decision makers, it requires the conviction that quarantine will be useful, and the will to implement enforcement methods if they are deemed necessary.

Such decisions should be based on a thorough review of scientific, legal and social issues. But when the infection-causing agent is an unknown pathogen, decisions may have to be made at a time when complete information is not yet available.

During the SARS epidemic, laboratory scientists around the world worked tirelessly and eventually succeeded in identifying and describing the SARS virus. At the time when quarantine decisions were needed, however, the scientific knowledge had not yet caught up with the epidemic. Authorities had to do the best they could with what they knew at the time.[16]

Quarantine may have been over-used

In hindsight, voices have been raised to the effect that the extent of quarantine during the outbreak of SARS was too sweeping, compared to the risk of transmission. In one commentary on SARS quarantine practices, it has been pointed out that SARS is most contagious not during incubation, but at a point that is well after symptoms appear.[17]

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16 Ibid.

17 Schabas, R. Severe acute respiratory syndrome: Did quarantine help? Can J Infect Dis Med Microbiol. 2004 Jul-Aug; 15(4): 204. Accessed at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2094974/

Another retrospective SARS article noted a couple of remarkable statistics: in Hong Kong, only 2.7% of all quarantined persons ever developed SARS; in Taiwan, the percentage was a mere 0.22%.[18]

How much is 'enough'?

A look at SARS quarantine statistics around the world shows widely divergent ideas of how much quarantine is 'enough'. As previously mentioned, both China and Canada quarantined about 30,000 people. This may be compared to the fact that in China, there were 5,327 reported cases of SARS, while in Canada there were only 251.[19]

It should be remembered, however, that much of Canada's massive use of quarantine was home-based and voluntary, while in China, quarantine measures included sealing off entire buildings or villages.

Hindsight is easier than foresight

Lacking the above-mentioned knowledge, statistics and hindsights, authorities may still prefer to err on the side of caution in the initial phases of a biological attack.

They could, however, choose to review quarantine rules if and when new information becomes available, and perhaps relax at least some of the restrictions. This might make restrictions of movement more understandable to those who are still affected by it, and increase the likelihood of compliance.[20]

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18 Ahmad, 2009

19 World Health Organization (website). Summary table of SARS cases by country, 1 November 2002 - 7 August 2003. Accessed at https://www.who.int/csr/sars/country/2003_08_15/en/

20 Reynolds, D.L. et.al. Understanding, compliance and psychological impact of the SARS quarantine experience. Epidemiology and Infection. Published online 30 July 2007. Accessed at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2870884/

Logistical challenges require preparation

Like all the other large-scale response efforts described in this book, a quarantine programme has its own set of logistical challenges.

If home quarantine is not practical or desirable, other forms of accommodation will have to be found and prepared for use. Such facilities, like the evacuation shelters, medical stockpiles and other emergency arrangements discussed in this book, should be identified beforehand and integrated into an overall disaster preparedness plan.

Here it should be remembered that if a biological attack is involved, evacuees from the hazard area may already be placing a strain on available accommodations (a fact which might make home quarantine a more attractive alternative).

Since persons in quarantine cannot leave the place to which they have been confined, safe arrangements must be also made for the delivery of food and necessary social services, as well as the removal of waste that may have to be treated as contaminated.

If quarantine enforcement is desired, a system for this must also be developed.

Travel restrictions may be needed

Travel restrictions is another way of hindering the spread of infection. A six-country review of this and other SARS-related countermeasures shows that each of the countries that were reviewed (China, Canada, Hong Kong, Singapore, Taiwan and Vietnam) provided travellers with health alert notices about the signs and symptoms of SARS, as well as information about where to seek help.[21]

Acting on a recommendation from the World Health Organization, each of the above countries also required arriving and departing

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21 Ahmad, 2009

passengers to submit health declaration cards to certify that they were SARS-free and had no contact to SARS-infected persons. Thermal scanning was used on millions of domestic and international travellers to detect signs of fever in persons entering or leaving affected areas.[22]

Internal travel restrictions in China required screening of people using any mode of travel (air, rail, bus, ferry, etc.), and checkpoints were set up on 71 roads from Beijing to other areas of the country. Travel to quarantined villages was also restricted.[23]

Travel advisories were issued by WHO

WHO and various governments also issued travel advisories recommending postponement of nonessential travel to specific areas. Such advisories – in addition to the general spread of information about the epidemic – resulted in a dramatic decrease in air travel to the affected areas during the epidemic.[24]

Travel advisories are bound to affect more than the public health of the area in question. In the hard-hit city of Toronto (where SARS had in fact been introduced to the city by an air traveler from Hong Kong), a WHO travel advisory was in effect for six days and cost the local tourist industry an estimated $260 million (Canadian).[25]

'Social distancing' may be effective

It would seem almost self-evident that simply staying away from other people during an epidemic should help limit the spread of a contagious disease. Many countries affected by the SARS epidemic thus tried to limit social interaction by cancelling mass gatherings, and by temporarily closing schools, theaters and other public facilities.

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22 Ibid.
23 Ibid.
24 Bell, D.M. Public Health Interventions and SARS Spread, 2003. Emerg Infect Dis. 2004 Nov; 10(11): 1900–1906. doi: 10.3201/eid1011.040729
25 Svoboda, 2004.

Hard evidence as to the effect of such 'social distancing' measures is limited, as these actions were often combined with other types of disease control such as intensified contact tracing.[26] However, a disease simulation study using computer-assisted modelling indicates that using a variety of social distancing methods can reduce infection during an influenza epidemic – but only if these measures are introduced within the first two weeks of first case of illness.[27]

Biology has no borders

The global SARS epidemic made it abundantly clear that biology has no borders. Contagious pathogens are seasoned travellers with no respect for political boundaries, systems of belief or methods of government.

The worldwide community will also need to put aside these constructions and find some common ground in order to meet the challenges of biopreparedness. In our next chapter, we will therefore be taking a closer look at the subject of international cooperation.

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26 Bell, 2004.

27 Kelso, J.K. et.al. Simulation suggests that rapid activation of social distancing can arrest epidemic development due to a novel strain of influenza. BMC Public Health 2009, 9:117 doi:10.1186/1471-2458-9-117

section 4

Additional issues

The final section of this book is essentially about cooperation.

Among other things, we will be examining the many ways in which nations around the world can find common ground – officially as well as informally – against a threat that has no boundaries. Our chapter on emergency and crisis communication, meanwhile, will show how timely and effective communication can promote a constructive alliance between authorities and the public.

Cross-organisational cooperation is at the heart of our chapter on biopreparedness training exercises.

Our book will conclude with a series of biopreparedness dilemmas designed to promote reflection and discussion.

13

International cooperation

The worldwide alliance of researchers that managed to swiftly identify the SARS virus is precisely the kind of international collaboration that is needed in a biopreparedness context. Pooling biopreparedness resources can make everyone safer.

At the beginning of the SARS epidemic, doctors, health authorities and governments around the world were boxing in the dark. As they struggled with this deadly new disease that could slip unnoticed into hospitals disguised as some other condition, they were missing a vital piece of information: the exact identity of the disease-causing agent.

As we have shown in the previous chapter, unrecognised cases of SARS caused the disease to spread unpredictably, especially among healthcare workers. Knowing the identity of the agent would make it possible to develop a reliable test for SARS and prevent 'mistaken identities' from contributing to the epidemic.

On 17 April 2003, the SARS virus emerged from the darkness when the World Health Organisation announced that the 'culprit' had been found: a novel coronavirus which was later dubbed SARS CoV.[1]

Ten countries provided groundbreaking help

The swift identification, characterisation and sequencing of the SARS virus was only possible because of a network of 11 laboratories in 10 different countries. Researchers from these institutions had pooled their knowledge, experience and facilities under the banner of WHO, which had organised the collaboration just one month earlier[2].

During the month-long effort, the rapidly evolving knowledge developed by this international team was quickly shared on the WHO website, as well as in expedited, peer-reviewed publications and lay media.[3]

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1 World Health Organization (website). Severe Acute Respiratory Syndrome (SARS) - multi-country outbreak - Update 32. 17 April 2003. Accessed at https://www.who.int/csr/don/2003_04_17/en/

2 Ibid – Update 2. 17 March 2003. Accessed at https://www.who.int/csr/don/2003_03_17/en/

3 Braden, C.R. et.al. Progress in Global Surveillance and Response Capacity 10 Years after Severe Acute Respiratory Syndrome. Emerg Infect Dis. 2013;19(6):864-869. https://dx.doi.org/10.3201/eid1906.130192

It was a groundbreaking effort, and an example of the kind of rapid, worldwide response that could also be invaluable after a biological attack with an unknown pathogen.

Laboratory and other capabilities can be shared

In our discussions of bio-attack responses, we have also shown how advanced laboratory expertise and capabilities at the BSL-4 level can be shared internationally, enabling countries without such facilities to draw on foreign capabilities after a biological attack.

Cross-border agreements for sharing other types of highly specialised biopreparedness know-how – dispersion and intervention modelling, for example, or the skills of experienced field investigators – could also be a welcome addition to a national biopreparedness programme. Countries who do not have such capabilities should seek to establish agreements of assistance with countries that do.

Countries who wish to improve their own biopreparedness systems could likewise ally themselves with more experienced nations. The Danish dispersion and intervention modelling system, for example, was created with the help of technology from foreign colleagues. The system was further developed and adapted to local conditions by the Danish biopreparedness organisation.

Civil-military cooperation is useful

It is often the case that a country's most advanced technology resides within the military. Biopreparedness capabilities may thus exist to which civilian organisations do not normally have access.

At the time of this writing, work was being done within NATO to prepare a set of guidelines for enhanced civilian-military cooperation among member nations in the event of large-scale terrorist threats involving chemical, biological, radiological or nuclear weapons (CBRN weapons). Such guidelines will facilitate a better and efficient sharing of biopreparedness capabilities between military and civilian

organisations and between countries as well. Until such time as this cooperation is formalised - and for nations outside of NATO - other types of formal or informal civil-military agreements of assistance could perhaps be sought.

Regional assistance agreements can be practical

In relation to medical countermeasures a major biological attack will very likely strain capacity (doctors, hospital beds, medical staff, medicines, etc.) beyond what a single nation can manage. Regional agreements promising mutual assistance can help adress this problem.

For example, in 2002 the five Nordic countries – Denmark, Iceland, Norway, Sweden and Finland formally promised to provide health preparedness assistance to each other in the event of a broad range of natural and man-made disasters, including bioterrorism.[4]

From a logistical point of view, agreements of this kind are especially practical among countries in the same general region. It may also be easier to establish biopreparedness agreements among neighbouring nations with similar interests who already collaborate in other matters.

The EU also promotes preparedness collaboration

The European Union has also addressed the need for cooperation among its member states with respect to what it calls 'serious cross-border threats to health' – a term covering a variety of EU-wide scenarios, including bioterrorism.

Among other things, the European Parliament approved in 2013 a measure that obliges member states to assist each other in the event

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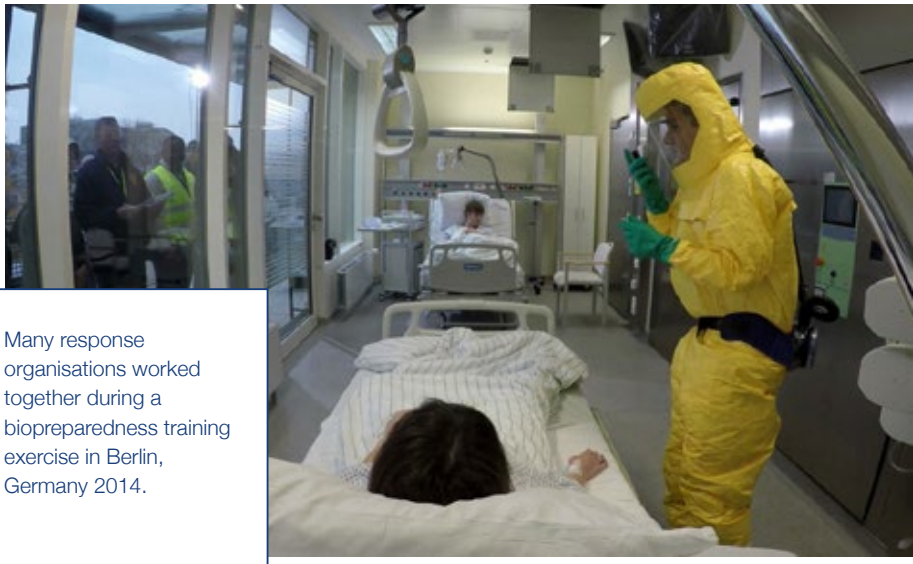
4 Nordic health preparedness agreement (Danish text), 2002. Accessed at https://www.retsinformation.dk/Forms/R0710.aspx?id=23030



Many response organisations worked together during a biopreparedness training exercise in Berlin, Germany 2014.

Photo: Joachim Puls / Filmsalz

of a health-related threat that is "overwhelming the national response capacities."[5]

To further facilitate biopreparedness collaboration, the EU has also asked its members to establish field investigational standards that are interoperable – meaning in this context a set of standard operating procedures based on common goals and requirements. The idea here is to make it easier for field investigators from one country to work with and assist their colleagues in another EU country.[6]

The Biological Weapons Convention unites 182 nations

The United Nations Biological Weapons Convention (BWC) is an international treaty which, if universally respected, would make bio-

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5 Decision No 1082/2013/EU of The European Parliament and of the Council of 22 October 2013 on serious cross-border threats to health. Official Journal of the European Union. Accessed at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32013D1082

6 EU Commision, DG Health and Consumer Protection, Health Threats Unit. Biological Incident Response & Environmental Sampling – a European Guideline on Principles of Field Investigation, p. 19. October, 2006.

preparedness unnecessary. The Convention, which came into force in 1975, is a supplement to the Geneva Convention of 1925, which forbids the use of biological and chemical weapons.

The BWC forbids the development, production and stockpiling of biological and toxin weapons; as of September 2018, it had been ratified or signed by 182 nations[7].

Members of the BWC meet at five-year intervals to explore ways of strengthening the implementation of this treaty. To prepare for these gatherings, annual meetings of BWC members and more frequent Meetings of Experts are held to discuss concrete ways to promote BWC compliance and assist member nations victimised by BWC violations.

International consensus can be difficult to achieve

At a Meeting of Experts in December 2018, a proposal from India and France was considered which would establish an international database to match requests for help with offers of assistance in the wake of a BWC violation. Such aid could include, for example, specific expertise, decontamination assistance and the provision of medical and other equipment.

Despite expressions of support for the database proposal, no consensus on the issue was reached at the meeting.[8]

Individual networking can be a way forward

Lack of decisive action can be a disappointing element of large, international gatherings at which underlying national interests can

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7 Arms Control Association (website). Biological Weapons Convention Signatories and States-Parties. Posted 26 Sept. 2018. Accessed at https://www.armscontrol.org/fact-sheets/bwcsig

8 Mackby, J. BWC Meeting Stumbles Over Money, Politics. Arms Control Association (website). Posted 8 January 2019. Accessed at https://www.armscontrol.org/act/2019-01/news/bwc-meeting-stumbles-over-money-politics

be an ‘elephant in the room’. On the other hand, BWC meetings and similar conferences also provide an invaluable opportunity for individual networking.

In the end, personal encounters of this kind may prove to be more immediately constructive than the long-haul work that takes place at the meeting itself. For example, a connection was made between Kenya and Denmark at a BWC meeting which ultimately resulted in an educational programme in Kenya and significant improvements to the country’s biosecurity system.

Any event at which nations meet to discuss biopreparedness issues should at the very least be regarded as an opportunity to take a step in the right direction – regardless of whether that step is taken in the meeting room or in the corridors outside.

UN Factfinding Missions - multinational investigation of alleged bioweapons use

The Secretary General of the United Nations is authorised, upon request from a member nation, to initiate international fact-finding missions to investigate the alleged use of biological and chemical weapons. For each mission, individual experts from around the world are chosen from a roster of qualified participants.

Ascertaining the illegal use of biological or chemical weapons requires all the skills and capabilities we have described in this book and more. The UN Office of Disarmament Affairs has therefore helped organise several international training exercises in recent years to build and maintain the operational and collaborative skills needed for this type of UN fact-finding mission.

Multi-national missions pose special challenges

To further enhance the efficiency of these missions, the Danish Centre for Biosecurity and Biopreparedness proposed in 2012 a new concept of operations designed to minimise language barriers and

The Biological Weapons Convention Meetings of Experts in Geneva, Switzerland, 2019.

Photo: CBB

differences in approach and training that could hamper the efforts of a multi-national unit.

Instead of individual team members from different countries, the new concept would use so-called functional sub-units. Each of these units would be based on already existing units in the membercountries. By using fully formed units in operative status in their home-countries the UN would benefit from training and experience already attained. Together a number of functional subunits would make up the factfinding mission according to the situation at hand.

Internally in the subunits the members would speak the same language and be accustomed to working together according to well-known procedures and with well-known equipment.

A UN fact-finding mission could, for example, include a subunit of field investigators from the US, a subunit of dispersion modelling experts from Denmark, a subunit of laboratory scientists from China, a subunit of witness interviewers from the UK, etc.

The concept was tested in principle during a tabletop exercise in Copenhagen in May 2013 and again in practice during full-scale training exercise in Berlin in November 2014. At the time of this writing, the future of this proposal was still uncertain, however.

WHO can organise rapid response to threats

The World Health Organization continues to stand as a global organiser and communicator with respect to evolving health threats around the world. While it is not a biopreparedness organisation, the help and overview it provides can be applied to the health-related effects of a biological attack as well as to that of a naturally occurring epidemic.

WHO organises global responses to health threats via its Global Outbreak Alert and Response Network (GOARN). During disease outbreaks, this network of collaborating institutions and responders is ready to pool its human and technical resources for rapid identification, confirmation and response to outbreaks of international importance.

It was a collaboration organised through GOARN, for example, that solved the riddle of the SARS virus. Incoming information from worldwide sources about other aspects of the unfolding epidemic was also collected and shared by WHO on its website and elsewhere.

Cross-border information-sharing is vital

We have made this point before, but it bears repeating here: the sharing of relevant information with others is the responsibility of every individual, government and preparedness organisation that is interested in minimising the effects of a biological attack. This type of reporting may begin with nothing more than a suspicion and a phone call to a local authority. But if the suspicion turns out to be justified, the initial early-warning call can be passed on to higher authorities and ultimately save lives around the world.

The US Centers for Disease Control, like the World Health Organization, is an institution that collects, processes and disseminates information related to serious, emerging health threats, both man-made and 'natural'. These and other information sources can spread the alert to other countries who may be able to offer help and/or who need to prepare for a possible biological attack.

Biological threats are always an international issue

It may be tempting to view biopreparedness as a matter of national security, and to focus efforts on preparing for the worst within one's own borders. But it should be obvious that it is also a matter of national self-interest to ensure that other countries are equally well-prepared.

In a globalised world, even nations with the highest level of vigilance and technology are only as safe as the weakest link in the biopreparedness chain.

14

Communicating with the public

Explaining the danger of a biological incident without causing fear may be difficult, because the threat to life and health is not immediately apparent. Much can be accomplished, however, if preparedness organisations and authorities can communicate and interact with the public in a constructive way.

In an online communication manual developed by the US Centers for Disease Control and Prevention (CDC), there is a basic piece of advice that takes first place in more ways than one. The first principle (on a list of six) for good crisis and emergency risk communication is, quite simply, to 'be first'.[1]

What this means in a biopreparedness context is that the first message to the public about a major biological incident should come from a competent, knowledgeable organisation.

The first message has a special impact

This may sound like a statement of the obvious, but as we have seen with the case of SARS in China, authorities may initially hesitate to release information about an emerging crisis. When the news finally breaks – and it will – it may instead be in the form of rumours and speculation that can be extremely difficult to debunk.

This relates directly to a psychological phenomenon described the CDC manual: in times of stress and crisis, people tend to accept and believe the first message they hear about the emergency. If no authoritative information is forthcoming, they may begin to 'fill in the blanks' with the help of whatever source they can find.

Even if more accurate information is presented later, it will still have to compete with the first message for public attention.[2]

'Being first' can prevent hearsay and rumours

When a reliable entity is the first to release information about a biological incident, it can thus establish itself as the go-to source of

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1 US Centers for Disease Control and Prevention. Crisis and Emergency Risk Communication, Chapter 2. Last updated 2014. Accessed at https://emergency.cdc.gov/cerc/ppt/CERC_Psychology_of_a_Crisis.pdf

2 Ibid.

knowledge about the emergency and prevent fake news or unqualified hearsay from taking hold.

This authority could be the police, a government, a public health department, a biopreparedness organisation or some other relevant entity. The main thing is that it must have the knowledge, resources and communication skills to quickly provide updated, accurate and understandable information to the public.

Panic is uncommon during emergencies

One reason why authorities may want to delay the release of information about an incident (or downplay its importance) is to avoid panic. Scenes come to mind from various disaster movies in which hordes of humanity are seen stampeding through the streets of a city under attack .

The public, however, is not as prone to panic as a moviemaker might imagine. Studies of collective behavior during disasters do show examples of stress, fear and other negative (but entirely natural) responses to such situations. But they also reveal massive evidence of cooperation, resourcefulness and altruism.[3, 4]

True panic – defined as "irrational, groundless or hysterical flight that is carried out with complete disregard for others" – is actually quite rare in real-life disaster scenarios.[5]

Information on biological threats must be extremely clear

A more widespread problem that should be addressed by communicators is that people may not take a given threat seriously. The

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3 O'Leary, M. (editor). The First 72 Hours: A Community Approach to Disaster Preparedness (Chapter 27). Lincoln (Nebraska), iUniverse Publishing (2004). Accessed at: https://www.atsdr.cdc.gov/emergency_response/common_misconceptions.pdf

4 Glass, T and Schoch-Spana, M. Bioterrorism and the People: How to vaccinate a City against Panic. Clinical Infectious Diseases, Volume 34 Issue 2. 15 Jan 2002. Accessed at https://doi.org/10.1086/338711

5 O'Leary, 2004.

Photo:Getty Images

lack of timely evacuation after hurricane warnings, for example, is a frequent problem. If initial threat notifications are in any way vague, people tend to interpret them in a less threatening manner.[6]

In biological emergencies, the fact that the initial threat is invisible and has no immediate effect on health can make it difficult for people to accept the idea of a clear and present danger. Communication on this issue will have to be exceptionally unambiguous.

The same type of clear communication will also be needed later, when people may be tempted to return to a contaminated area where buildings and belongings remain intact and there is no visible evidence of danger.

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6 Ibid.

Six principles can guide crisis communication

Unambiguous information must describe a harsh reality, but the message itself does not have to be harshly expressed. Ideally, it should live up to all six of the principles described in the CDC manual. They are:[7]

- Be first
- Be right
- Be credible
- Express empathy
- Promote action
- Show respect

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7 US Centers for Disease Control and Prevention. Crisis and Emergency Risk Communication, Introduction. Last updated 2018. Accessed at https://emergency.cdc.gov/cerc/ppt/CERC_Introduction.pdf

Much of the discussion that follows in this chapter will relate in one way or another to these principles, viewed from a biopreparedness perspective.

State the facts – and admit the uncertainties

The accuracy of information released to the public is of course key to maintaining credibility. 'Being right' means that any information about a given incident should be verified to greatest extent possible by relevant experts. The release of any information to the public should also be approved by the top management of the organisation that releases it.

This does not mean that communication should wait until every uncertainty is cleared up. There will always be more questions than answers at the beginning of a biological incident, and not everything can be immediately verified. Under such circumstances, the best that can be done is to simply

- state what is known
- acknowledge the uncertainties
- explain what is being done to learn more

Always avoid speculation

Speculation – for example, providing journalists with a guess about the nature of a biological agent that has not yet been analysed – is an absolute no-go.

Honestly recognising any knowledge gaps and assuring the public that further investigations are underway is more likely to boost than damage the credibility of the organisation. Pretending to know everything is not credible.

Conflicting messages can damage credibility

Being credible is not necessarily the same thing as being right. Infor-

mation that sounds credible can be dead wrong. On the other hand, the facts of a case could be right as rain, but if the organisation that presents them has lost the trust of its listeners, 'alternative facts' may prevail.

A common pitfall that can damage credibility is when communicators deliver conflicting messages. For example, one agency might state that the correct prophylactic medication after an anthrax attack is a vaccination, while another agency (which may not have received the latest update on the matter) states that the preferred prophylaxis is a 60-day treatment of antibiotics.

When confusion like this happens, people may end up consulting 'Doctor Google'. All the organisations involved in responding to a biological incident should therefore share and align their information as much as possible so that they can all speak with the same voice.

New information can contradict old assumptions

In an evolving crisis, new information will sometimes contradict earlier assumptions. To the public, this could seem like 'the right hand doesn't know what the left hand is doing.'

When presenting new information that conflicts with previous statements, communicators must therefore be careful to explain that new discoveries have given investigators a more accurate picture of the situation.

Honesty and empathy are better than over-confidence

Another communication pitfall is to try to cover up or downplay the delays, mix-ups or mistakes that are bound to happen in an emergency where everyone is working under time constraints and stress. If and when this happens, an honest explanation and an expression of regret (without angry defensiveness) is the best response.

Making broad promises to fix all the problems and catch all the

culprits after a biological attack is a very bad idea. The same goes for displays of over-confidence at the outset of an incident that is likely to get worse before it gets better. In this type of situation, no one can promise anything except to do their best.

Empathy, on the other hand, is a key component of trust and credibility. A spokesperson who expresses understanding for what people are going through during and after a biological disaster will make them more open to whatever else is said after that. Expressions of empathy should therefore to be made quickly – preferably within the first 30 seconds of a presentation.[8]

Communication should also promote action

It is also important to include something constructive in public statements – for example, mentioning the ways in which response teams are working to mitigate the incident. This is a form of reassurance that is not over-confident, but which can offer some hope at a difficult time.

As the incident unfolds, it will also be important to offer constructive, action-based advice about what people can do to protect themselves and their families. This kind of information is empowering and can activate much-needed inner resources.

It might even be said that having something constructive to do during a large-scale emergency is an extra 'vaccination' against panic.[9]

In the context of a biological incident, action-based information includes such things as where to find evacuee shelters, how to get prophylactic medication, how to minimise the risk of infection, and the possible need for voluntary quarantine or other restrictions of movement. But it could also include other kinds of helpful activities.

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8 Reynolds, B. Communicating in a Crisis is Different. Domestic Preparedness Journal. 28 Mar 2007. Accessed at https://www.domesticpreparedness.com/commentary/communicating-in-a-crisis-is-different/

9 Glass and Schoch-Spana, 2002.

Volunteers are ready to assist

Modern theories of disaster management tend to cast the public in the role of passive bystander/victim or potentially dangerous mob[10]. As we have seen earlier in this chapter, however, it seems likely that people who find themselves in the middle of a major emergency are not very panic-prone, and they harbour reserves of strength and resourcefulness.

Outside the immediate disaster area, moreover, there are usually even more 'reserves' in the form of concerned citizens who want to help. Sometimes first responders to an emergency actually find themselves deluged with unexpected offers of volunteer assistance; a hotline for medical volunteers after the 2001 World Trade Center attack, for example, resulted in over 40,000 calls.[11]

Dealing with such a massive public response can become a problem in itself if response and mitigation teams are not prepared for it.

Treat the public as a potential ally

A more useful approach to disaster management would be to treat the public as a potential ally, and make beforehand plans and agreements for how volunteer energies can be put to good use[12].

There are many practical and even life-saving things that ordinary citizens can do in the event of a biological attack. During the evacuation of a very large hazard area, for example, able-bodied people who themselves are evacuating from affected buildings can be mobilised to help their elderly or handicapped neighbours to safety as well.

In neighbourhoods outside the hazard area, community organisations such as church groups, Rotary clubs and the like can be enlisted to

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10 O'Leary, 2004.
11 Ibid.
12 Glass and Schoch-Spana, 2002.

help distribute medication, set up evacuee shelters or perhaps raise money to support relief efforts.

Communicators, in collaboration with preparedness organisations, could focus on letting the public know exactly when and where volunteer help is needed and tell them how they can join this effort.

Show respect

Respecting the needs and norms of the people affected by a major biological incident is akin to empathy in that it will make people more open to a given message. On the other hand, statements that have a condescending tone, or a spokesperson who seems to 'talk down' to people, is not likely to be well received.

Use many different forms of communication

Information needs will also vary depending on how close people are to the site of the incident. People in a hazard area will need to know why evacuation is necessary and how they can protect themselves from falling ill; those immediately outside the area will want to know if the danger will spread, and whether they can help.

Differences in age, level of education, social norms, etc. will also affect the channels that people use to get information. Some will prefer television, radio or print media, while others will respond to information presented on social media or websites. To reach as many as possible, messages should be adapted to a variety of channels.[13]

Keep the message simple and easy to understand

A golden rule for public communication, whether written or spoken, has always been to 'keep it simple'. This is good advice for any type

13 Ibid.

of public information, but especially in a crisis, where people tend to miss, forget or misinterpret much of what they hear.[14]

Necessary knowledge and information should be stated plainly in lay terms, and should be presented up front rather than at the end of a long background explanation. Messages should be relatively short, and jargon and acronyms should be avoided. Key points should repeated.

'The faces of SARS' became trusted communicators

During the SARS crisis in Canada, there were two people who became household names in Toronto. They were Donald Low and Sheela Basrur, two expert spokespersons who became 'the public faces of SARS'. During the four-month period when the city was hit the hardest, they gave countless interviews and appeared regularly on evening television newscasts to calmly explain what was going on.[15]

Low, who at the time was chief of microbiology at Toronto's Mt. Sinai Hospital, had a gift for getting to the core of an issue and explaining it in words that ordinary people could understand. Basrur, as Toronto's chief medical officer of health, also had the credentials and communication skills needed to act as a calm voice of reason at an extremely difficult time.[16]

Together, Low and Basrur became a trusted, reassuring and frequently-seen presence during the epidemic.

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14 US Centers for Disease Control and Prevention. Crisis and Emergency Risk Communication, Chapter 2. Last updated 2014. Accessed at https://emergency.cdc.gov/cerc/ppt/CERC_Psychology_of_a_Crisis.pdf

15 Kane, L and McKnight, Z. Donald Low: Colleagues remember a voice of reassurance in Toronto's SARS crisis. Toronto Star, 19 Sept 2013. Accessed at https://www.thestar.com/life/health_wellness/2013/09/19/donald_low_dies html

16 Ibid.

Organisations need a human face

Having a well-trained, experienced and empathetic spokesperson in place during a biological crisis can lend a human face to an otherwise anonymous organisation and bring its communication to a level that is up close and personal. And it must be stressed that the job involves more than reading a prepared statement in front of a microphone.

During a biological incident, spokespersons must be able to communicate effectively and credibly in any public setting where information is needed and questions are being asked: at press conferences and town meetings, in television appearances and at evacuee shelters.

They must be prepared to respond to unpredictable questions with empathy and without getting flustered or angry.

The spokesperson must be properly trained

Appropriate media training is an absolute must for the job of spokesperson. But there are two very basic qualifications that this person must have from the get-go:

- a thorough knowledge of the subject matter to be communicated
- the ability to talk about it clearly and with confidence

Added credibility will be gained if the spokesperson is a high-ranking and highly experienced member of the organisation that he or she represents.[17]

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17 Centers for Disease Control and Prevention. Crisis Emergency Risk Communication, Chapter 6. Last updated 2014. Accessed at https://emergency.cdc.gov/cerc/ppt/CERC_Spokesperson.pdf

Communication is more than giving instructions

As with most of the topics covered in this book, crisis communication is a huge subject in its own right. Courses of varying length and complexity are available through a great many vendors worldwide, and further insights may also be gained by exploring the links that have been footnoted in this chapter.

The first step, however, is to recognise that communicating with the public during and in the wake of a major emergency – biological or otherwise – is not just a matter of 'telling people what to do.' It is a form of interaction which, if done well, can also motivate, energise and result in positive contributions to mitigation efforts.

Crisis hotlines: human voices, volunteer efforts

When disaster strikes, one-on-one communication can be a useful supplement to mass media for some people. This certainly seems to have been the case in Canada, where an information hotline set up by the Toronto Public Health Department logged an overwhelming 326,625 calls during the outbreak of SARS in 2003.[18]

One third of these callers bypassed the 'recorded information' option and asked to speak with a member of the hotline staff. Unfortunately, staffing shortages and the complexity of some of the calls meant that only a small percentage of these callers (8.9%) managed to connect with a human voice.

Telephone hotlines became a source of information and counselling in many countries during the SARS epidemic[19]. It is interesting to note that in Hong Kong, an emotional support hotline established during the initial, highly demoralising phase of the epidemic became an example of how volunteer efforts can supplement the work of government organisations.

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18 Svoboda, T et.al. Public Health Measures to Control the Spread of the Severe Acute Respiratory Syndrome during the Outbreak in Toronto. N Engl J Med 2004; 350:2352-2361. Accessed at https://www.nejm.org/doi/full/10.1056/NEJMoa032111

19 Ahmad, A. et.al. Controlling SARS: a review on China's response compared with other SARS-affected countries. Tropical Medicine & International Health, vol. 1 issue s1. Nov 2009. Accessed at https://doi.org/10.1111/j.1365-3156.2008.02146.x

The hotline represented the efforts of 80 social workers and medical students from the Chinese University of Hong Kong, who had joined forces with a Lutheran church organisation to set up the service. While admittedly on a much smaller and more improvised scale than the hotline service in Canada, a number of similar hotlines were later set up in the city to help address the public need for this type of support.[20]

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20 Leung, T. and Wong, H. Journal of Human Behavior in the Social Environment, vol. 12(1) 2005. Accessed at: https://web.swk.cuhk.edu.hk/~hwong/pubfile/journal/2005_Community_Reactions_to_SARS_Crisis_in_HK_JHBSE.pdf

15

Conducting a full-scale training exercise

Like any other skill, biopreparedness requires practical training as well as theoretical knowledge. In this chapter, we will describe some of the challenges of arranging full-scale, hands-on learning.

On a fine autumn day in the Danish town of Viborg, a man in a silver-grey station wagon pulls up in front of the Academy of Physical Education, where he has been given permission to deliver a special de-humidifier to the school auditorium. The device, he says, is for the benefit of a speaker who is due to address the school on the following day, and who has requested the de-humidifier.

At 4 a.m. the next morning, four school employees begin to clean the auditorium and prepare it for the day's big event. They set up the de-humidifier near a ventilation duct and turn it on. The device unexpectedly turns some powdery dust from inside, and all four employees are dirtied by it.

A few hours later, people start getting sick.

It all begins with a storyline

Thus began the fictional storyline that was used during a full-scale training exercise in Viborg, Denmark, on 3 October 2017. The exercise brought together many organisations, including local and national police, hospital staff, firefighters, criminal investigators, public health authorities, the regional government, the Home Guard, the Danish Centre for Biosecurity and Biopreparedness (CBB) and a group of students from the city's Academy of Physical Education.

Needless to say, an exercise of this magnitude requires a lot of planning.

The exercise required a year of preparation

The storyline was prepared by CBB and adjusted at a series of planning meetings involving all the above-mentioned organisations. Meetings took place over a period of one full year, during which time the various agencies provided input as to the specific activities they would like to rehearse and refine.

Photo: Ernst Van Norde / Ritzau Scanpix

Less than a year after the training exercise in Viborg, response capabilities were once again put to the test, this time during a real-life incident involving ricin.

Training that was incorporated into the exercise scenario included:

- notifying relevant authorities
- threat analysis procedures
- coordinating the activities among the various organisations
- cordoning off the biological hazard area
- sampling procedures
- analysis and identification of biological agents
- cleansing contaminated persons
- appropriate treatment of victims
- hospital emergency room preparedness
- responding to the press

Role-players were told what to say and do

Everyone who was in any way involved in the training activity knew that the incident was only a drill. But no one except the planners and a group of role-players (including, among others, some students from the school) was aware of exactly what was going to happen.

Students who played the part of victims and/or evacuees were furnished with a restricted Twitter account shared only be other participants in the exercise. 'Victims' who were supposed to become ill were additionally furnished with written reminders of what to say and do.

Chance remarks provided important clues

The scenario that was played out in Viborg was somewhat tricky and was based on a *mid-spectrum agent*. This gave only a very short incubation time, making the situation seem more like a type 2 incident with the appearance of symptoms in sick people. This allowed participants to experience how suspicions of a deliberate biological attack can develop when people fall ill.

The exercise also demonstrated how a tip or a chance remark can lead to important discoveries. Important details were 'planted' among the various role-players, whose statements and actions were designed to arouse specific suspicions.

For example, attention was focused on the presumed delivery device when a role-playing school employee said in passing that some kind of new apparatus had recently been set up in the school auditorium. Another employee had been instructed to make a remark at some point about the silver-gray station wagon used to deliver the de-humidifier.

The 'dust' is shown to be ricin

For CBB, the exercise involved training such things as determining a hazard area, taking samples from the de-humidifier and other areas, and identifying the biological agent used in the 'attack'.

The 'dust' that was sprayed over the four workers at the school is thus revealed to be powdered ricin – a substance that is classified as a *mid-spectrum agent* because its effect on humans lies somewhere in between those of 'classic' biological and chemical agents.

Diseases caused by *mid-spectrum agents* generally have a shorter incubation time than 'ordinary' biological agents. For ricin, the incubation time is 4-8 hours.

The hospital cleansed four 'contaminated' patients

Because the time frame of the training activity was designed to be relatively short (6 hours), the exercise began with the appearance of symptoms. The preceding events were left for participants to work out for themselves, based on the events, statements and discoveries that took place during the exercise.

The first to become visibly ill in the scenario were the four school employees who set up the de-humidifier. Their role was to go the emergency room of the local hospital in Viborg with symptoms including eye irritation, breathing difficulties, vomiting and burning mouth and throat pain.

Their symptoms, combined with what they said and did at the hospital, were designed to arouse suspicion of a deliberately-caused illness, and to make hospital personnel aware that the four patients were probably contaminated and would have to be cleansed before being admitted to the hospital.

Back at the school, meanwhile, a cluster of student illnesses linked to a specific dormitory drew attention to the dormitory ventilation system, which connects to the auditorium and the de-humidifier.

Mistakes are the essence of learning

Organising a large-scale biopreparedness training exercise involves a complex balance of needs, interests, time and resources. But one of the most important things to remember during a training exercise is that mistakes are important and valuable.

No one should be afraid of making mistakes. Mistakes that are openly admitted and analysed can ultimately provide the best kind of learning.

Additional principles that can help ensure a successful outcome include:

- **Allow enough time and human resources for both the planning and the execution of the exercise.**
- **Set up specific criteria for success that can be used for evaluation purposes.**
- **Do not 'pretend' to do something that is part of the actual training exercise. Procedures that are not performed in real time will not be remembered in an emergency.**
- **Prepare a detailed script/timeline for the exercise, including specific events, expected responses and any practical details.**
- **Make arrangements for a competent overall evaluation of the exercise, in addition to sector evaluations.**

Monitors kept the exercise on track

A full-scale training exercise is a dress rehearsal for 'the real thing' and must therefore encompass unexpected events and difficulties. Some of these may be written into the storyline; others may develop during the exercise itself, depending on how the participants deal with the situation.

Unplanned activity can provide valuable, albeit unplanned, learnings. Allowing for unplanned activity and learnings can, however, be a rather delicate balancing act. If participants begin to pursue an area of inquiry that is wholly irrelevant, the entire exercise can get off track, and important learnings will be missed.

The exercise in Viborg was therefore monitored by leaders from each of the participating organisations. These monitors were authorised to stop the action, explain what was wrong, and bring the activity back on track.

This occurred once during the exercise in Viborg, when a parked car (totally unrelated to the exercise) was brought to the intention of the incident commanders. This could have derailed the exercise into a hunt for bombs instead of a biological weapon.

A storm of Twitter messages appeared

An interesting learning was provided by student 'evacuees', who at one point had been instructed by police to wait in a designated room until further notice (the intent had been to inform them of the need to seek medical attention if they developed symptoms of ricin poisoning).

After waiting for some time during which no information was forthcoming, a storm of Twitter messages from the students began to appear to the effect that they were being 'held' by police. The tone of the messages also suggested that the credibility of police had suffered because of the information void.

The incident served to demonstrate the need for authorities to 'be first' with relevant and credible information. If the Twitter messages had been sent via open accounts instead of in a closed group, they would have attracted a great deal of attention, not least from the press, and spread speculation instead of facts into the surrounding community.

Apart from the students' need for information, participants in the exercise also had to deal with role-players representing worried parents, mystified neighbours and an extremely curious press corps.

The exercise ended with an arrest

A criminal investigation was also built into the scenario: towards the end of the exercise, a call was made to police from the owner of a local holiday camp. The campsite owner had been instructed to say that she was concerned about one of her guests, whom she thought might be a burglar who was regularly victimising the town.

The person was described as a man who had been staying at the camp for a couple of weeks, coming and going at all hours of the night in a silver-gray station wagon.

Suspecting that the vehicle could be the same as the one used to deliver the de-humidifier, the campsite was investigated, and an arrest was made.

Evaluation: the primary goal was achieved

During the exercise, non-participating observers from each organisation followed the action and later helped evaluate the activity.

Each organisation was evaluated separately with the help of an observer from their own sector. This had the advantage of ensuring that internal procedures were correctly executed. At the same time, however, the evaluation system could not provide an overall assessment of how well the various agencies were able to cooperate with each other and understand the larger picture.

CBB's view is that the exercise as a whole was successful, insofar as the effort would in a real-life situation have limited the loss of life and prevented widespread fear in the surrounding community. This is one of the primary goals of any real-life biopreparedness mission and should therefore also be a primary criterion for judging its success.

The drill had an unexpected epilog

Eleven months later, biopreparedness response and cooperation skills were again put to the test in the town of Viborg – but this time it wasn't a drill but a real-life incident involving ricin[1].

Local and national news media followed the episode closely, describing a suicidal 21-year-old man who had been admitted to the casualty ward of the local hospital after swallowing what was termed a 'dangerous substance.' Due to the nature of the incident, health authorities notified the police, who in turn contacted CBB and emergency services.[2]

The area around the young man's residence was cordoned off, CBB field investigators in protective clothing took samples from his apartment, and a helicopter flew the samples back to Copenhagen for analysis. [3]

The 'substance' was made from castor beans

By the next day, police were able to inform the press that the 'dangerous substance' was homemade ricin, which the young man had illegally produced from ground-up castor beans. By then, police

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1 This incident was also referred to in Chapter 10, where the decontamination procedure was described.

2 TV2 (news agency report on the website of a Danish-language television station) Ung mand fængsles efter selvmordsforsøg med farligt giftstof. 5 Sept. 2018. Accessed at http://nyheder.tv2.dk/krimi/2018-09-05-ung-mand-faengsles-efter-selvmordsforsog-med-farligt-giftstof

3 Pedersen, T. 21-årig varetægtsfængslet. Viborg Stifts Folkeblad (Danish-language newspaper), 5 Sept. 2018. Accessed at https://viborg-folkeblad.dk/viborg/21-aarig-varetaegtsfaengslet-Forsoegte-at-lave-doedelig-gift/artikel/389869

had also arrested the young man, who had apparently not taken a lethal dose of the homemade toxin, and who therefore survived the incident. He was charged with illegal possession of a biological substance that could endanger the lives of others.[4]

A day later, guided by CBB, emergency services personnel wearing protective clothing decontaminated the apartment where the ricin had been prepared.[5]

Training is worth it

The occurrence of this real-life biological incident provides clear indication that targeted training of biological incident handling and exercise must be given high priority.

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4 Sand, P.K.: Ung mand forsøgte selvmord med farlig gift. TV Midt-Vest (website of a Danish television station). Accessed at https://www.tvmidtvest.dk/artikel/politiaktion-i-viborg-ung-mand-forsoegte-selvmord-med-farlig-gift

5 Bjærge, O. Ejendom på Kirkebækvej renses i bund. Viborg Stifts Folkeblad, 6 Sept. 2018. Accessed at https://viborg-folkeblad.dk/viborg/Ejendom-paa-Kirkebaekvej-renses-i-bund/artikel/390019

16

Dilemmas for discussion

In this, our final chapter, we present a few fictional scenarios that will provide an opportunity to discuss and reflect on some difficult but important biopreparedness questions.

The mitigation of a biological attack is not easily understood. Compared to the visible interventions that take place during other kinds of disaster (burning buildings, raging hurricanes or people who suddenly begin to choke and die) there are mostly invisible threats and questions that cannot immediately be answered. Not to mention a delay in information which contributes to decision-making dilemmas that demand attention.

Below we've prepared a few biopreparedness dilemmas and related questions that have no 'right' answers. Our hope is that you can now use your knowledge of biopreparedness to answer them anyway, as best you can.

Dilemma 1: A question of priorities

Twelve hours into an incident where a major city has been exposed to an aerosol of *B.anthracis* evacuations have begun; the next step for authorities is to initiate medical countermeasures (mass distribution of antibiotics) as quickly as possible.

Preparedness plans call for mobilising stockpiles of relevant medication, but it soon becomes apparent that these reserves will not be enough to cover the needs. Antibiotics for veterinary use can, however, be mobilised within a day, and this will probably be enough to close the gap.

When this plan becomes public, however, voices are immediately raised about discrimination and 'animal-class citizens'.

- A mutual assistance agreement with a neighboring country ensures that additional antibiotics intended for human consumption can be procured. These supplies can also cover the remaining need in the city – but it will take four days to procure and deliver the medicine.
- Who should receive the medication for human consumption that is immediately available? Why?

- How should authorities respond to the negative reactions mentioned above?
- Should authorities refrain from using veterinary antibiotics and wait until the human medication becomes available? Why?
- In view of the average incubation period for anthrax infections (2-5 days), would it be reasonable to let people decide for themselves if they want to wait four days for human medication instead of accepting veterinary antibiotics? Why?
- If medication shortages should occur despite all the efforts described above, which groups of persons should be offered medication?

Dilemma 2: A dangerous tragedy

After a biological attack on a major city using a virus, a country-wide mass vaccination campaign has been swiftly and effectively initiated. No disease outbreak has yet occurred, but in the midst of the mass immunisation programme, an adverse event with the vaccine causes the death of a 14-year-old boy.

The vaccination campaign is still in full swing, but an antivaccination movement, led by the charismatic mother of the dead boy is now gathering momentum on Facebook.

The principle of herd immunity will protect the population up to a certain point, even if some people refuse to be vaccinated. The 'No More Needles' crusade is gaining ground, however, and will soon begin to threaten the success of the immunisation programme.

- How should government and/or health authorities respond to questions about the boy's death?
- What can be done to bring the vaccination campaign back on track?
- Do you believe that forced vaccination is an option? Why?
- Under the above circumstances, how should authorities comment on an actual smallpox outbreak, if it occurs?

Dilemma 3: A preparedness nightmare

A telephoned threat of a biological attack leads to the discovery of an apparent delivery device hidden in a street sweeper. On the day and time at which this occurs, the vehicle has been rolling up and down the streets of a major city for a couple of hours, but it has been abandoned by the time it is found and investigated.

The threat analysis conducted by the country's expert authority concludes that the threat is credible, due in part to recent bioterrorist activity in a neighbouring country.

The threat affects a large residential area, as well as the entire business district of the city. Field investigators are sent to the site, a country-wide manhunt is set in motion to find the operator of the street sweeper, and evacuation of the presumed hazard area is initiated.

Four hours later, people are streaming out of homes, workplaces and shopping centres when preliminary analysis results are received from the laboratory. All the samples taken by FIT have turned up negative for any kind of biological warfare agent.

- Do you think the evacuation should have been postponed until after the laboratory results were received? Why?
- How should authorities respond to the critical questions that will now be asked about the incident?
- How should biopreparedness units react if another threat is received or discovered in the immediate future?
- How do you think biopreparedness and other organisations might rebuild credibility after this incident?

Glossary of terms, abbreviations and acronyms

Note: The definitions provided here are intended for use in a biopreparedness context

Action card

Concise reminders of how to perform specific procedures. Usually printed on a laminated card that is placed conveniently for easy access.

Aerosol

An airborne cloud consisting of very small particles. Biological warfare agents can be effectively dispersed as an aerosol.

Amerithrax

An expression sometimes used to describe the anthrax letter attacks in the US in 2001.

Area of exposure

A geographical area over which the release of an aerosol biological agent has created a concentration of agent in the air that exceeds a predefined threshold. The threshold may be set by the government, a biopreparedness organisation or other relevant authority.

Attack indicators

Unusual circumstances (usually epidemiological or clinical e.g. an outbreak of disease that is unusual for a given area) that could be signs of a biological attack.

Bacteriophages

A group of viruses that attack and destroy bacteria. Also referred to as phages.

Biological attack

The use of a dangerous biological substance to cause deliberate harm to others.

Biological incident

A real or suspected attack, accident or hoax involving a dangerous biological substance or the suspicion of such substance.

Biological substance

A biological organism (bacteria, virus or fungus) or a biological toxin.

Biological warfare agent

A hazardous biological substance (virus, bacteria or fungus) or hazardous biological toxin that has been technically and/or scientifically manipulated or formulated to maximise its potential to cause deliberate harm.

Biomarkers

DNA sequences, growth properties or other biological characteristics that are specific for a particular biological agent.

Biomedical intelligence

Intelligence resulting from an analysis of relevant medical, bioscientific and environmental information from domestic and international sources.

Biopreparedness

Methods, procedures, equipment, and the operative ability to use them, in response to incidents involving biological substances that can endanger humans, animals or materiel.

Biosafety level

Refers to four internationally recognised levels of biological laboratory safety. The highest of these is Biosafety Level 4 (BSL4).

Bioterrorism

The use of dangerous biological substances to commit terrorist acts.

Case definition

A set of criteria that is used to determine whether a given case of illness is part of a specific disease outbreak.

Chain of custody

A complete, chronological list of persons who have in any way handled a piece of evidence connected to the investigation of a crime.

Contact tracing

The activity of identifying persons who have been in contact with a patient that has been diagnosed with an infectious disease. The purpose of the activity is to ensure that all contacts are aware of their exposure, and that necessary measures such as vaccination, treatment or quarantine are implemented.

Covert attack

A biological attack which is not immediately apparent, maybe unrecognised, and for which no one has claimed responsibility.

Contagiousness

The degree to which a disease caused by a biological agent can be transmitted to others.

Contaminated persons

In the context of a biological incident, persons are regarded as contaminated if they have been so close to a source of biological contamination that they have actually seen it and/or have visible residue on their clothing.

Controlled biological

Biological substances that are legally restricted in various ways (use, sale, substances transport, etc.) because of their potential to cause deliberate or accidental harm.

Control list

A list of controlled biological substances. The list is usually incorporated into national or international laws and agreements that restrict the use of the substances on the list.

Cross contamination

The transfer of dangerous biological contamination from one person or object to another via physical contact.

Decontamination

In a biological context: the process of removing or killing pathogenic organisms from any and all surfaces and substances in a contaminated environment. Also referred to as decon.

Delivery device

A device that can effectively disperse a dangerous biological agent with the intent to cause harm.

Deniability

The extent to which the perpetrator of a biological attack can deny any responsibility for the event, either by camouflaging it as a natural outbreak of disease or by making it appear to be the work of someone else.

Dispersion map

A map which, in the context of this book, is created with the help of dispersion modelling. It shows the geographical area over which an aerosol, biologically hazardous agent is likely to have caused hazardous surface contamination at a given point in time, and enables emergency personnel to plan the actual, physical setup of cordons and work areas needed for an effective response.

Dispersion modelling

Computer-assisted calculations designed to map and track the

spread of a dangerous biological agent that has been released into the environment. Also referred to as dispersion analysis.

DNA sequencer

A scientific instrument which automates the DNA sequencing process.

DNA sequencing

A computer-assisted process used to identify the sequence of nucleic acids in a strand of DNA. This process is used to describe some or all of the genetic information in the DNA of a given biological substance.

Dual-use material

A biological substance, a delivery system, related material or information that can be used for both legitimate and illegal purposes.

Exposed persons

In the context of a biological incident, persons who have been in a biologically hazardous area or area of exposure but have *not* been close enough to the source of contamination to see it, and do *not* have visible residue on their clothing.

Flexible response

A scaled-down response to an incident that does not involve an immediate biological threat but has the potential to cause disruption. The purpose is to provide confidence and prevent fear by on-site counselling of citizens and personnel. A threat analysis is always required to determine whether a flexible response is appropriate.

Full response

A complete field investigation and mitigation efforts with respect to a biological incident. For a biopreparedness organisation, this will involve threat analysis, environmental sampling and analysis as well as computer-assisted modelling to determine the hazardous area. The incident will also involve police and other external entities.

Hazard area

A geographical area in which a dangerous aerosol of biological agent has settled onto the ground and other surfaces and caused a contamination that exceeds a pre-defined threshold. Re-aerosolisation of the agent will create a risk of exposure and infection.

Herd immunity

A general immunity to epidemic infection that can be achieved even if 100% of the population has not been vaccinated. If a large enough percentage of the population is immunised, unvaccinated individuals will achieve 'free' protection, because they will be surrounded by persons who cannot be infected.

Inactivation

The process of killing live biological agents prior to laboratory analysis.

Incubation period

The period of time between a person's exposure to a hazardous biological substance and the time at which symptoms of illness begin to appear. Depending on the disease, the incubation period can be anywhere from hours to weeks.

Intervention modelling

Computer-assisted mathematical modelling to gauge the effect of possible interventions in a given situation involving a specific biological agent. Typical interventions include medical countermeasures, evacuation, quarantine, and isolation of patients.

Isolation

A measure used to contain or prevent the epidemic spread of disease. Persons who have developed a dangerous, communicable disease are isolated in a hospital unit designed to protect others from becoming infected.

Lethality

The degree to which a biological agent can kill rather than incapacitate its victims.

Medical countermeasures

Life-saving medicine and medical products that are used to diagnose, treat or protect against illness caused by the release of a hazardous biological agent.

Microbial forensics

A form of criminal investigation in which highly specialised microbiological laboratory findings at the molecular level are used to generate useful clues in a police inquiry. This type of collaboration can, for example, help link a biological attack to a specific perpetrator.

Microphages

A group of viruses that attack and destroy bacteria.

Mid-spectrum agent

A biologically derived compound such as the toxin extracted from castor beans (ricin), whose effects on humans lie somewhere in the middle of a spectrum with 'classic' biological agents in one end and chemical agents in the other. Mid-spectrum agents generally have a shorter incubation time than other biological agents making them resemble chemical agents in this respect.

National Operational Staff (NOST)

A high-level Danish authority which can be activated during large-scale emergencies, and whose members represent 12 local operational staffs (police, fire and rescue centres, municipalities, etc.). NOST is tasked with maintaining a cross-sector overview of all emergency operations, and can support crisis activities across all the agencies and units that are dealing with the situation on the ground.

Next Generation Sequencing

A fast, accurate technology used to perform high-thoroughput DNA sequencing. Can be used to detect natural or deliberate alterations to a nucleic acid sequence.

Outbreak investigation

In the context of biopreparedness an investigation to help determine whether a given disease outbreak is due to natural causes or has been caused by a deliberate biological attack and to locate the release site of a covert biological attack. The investigation focuses on commonalities among patients such as physical location, residences, activities, workplaces, etc.

Overt attack

The release of a biological agent in a manner that makes it apparent that an attack has taken place or that is preceded or followed by a public announcement in which responsibility is taken for the act.

Persistence

The degree to which a biological agent can continue to cause disease despite adverse environmental conditions.

Personal Protective Equipment

The breathing gear and protective suit, gloves and boots worn by persons working in a contaminated area. Also referred to as PPE.

Points of distribution

Strategically placed locations to which medicines, vaccines and other emergency medical supplies may be delivered during a biological emergency that involves mass vaccination or medication.

Preventability

The degree to which vaccination can prevent a given biological agent from causing disease.

Prioritised list of agents

A list of hazardous biological substances that are believed to be at particularly high risk of deliberate misuse.

Quarantine

A restriction of movement required of persons who may have been exposed to a communicable disease, but who have not yet shown any symptoms. These persons are kept away from the rest of the population for an observation period, either at home or in special facilities.

Re-aerosolisation

The process by which a biological agent that has been deposited onto a given surface is whirled back into the air, thus creating renewed risk of inhalation and infection. Also referred to as secondary aerosolisation.

Release site

The site at which a biological warfare agent was released into the environment.

Ring vaccination

A type of vaccination programme which involves tracking down and vaccinating everyone who may have had direct contact with a patient suffering from a serious, contagious disease. Contacts to the primary contacts are also immunised.

Risk analysis

In the context of this book, a systematic report and analysis of all information about a biological incident that does not involve a terrorist threat. See also *threat analysis*.

Sampling strategy

A strategy indicating when and where to take clinical or environmental samples at the site of a biological incident.

Secondary contamination

See *cross contamination*.

Stable isotope analysis

A type of laboratory analysis that can identify microscopic traces of chemicals that were present in the solid or liquid growth media used during the production of a given bioweapon.

Standard operating

Instructions for performing a specific, standardised task. Its purpose is to procedures ensure that a given procedure is always performed in a uniform manner and at a consistent level of quality.

Threat analysis

A systematic analysis of all available information about a suspected biological attack. Its purpose is to quickly gain an overview of the situation, discover whether it does in fact involve a biological threat, and determine what action, if any, is needed.

Treatability

The extent to which medical treatment will have a positive effect on a given disease.

Type 1 incident

A deliberate biological attack in which the release site has been identified. This will, in general, be due to the discovery of a delivery device.

Type 2 incident

A deliberate and covert biological attack in which the release site has not been identified and no delivery device has been found. Such attacks may go unrecognised for a long time. They are characterised by the outbreak of a disease caused by an agent that is associated with bioterrorism.

Type 3 incident

The accidental and unintentional release of a legally possessed hazardous biological substance into the environment.

Weaponisation

The process of altering or formulating a biological agent to make it easier to disperse or more effective at causing disease.

Acronyms and abbreviations

BSL4
Biosafety Level 4

BWC
Biological Weapons Convention

CBB
Centre for Biosecurity and Biopreparedness (the Danish biopreparedness organisation)

CBRN
Chemical, Biological, Radiological and Nuclear. Commonly used in discussions of events involving these types of substances.

CDC
US Centers for Disease Control and Prevention

COMA
Coordination of Operative, Medical and Analytical (counselling)

ELISA
Enzyme-Linked Immunosorbent Assay

FIT
Field Investigation Team

GOARN
Global Outbreak Alert and Response Network

ICP
Incident Command Post

NOST
National Operational Staff

PCR
Polymerase chain reaction

POD
Points of Distribution

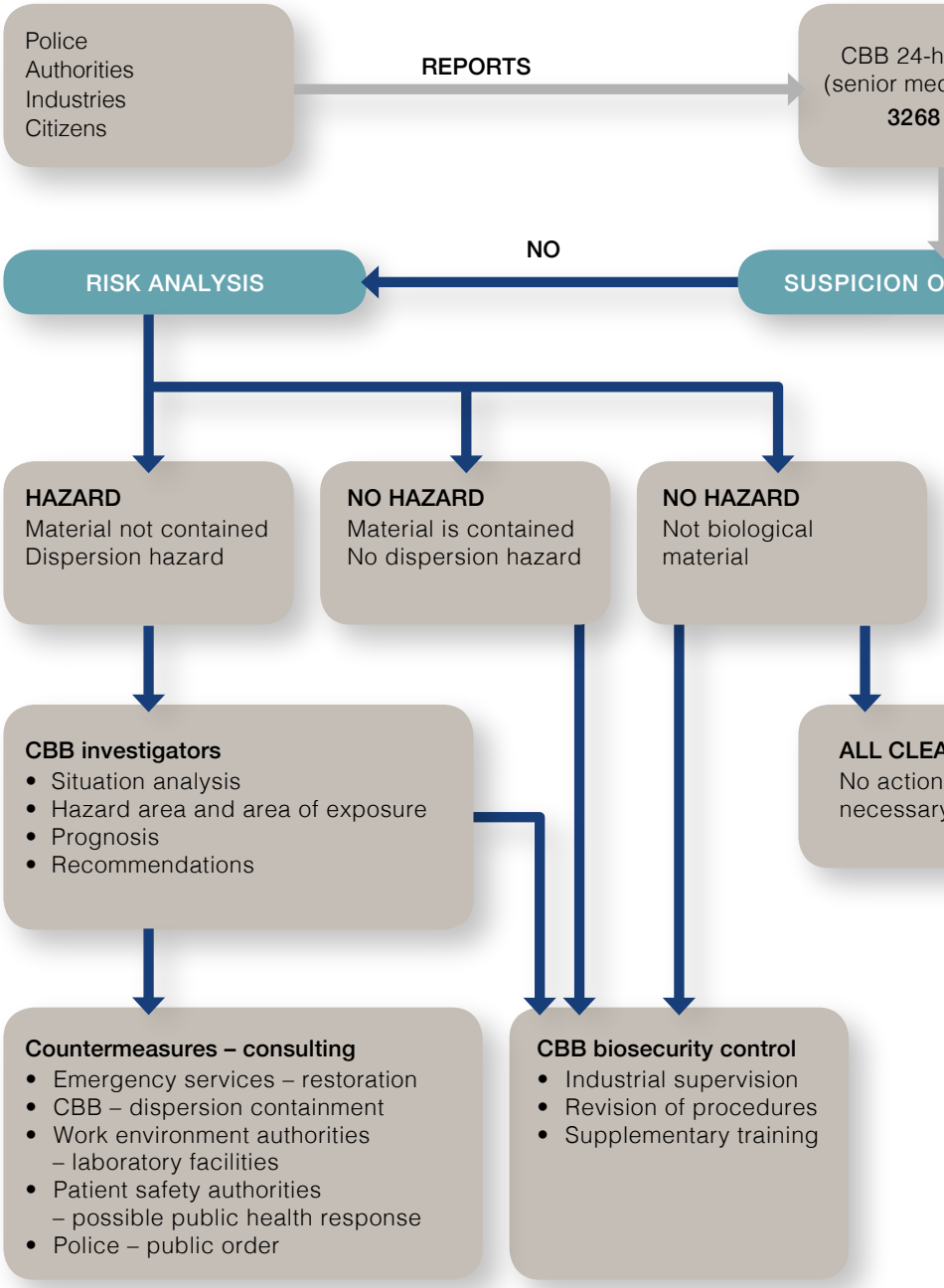
PPE
Personal Protective Equipment

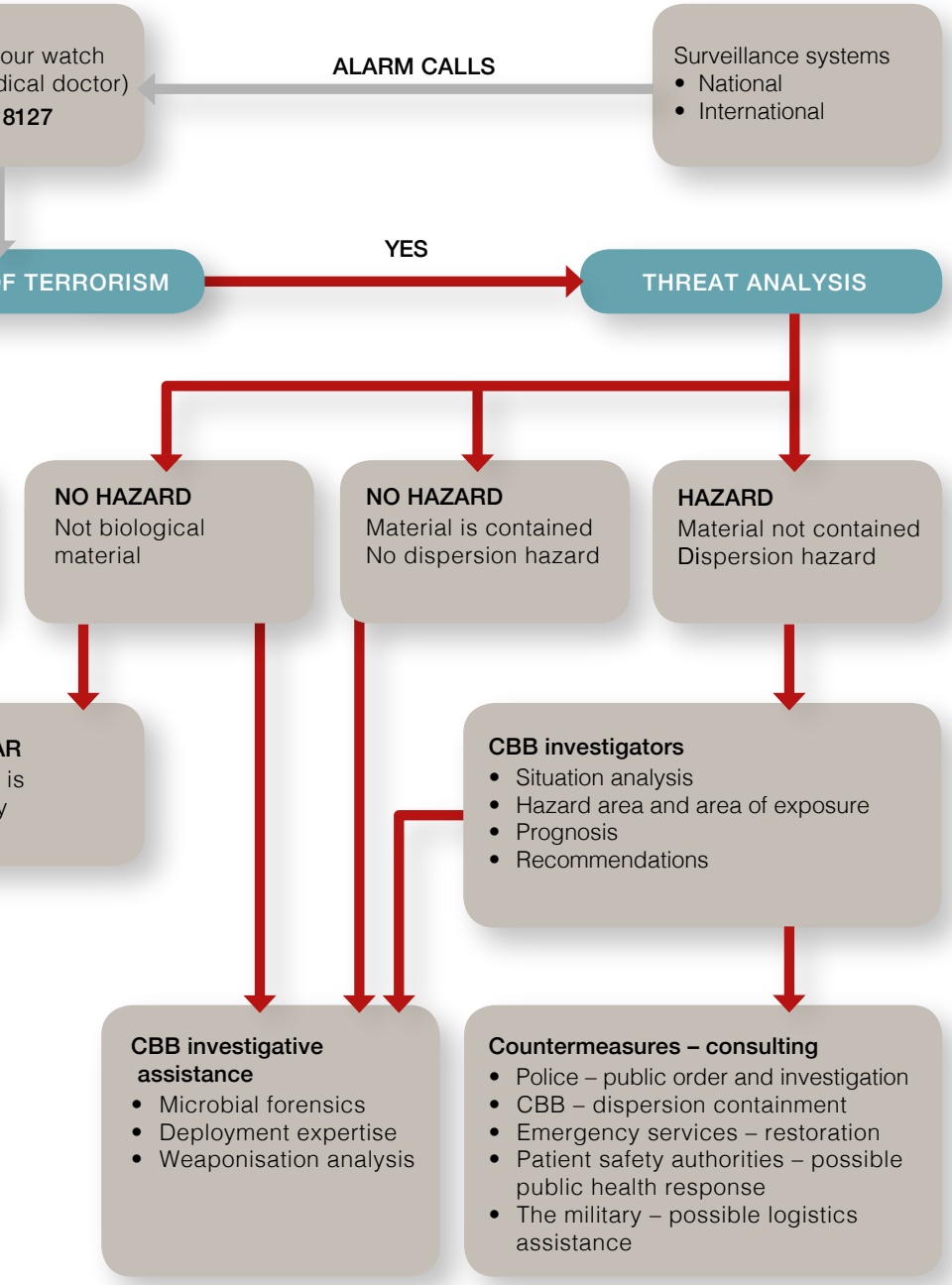
SARS
Severe Acute Respiratory Syndrome

SDS-PAGE
Sodium Dodecyl Sulfate-Polyacrylamide Gel Electrophoresis

SOP
Standard operating procedure

Suspicion of uncontrolled hazardous biological material

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dical doctor)
8127
ALARM CALLS
Surveillance systems
• National
• International
F TERRORISM
YES
THREAT ANALYSIS
NO HAZARD
Not biological material
NO HAZARD
Material is contained
No dispersion hazard
HAZARD
Material not contained
Dispersion hazard
AR
is
y
CBB investigators
• Situation analysis
• Hazard area and area of exposure
• Prognosis
• Recommendations
CBB investigative assistance
• Microbial forensics
• Deployment expertise
• Weaponisation analysis
Countermeasures – consulting
• Police – public order and investigation
• CBB – dispersion containment
• Emergency services – restoration
• Patient safety authorities – possible public health response
• The military – possible logistics assistance

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