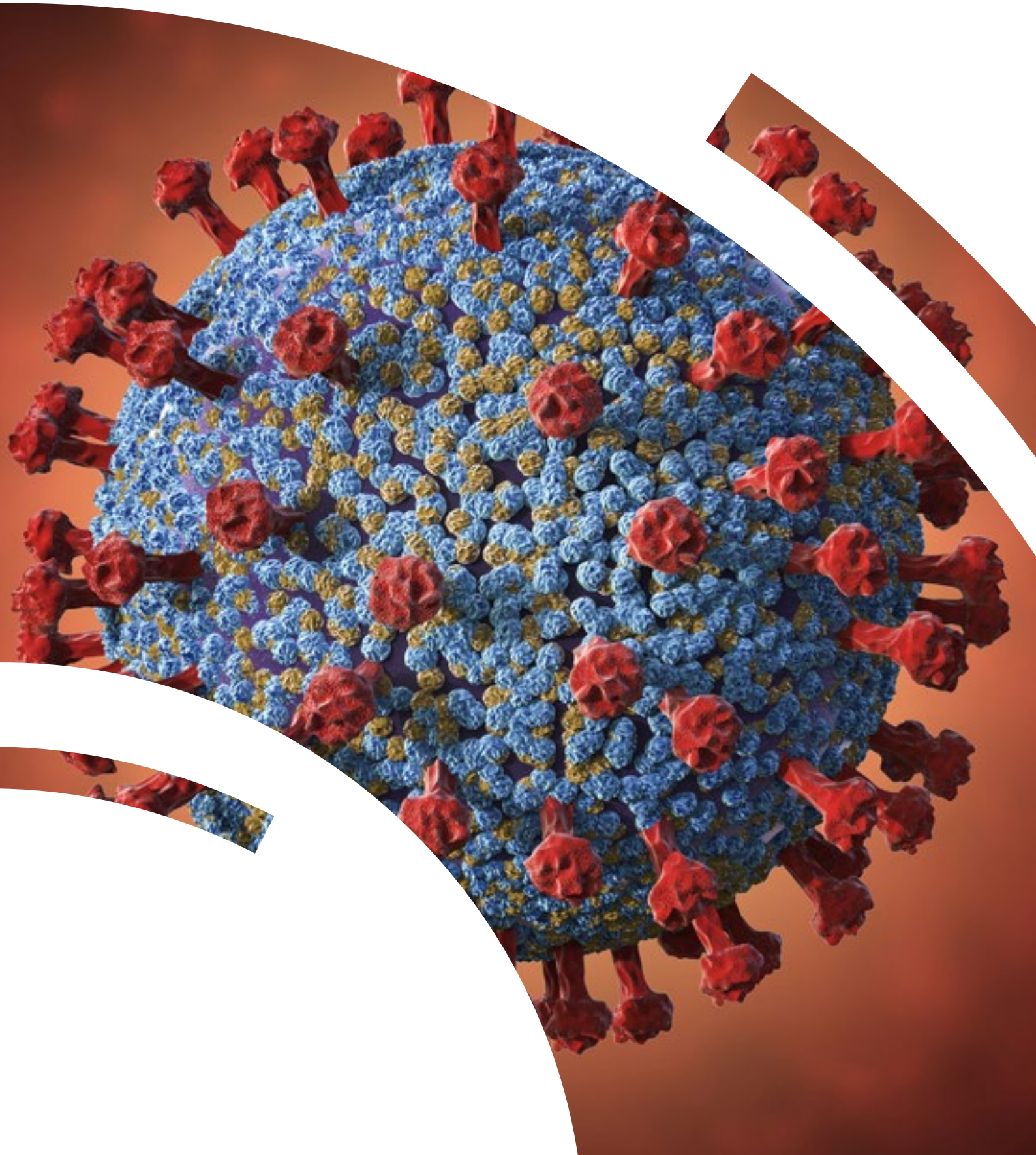
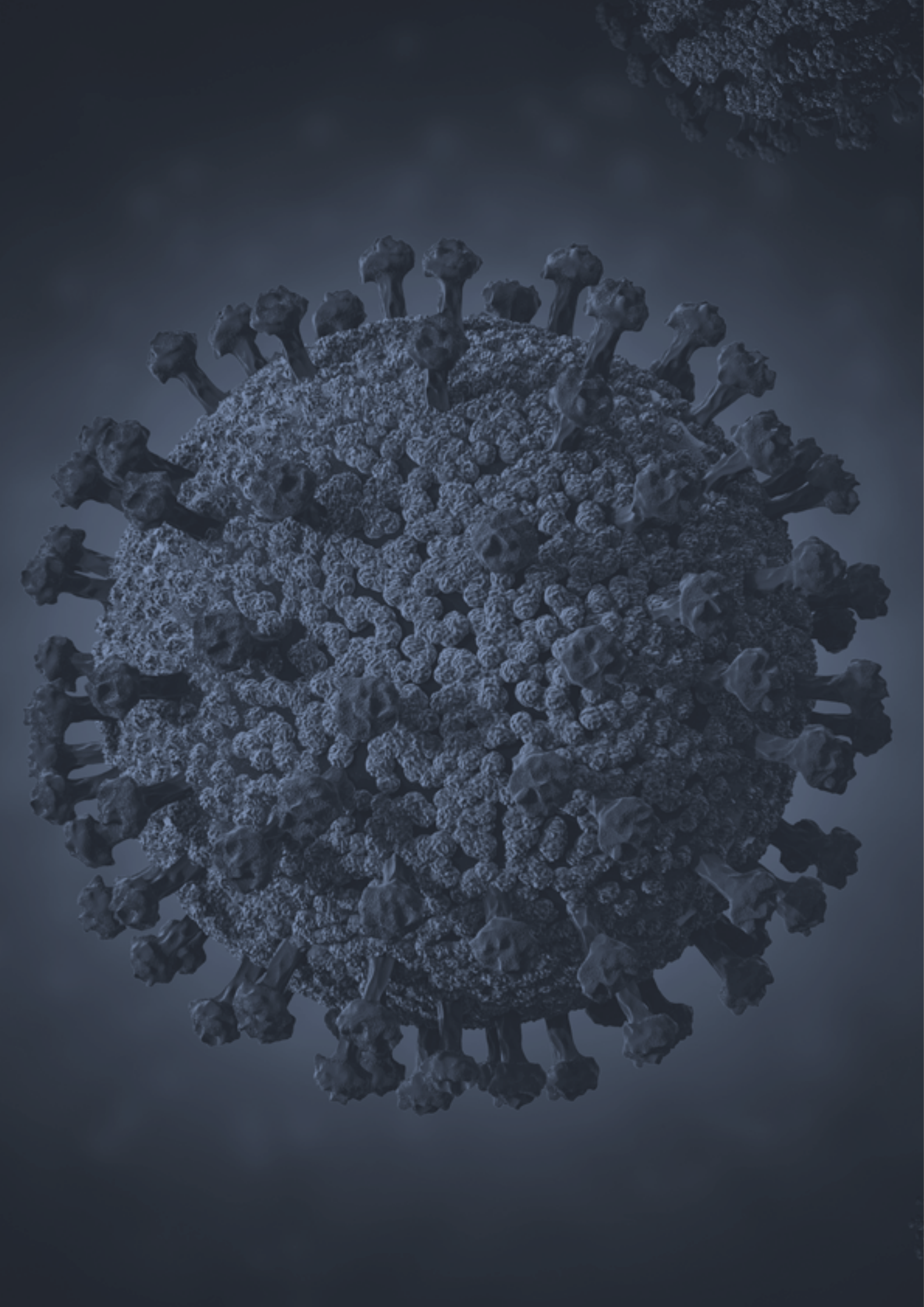
Bioterrorism: Applying the Lens of COVID-19

Report 2021

CTPN
COUNTER TERRORISM PREPAREDNESS NETWORK





Bioterrorism: Applying the Lens of COVID-19 Report 2021 is published by the Counter Terrorism Preparedness Network (CTPN).

CTPN is an international collaboration governed by the CTPN International Board, facilitated by London Resilience Group and hosted by the London Fire Commissioner.

Lead Author
Alex Townsend-Drake
Head of Programme
Counter Terrorism Preparedness Network

Co-Authors
Dr Donell Harvin
Chief, Homeland Security and Intelligence
Executive Director, National Capital Region Threat Intelligence Consortium
Homeland Security and Emergency Management Agency, Washington DC

Dr Chloe Sellwood
Deputy Head of Emergency Preparedness, Resilience and Response (London)
UK National Lead for Pandemic Influenza, National Health Service, England

Independent Reviewers
Daniel Cartwright
Deputy Assistant Commissioner, London Fire Brigade
UK Fire and Rescue Service National Resilience Deputy Lead for CBRN(e)

Graham Finnigan
Capabilities Advisor and NILO Coordinator
UK National Ambulance Resilience Unit (NARU)

Rachel Flowers
Director of Public Health
London Borough of Croydon

Dr Michèle Gemünden
Senior Researcher, Swiss and Euro-Atlantic Security Team Center for Security Studies (CSS), ETH Zurich

Dan Kaszeta
Associate Fellow
Royal United Services Institute

Lee Kendrick
Head, National CBRN(e) Centre
UK National Counter Terrorism Policing HQ

Jeffrey Muller
CBRN(e) Expert Consultant
United Nations Office of Counter Terrorism

Professor Nick Tyler CBE
Chadwick Professor of Civil Engineering
Director, Centre for Transport Studies
University College London

Wiktor Wojtas
Policy Analyst, Counter Terrorism Unit
European Commission

Counter Terrorism Preparedness Network

Member Cities


Barcelona


Boston


Dublin


Greater Manchester


Munich


New York


Rotterdam


Stockholm

Who we are

The Counter Terrorism Preparedness Network (CTPN) is an international collaboration that brings together strategic leaders, practitioners and academics to inform city-level policies and practices that build resilience to help keep our cities and communities safe from terrorism.

CTPN aims to influence and develop the multi-agency arrangements of cities in preparing for, responding to and recovering from terrorism.

What we do

CTPN aligns with strategies and priorities at local, national and international levels to deliver:

Research
We bring together academic literature and official reports with the knowledge and experience of CTPN members. We combine these with analyses from subject-matter experts and incorporate case studies to propose recommendations for city authorities.

Events
We convene and facilitate international conferences, bespoke seminars and scenario-based exercises that enable the exchange of learning and practices, develop connections, and inform approaches to counter terrorism preparedness, resilience and consequence management.

Projects
We deliver projects according to the CTPN work programme, report recommendations and emerging needs (including those generated by wider strategic partnerships and commissions) as governed by the CTPN international board.

London

Montreal

Washington DC

Zurich

Why we do it

Terrorism is a global, networked and persistent threat that requires a global, networked and persistent response. CTPN fills a need for a multi-national, multi-agency and multi-disciplinary network at the city level.

Cities are the backbone of urban security. The response to terrorist attacks, as with most emergencies, happens first and foremost at the local or city level.

Cities are essential building blocks for achieving the delivery of grand strategy. Cities that develop arrangements and policy in an integrated manner can use this as a lever in developing resilience.

Security and development are mutually dependent; one demands the other. This requires an integrated and holistic approach at all levels.

1 Executive Summary

> **“The weaknesses and lack of preparedness exposed by this pandemic provide a window onto how a bioterrorist attack might unfold and may increase its risks. Non-state groups could gain access to virulent strains that could pose similar devastation to societies around the globe.”**
>
> Antonio Guterres, United Nations Secretary General[1]

Terrorism remains at the top of the political agenda locally, nationally and internationally. This is accompanied by the ever-present threat posed by the intentional or unintentional release of bioagents or outbreaks of naturally occurring diseases. The World Health Organisation (WHO) tracks approximately 7,000 signals of potential outbreaks every month,[2] and pandemic influenza has been rated as a high risk for years. Yet many nations have struggled to respond effectively to the coronavirus disease (COVID-19) pandemic.[3]

The WHO declared COVID-19 a Public Health Emergency of International Concern (PHEIC) on 30 January and a pandemic on 12 March 2020. COVID-19 is of global and historic significance and continues to exert a significant impact on geopolitical and socio-economic realities as well as government decision-making. It has arguably become the biggest crisis the planet has faced since the Second World War and it will probably have impacts on international security in ways that are difficult to anticipate and are not yet fully understood.

A recent report highlighted that COVID-19 offered an opportunity to test and assess the strength of national security and governance but exposed profound shortcomings that reflected significant gaps in preparedness.[4]

This is underscored by the Global Health Security Index, which found health security to be fundamentally weak around the world, with over 80% of countries scoring in the bottom tier for indicators related to malicious biothreats.[5]

COVID-19 has unveiled vulnerabilities on a global scale, and it is generally accepted as a generation-defining moment with an impact even more varied and profound than 9/11. The widespread loss of life has been joined by a major economic downturn and drastic changes in societal norms. International relations are changing, as is the balance between citizens and their governments.[6] This is against the backdrop of global population growth, urbanisation and globalisation. There are also the risks associated with biological and technological advances; shifting health challenges including growing antimicrobial resistance;[7] political uncertainty; the spread of misinformation; and climate change.

All these factors accelerate the threat profile and complexities in the context of public health crises and terrorism. Due to the higher likelihood of conventional terrorism, preparedness for unconventional terrorism (e.g. bioterrorism) has often received relatively little attention.

However, COVID-19 could heighten the potential of bioweapons as a terrorist methodology because of the preparedness gaps that have been exposed.

This is a view endorsed by both the United Nations Secretary General and the Council of Europe.[8]

It is important to emphasise early on that the threat of bioterrorism is generally considered to be relatively low. Terrorism is, of course, just one of many threats to contend with and bioterrorism just one component. It must be kept in perspective and be considered proportionately. Bioterrorism has, however, been highlighted as a concern,[9] driven by an array of strategic consequences accelerated by COVID-19 and advances in technology and the biosciences. The means, motives and opportunities are apparent; ensuring an appropriate level of preparedness is clearly justified.

The point here is that COVID-19 must be recognised as a lesson in the potentially potent impact of weaponised bioagents. Although not intending to overstate or mislead in terms of the threat, this report outlines the need and opportunity for a comprehensive, robust and integrated approach towards preparedness for public health crises and bioterrorism, which show similarities and overlaps in their consequences.

Therefore, the main objectives of this report are to:

1. Argue that the threat of bioterrorism is accelerating against the backdrop of COVID-19 and advances in technology and biosciences;
2. Contrast the vulnerabilities and consequences exposed by COVID-19 with those of bioterrorism to highlight the similarities and differences;
3. Propose that preparedness for bioterrorism will inevitably raise capabilities to cope with public health crises and vice versa, if an integrated approach is applied;
4. Present recommendations for city authorities to enhance preparedness and capabilities for bioterrorism and therefore public health crises.

To facilitate this, the report will explore the differences between naturally occurring diseases and the intentional release of weaponised bioagents; review the threat of bioterrorism; and analyse the vulnerabilities demonstrated by COVID-19 to consider these in the context of a bio-attack (on the basis that bioterrorism could cause a public health crisis far more impactful than COVID-19). It subsequently underlines the importance of political and strategic leadership; multi-agency preparedness and public health; as well as informing and influencing community behaviours. Recommendations are listed on pages 62-63.

Context and Terminology

This is an international report designed for an international audience and it is, therefore, relatively high-level in order to enable transferability. By bringing together academic literature, official reports and open-source information with analyses from professionals and subject-matter experts this report will argue that preparedness for bioterrorism and public health crises should be viewed as mutually dependent and must be intensified.

The report recognises city-level preparedness to be a critical building block for national preparedness and collective resilience. It recognises that city administrations wield significant influence in this regard and are increasingly recipients of devolved powers. It notes a duty upon city authorities to prepare for crises, protect their citizens and safeguard their economies. Indeed, the new counter terrorism agenda of the European Commission highlighted the importance of strategic dialogue between cities, describing them as the backbone of urban security.[10] As such, the report incorporates some case studies from CTPN members with a view to sharing experiences, practices and initiatives. Reflections are relevant for both national and local stakeholders, but city-level authorities are the target audience.

The report further stresses the importance of holistic investments that can contribute to preparedness and public health as well as city operations. Financial instability after COVID-19 means that incorporating new security and preparedness measures will be a luxury. Rather, approaches towards security and preparedness need to be combined with wider benefits, such as infrastructural development and public health. Measures that can be absorbed or incorporated into wider societal projects (e.g. regeneration projects) and vice versa may maximise cost efficiencies and increase their appeal.

To demonstrate this, the report contrasts naturally occurring disease outbreaks and biological (bio) agents released in a terrorist attack. It therefore combines naturally occurring diseases and weaponised bioagents into the term “biothreats”. Unless referring to a specific disease (e.g. COVID-19) or weaponised bioagent (e.g. Anthrax), the terms “naturally occurring diseases” and “bioagents” are used to make a distinction. The term “bioagents” refers to those agents that already exist and are unmodified, but that could be intentionally disseminated as a bioweapon. The report later refers to “engineered biology”, which is the modification of such agents. Where the term “biothreats” is used in isolation, it is intended as a neutral expression where natural or malicious threats may apply. The word “pathogen” is also used as appropriate. This is simply an organism that causes disease.

The report recognises that some biothreats can spread between people (e.g. Ebola) and others may not (e.g. Anthrax). As the lens of COVID-19 is being applied, the report is primarily considering biothreats that do spread, while acknowledging those that may not. This, of course, has implications for planning that would need to be analysed locally.

In terms of emergency preparedness and response, weaponised bioagents often fall within chemical, biological, radiological, nuclear (explosive) planning. On occasion the abbreviation CBRN(e) is used to refer to this group within the report.

2

Naturally Occurring Diseases vs Weaponised Bioagents

“Catastrophic biological threats highlight the inextricable link between security and public health concerns. These threats, whether naturally occurring, intentional, or accidental, have the potential to cause loss-of-life and sustained damage to the economy, societal stability, and global security.”

United States Government Accountability Office Report[11]

Diseases and Pandemics

Daily life involves almost constant contact with biothreats including bacteria, viruses, plant and animal irritants, pollutants, toxins and others. Although most exposures result in no significant adverse effects, those that do can trigger outbreaks. These are often defined by their geographical range, which can include a community, a country or even the entire globe (called a pandemic).[12] They are caused by high-consequence infectious diseases (HCIDs), acute illnesses that spread rapidly from person to person at a rate above that usually seen in the population, and often rising faster than the disease can be controlled. These collectively result in the greatest proportion of human morbidity and mortality.[13]

A pandemic can occur at any time and originate from anywhere in the world. It may manifest over one or more waves in a human population that has little or no immunity and therefore global spread is highly likely. All ages may be affected. Illness is likely to present variously, ranging from asymptomatic cases to patients with mild symptoms to those resulting in hospitalisation, intensive care or death. It is possible that people without symptoms – or those with minimal symptoms – could spread the pathogen. The exact pattern only becomes apparent as the pandemic progresses and may not be fully understood until some years after it ends.[14] This may depend on the disease and whether its characteristics are already known or not, which makes a significant difference to understanding its pattern and implications.

In some cases (e.g. COVID-19), the effects may not be immediately apparent because someone who has been contaminated by a virus or bioagent may not present visible symptoms for some time after exposure[15] (a period referred to as incubation) and therefore may unknowingly infect others.[16] This creates a somewhat fluid chain reaction that is significantly influenced by rising population densities, the ease of global travel and social interconnectivity, as well as limits on public health and medical systems.

> **When complex interlinked systems are pushed too far from their natural equilibrium by external factors, such as diseases, then a system failure can cause a cascade of impacts and become highly unpredictable.**

This is because when the unexpected happens a relatively small change to the system can cause runaway effects that become uncontrollable, leading to unpredictable outcomes with global impacts.[17] The uncertainty about the scale, severity and pattern of development of any pandemic makes them complex and dynamic, requiring a highly specialist and centrally coordinated response. The invisible nature of a biothreat also adds extra layers of complexity and is psychologically demanding for responders and society itself.

The COVID-19 pandemic, caused by the SARS-CoV-2 virus, has demonstrated how the transmission

of a naturally occurring disease can have unprecedented global impacts. The outbreak of this airborne virus, which began in Wuhan, China, in December 2019, continues to present significant challenges for the entire world. Globally, on the morning of 16 March 2021, the WHO COVID-19 dashboard reported 119,791,453 cases of COVID-19, including 2,652,966 deaths. Some of the most complex political, social and economic issues experienced in generations have been generated or exacerbated, fundamentally shifting how society operates. It has disrupted health and socialcare services and led to the implementation of widespread pharmaceutical and societal interventions in a bid to contain and delay its spread. This included harnessing existing and available medical treatment options and facilities; implementing mechanisms to control further spread of the disease (including quarantine and social distancing); public education; and disease prevention.

It also precipitated the urgent issues of testing, contact tracing, vaccination and treatment programmes. Furthermore, steep rises in unemployment, social deprivation and food poverty have been evident, giving way to a plethora of ripple effects, such as impacts upon mental health, critical/palliative care and the widening of societal and health inequalities.

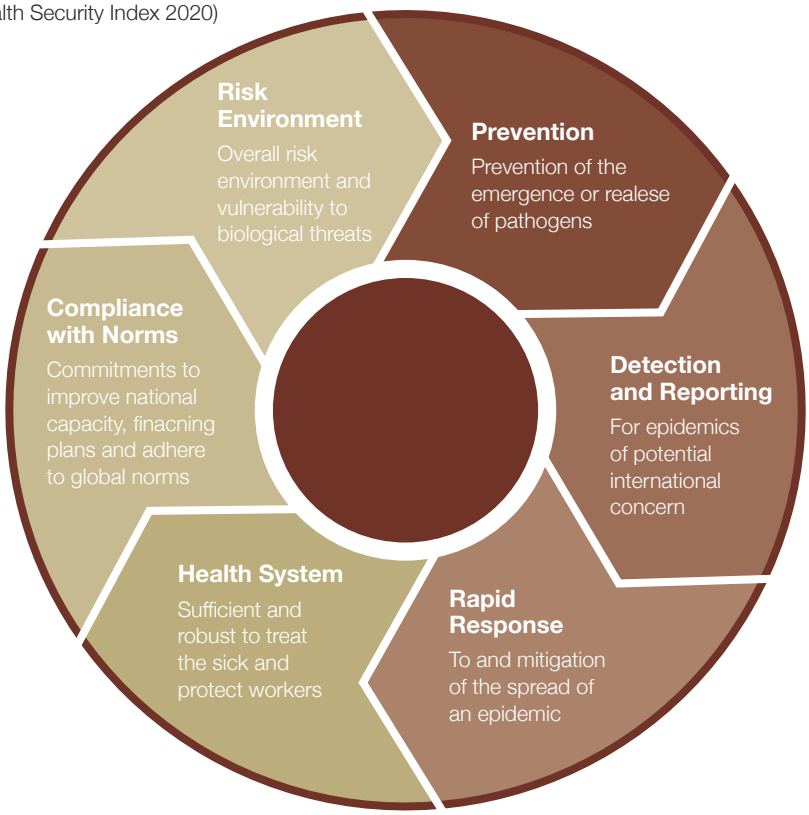
Other notable examples that have caused (and continue to cause) concern include pandemic influenza, SARS (Severe Acute Respiratory Syndrome), MERS (Middle East Respiratory Syndrome), Ebola and AIDS. The AIDS pandemic persists a full 35 years after the discovery of the causative agent, the HIV virus, while the SARS epidemic (2003–04) was controlled through an international public health effort. It has been estimated that the most recent influenza pandemic caused by the H1N1 virus (referred to colloquially as "swine flu") killed 151,700–575,400 people worldwide in 2009–10.[18,19]

That virus has now embedded in the human population and circulates the globe annually as one of the influenza strains causing seasonal epidemics. Epidemics and pandemics can arise quickly or gradually, be halted or persist for decades.

Reviewing lessons from the Ebola 2014–16 outbreak in West Africa, the WHO highlighted the importance of integrating research, social science and community engagement into the heart of the response. The need for the quick turnaround of test results, licensed vaccines, advances in Ebola care/treatment, support for survivors, fast-acting emergency response structures and funding mechanisms were also noted.[20] However, despite warnings of the Ebola epidemic, it was only reframed as a global security threat once it had infiltrated urban areas and crossed borders.[21] In response to SARS, the timely dissemination of accurate and scientifically based information and training to health officials and

Categories of Health Security

(Adapted from the Global Health Security Index 2020)



communities was reported as key.[22] Beyond these experiences, the WHO has considered scenarios where millions of people could succumb to influenza before it is brought under control. Yet, preparedness for COVID-19 proved to be insufficient.

This is not to ignore the inevitable complexities and challenges of responding to a pandemic. It is worth noting that some regions may be more vulnerable or susceptible to biothreats for reasons outside of the technological and medical advancement of the population.

Factors such as human behaviour; healthcare coverage and accessibility; biopolitics (the administration of the processes of life at the aggregate level of the population); and geopolitics (the interconnectivity between territories and alliances at a state level) play pivotal roles that can hinder or enable the spread of an outbreak. Changes in certain conditions, such as climate variance or mutations in an infectious agent, may make their spread more effective and/or treatment more difficult.[23] It is those conditions determined by physical, social, economic and environmental factors or processes that increase the susceptibility of an individual, a community, assets or systems to the impact of biothreats. The main consequence of this is a cycle in which the vulnerability of a system makes it more sensitive to risk.[24]

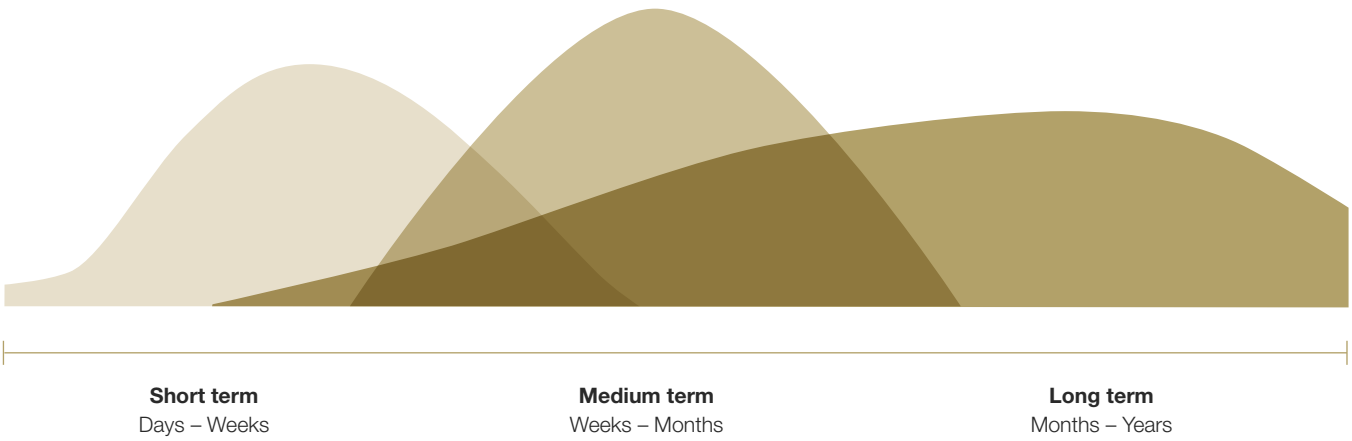
This means different groups can experience different impacts at the same and different times. In other words, different communities, regions and nations may be confronted by different phases simultaneously, creating waves within waves. This highlights how human existence and the world that surrounds it forms a complex relationship of cause and effect[25] that can be intensified in such crises.

A core challenge with COVID-19 – one that would apply to weaponised bioagents – is that there are also multiple relationships that can enhance or hinder the proliferation of the outcome that are not necessarily a cause or an effect. COVID-19 has demonstrated broad interdependencies with negative emergent properties. This is why COVID-19 has had such a profound effect all over the world, and differently in different places.

> **COVID-19 and naturally occurring diseases serve as powerful reminders of the damage that disease can cause and highlight the importance of being adequately prepared to respond to a bio-attack.[26]**

Overlaps in Phases and Impacts

Note: this portrays how short, medium, long-term impacts may emerge simultaneously and overlap. These may differ subject to national and local contexts creating waves within waves across communities.



Short term
Days – Weeks

Medium term
Weeks – Months

Long term
Months – Years

The Evolution of Bioweapons

Just as there are examples of naturally occurring diseases throughout history (e.g. the Spanish flu of 1918), there is ample literature that points to how bioweapons have evolved that provides important context. Examples include the poisoning of water wells with human corpses in Tortona, Italy, in 1155; the spread of plague victims in Caffa on the Crimean Peninsula in 1346; and in 1495 the mixing of wine with the blood of leprosy patients to sell to French soldiers after they invaded Naples. Native Americans have been described as one of the earliest victims of biowarfare through the devastating release of smallpox and measles.[27] The list of legendary narratives and historically verifiable incidents goes on.

Fast-forward to the 20th century, and advances in bacteriology and scientific research developed the threat from intentionally spreading natural disease pathogens to weaponised bioagents. In the early 1900s, the focus of research was aimed at destroying crops and livestock. This culminated during the height of the Second World War, when the Imperial Japanese Army conducted extensive research on the use of bioagents as a wartime weapon against humans, attacking 11 Chinese cities with a range of bioweapons. These included poisoning more than 1,000 water wells to study the effects of cholera and typhus outbreaks and releasing thousands of plague-infected fleas by air over Chinese cities.[28]

Other states began developing their own offensive bioweapons programmes. Throughout the Cold War, the United States Biological Weapons Program continued research that entailed conducting open-air tests; exposing animals, volunteers and unsuspecting civilians to pathogenic and non-pathogenic microbes, including bacterial aerosols in public places such as bus stations and airports.[29] The Scottish island of Gruinard was contaminated in 1942–43 when it was used as a UK government test centre for bioweapons (specifically bombs containing live Anthrax spores). It was not until 1987 that the ground was declared Anthrax-free.[30] The Soviet Union established a biowarfare project of its own, dubbed “Biopreparat”, a large-scale secret project that sought to develop and produce bioagents from the most dangerous viruses and bacteria available. The work included engineering multi-drug-resistant bacteria and producing and stockpiling bioagents, such as Anthrax. Further evidence was provided by an accidental release of Anthrax spores from a production facility in Sverdlowsk which, propelled by a slow wind, killed more than 60 people.[31] After the collapse of the Soviet Union, nearly all research and production was halted. Little is known about the bioweapons that were produced or where they are stored today.[32,33]

Historically, biowarfare programmes that target human health have been extended to target crops and farm animals to deny food to the enemy, cause economic damage or sap morale. During the First World War, German saboteurs in the United States used Anthrax and glanders to infect more than 3,500 horses before they were shipped to the British and French armies, rendering them unfit for service when they arrived. During the Second World War, the United States and Canada developed anti-livestock agents such as rinderpest, a highly lethal disease of cattle that was declared eradicated in 2011.[34,35] From the mid to late 20th century,

the Soviet Union's anti-agricultural warfare programme employed 10,000 people and targeted poultry, livestock and crops. More recently, during the Iran–Iraq War of the 1980s, Iraq developed fungal agents to attack Iran's staple food crops.[36]

Despite the introduction of the Biological Weapons Convention as a supplement to the 1925 Geneva Protocol to prohibit the use of bioweapons, several nation-states are known to maintain these capabilities.[37,38] North Korea, for example, has allegedly weaponised 13 different agents. These included Anthrax, cholera, typhoid, yellow fever, botulism, Korean haemorrhagic fever, smallpox and bubonic plague. It has been suggested that such bioweapons can be more lethal than nuclear weapons.[39]

It is no surprise that there has been a sharp increase in high-containment laboratories in operation or being built across Asia, Africa, Europe, Russia and the United States.[40,41]

These facilities are driven by the same kind of geopolitical competition that triggers war rather than a desire to serve public health needs,[42] and raises issues of laboratory safety and security. This poses the insider threat as a significant security challenge.[43] Fortunately, security measures limit who can work with certain pathogens and in which laboratories, but this doesn't remove the threat.

The rise in high-containment laboratories is akin to an arms race, on the premise that such capabilities may equate to deterrence through a stalemate or mutually assured paralysis (via the perception of mutually assured destruction). This, as Kofi Annan emphasised, creates a vacuum that can be exploited.[44,45] Consider, for example, the assassination of Bulgarian Georgi Markov in 1978 on a London street via a micro-engineered pellet containing ricin,[46] or how this principle translates to the maintenance of chemical and radioactive weapons. More recent examples include the poisonings of Alexander Litvinenko by radioactive Polonium-210 in 2006; Sergei Skripal and his daughter Yulia Skripal by the chemical nerve agent Novichok in 2018; and the unsuccessful poisoning of the Russian opposition leader, Alexei Navalny, in 2020. Such transnational hybrid activities are highly political and referred to as the "grey zone", in which states may seek to showcase their power and exert influence.

The use of state-sponsored bioweapons, although beyond the remit of this report, is a dilemma that should also be transferred into preparedness for direct or hybrid bio-attacks at all levels.

Bio-attacks could be designed to inflict maximum fatalities, casualties, and/or disruption to society. They may be hostile acts from foreign states, serious organised crime groups or terrorist cells.[47]

In 2020, national security challenges were growing in severity and complexity, while the terrorist threat persisted at scale.[48]

Bioweapons and Terrorism

In extremis, the use of weaponised bioagents can be considered as an act of war (consider NATO Articles 4 and 5). It was famously stated that war is a continuation of politics by other means, an act of violence to compel the enemy to fulfil a will.[49] Their use could be part of an ideological, political or perhaps religious contest for control of the state, usually between the government and a rebel group.[50] This relates to bioterrorism as the focus of this report.

Although United Nations members have been unable to agree on a definition of terrorism because of differences in interpreting the actions of states or those involved in resistance movements, the most general usage of the term considers terrorism to be "the unlawful use or threatened use of force or violence against people or property to coerce or intimidate governments or societies, often to achieve political, religious or ideological objectives".[51] Put simply, an act of terrorism can be understood as a premeditated, politically motivated attack through a variety of means and methods, including bioagents (bioterrorism).

INTERPOL define bioterrorism as, "the intentional release of biological agents or toxins for the purpose of harming or killing humans, animals or plants with the intent to intimidate or coerce a government or civilian population to further political or social objectives".[52]

A bio-attack is, therefore, the intentional release of a pathogen (disease causing agent) or biotoxin (poisonous substance produced by a living organism) against humans, plants or animals. This may be through weaponised bioagents or engineered biology. These can pose complex public health challenges, causing large numbers of deaths while being difficult to contain.

A bio-attack could also result in an epidemic or pandemic, for example if Ebola or Lassa viruses were used as the bioagents.[53]

Detecting releases and containing their spread is key. The UK Biological Security Strategy is committed to rapidly and effectively detecting, characterising and reporting the presence and nature of harmful biological material that could represent a significant risk or threat.[54]

Similarly, the United States public health system and primary healthcare providers are obliged to prepare for various bioagents, including pathogens that are rarely seen in the country. These high-priority agents include organisms that pose a risk to national security because they can be easily disseminated or transmitted from person to person; result in high mortality rates and have the potential for major public health impact; might cause public panic and social disruption; and require special action for public health preparedness.[55]

Although the consequences of a terrorist attack using weaponised bioagents could unfold like a pandemic such as COVID-19, there are clear distinctions to be made:

- A bio-attack is both intentional and malicious. It is therefore considered to be an act of war or terrorism. It is highly political and invokes bespoke and specialist structures at local, national and international levels that shift the approach of governments and agencies.
- Management of societal and health impacts would be accompanied by the need to activate significant intelligence and investigative apparatus, as well as the associated sensitive and time-critical operations necessary to apprehend the terrorists themselves.
- Terrorist attacks result in sharp shifts in societal behaviours and attitudes, often experienced through psychological impacts, a rise in community tensions and hate crime.
- Bioagents could be engineered to be highly potent and fatal. They may be released in mass, whether overtly or covertly, targeted or otherwise, and have the potential to cause more disruption and kill or incapacitate significantly more people.[56,57]

The following table of examples demonstrate the variance in case fatality rates, which are likely to be at the higher end if malicious. In contrast to a naturally occurring disease emerging somewhere, leading to locally increasing cases and spreading from there, a malicious release of the same pathogen could mean that it appears in more places at the same time or across a wider geographical area. Even without engineering, this would create a situation quite different from a natural outbreak and could begin with a comparatively higher level of impact. This is, of course, dependent on whether the bioagent can spread between humans or not.

Anthrax offers a case in point. It is a zoonosis caused by *Bacillus Anthracis*, where one deep breath of weaponised aerosol may lead to septicaemia, rapid progression to shock and respiratory failure. Mortality rates are substantial even with access to full intensive care facilities, which would not be sustainable in a large-scale attack. Although Anthrax is very unlikely to spread between people, smallpox has proven potential as a highly contagious malicious bioagent even before any engineered enhancement. International stocks of vaccine are acknowledged to be inadequate, and the WHO urged countries to consider means of increasing these stocks,[63]

with the remaining fear that it could be used maliciously.

Proliferation of bioweapons, international terrorism and pandemics have been highlighted as key challenges for national security.[64] In conflict zones, advances in weapons technology have allowed the use of weapons over much wider geographic areas than in the past. Recent events, such as the use of chemical weapons on civilians by terrorist groups in Syria have demonstrated a real threat.[65] This transfers across to bioagents that, although technically challenging to produce and disperse, are becoming increasingly accessible.

This is a highly sensitive space to navigate. Bioweapons and terrorism raise extremely difficult questions about peace, security, human rights, the international system and the vulnerability of even the strongest states.[66] Similar can be said about a pandemic, where a nexus of global, national, regional and local impacts and interdependencies are also witnessed.

Both pandemics and terrorist attacks are widely considered to be high-risk and high-impact. Although terrorism in general is considered relatively likely, bioterrorism has been considered to be relatively low likelihood.

It is proposed that the threat of bioterrorism is accelerating, with potentially severe consequences.

Indeed, the threat of a bioagent designed to maximise transmission and lethality warrants attention.[67] Just like pandemics, a large-scale terrorist attack can shock systems in unexpected ways.[68] When combined (a bio-attack that causes a pandemic), the potential is catastrophic.

Agent	Case Fatality Rate	
Anthrax	10-50%+	Varies depending on clinical features, highest for inhalation (historically up to 85%).[58]
Botulism	5-10%	Incidence is low but mortality can be high without prompt diagnosis and appropriate, immediate treatment.[59]
Plague	30-100%	A severe disease, particularly if it causes a systemic infection or is in its pneumonic form. It is invariably fatal unless treated early.[60]
Smallpox	1-30%	Variola minor has a mortality rate of 1%, whereas the more common major has a mortality rate of 30%. 65–80% of survivors are marked with deep, pitted scars.[61] Both were declared as eradicated.
Viral haemorrhagic fevers (e.g. Ebola)	25-90%	Average 50%: A rare, but severe and often fatal disease.[62]

3

Bioterrorism: An Accelerating Threat

“While terrorism continues to pose a threat to the whole world, CBRN(e) terrorism is of particular concern for Member States and the international community. We must remain vigilant as any possibility of terrorists accessing and using CBRN(e) weapons and materials poses a serious threat to international peace and security.”

Vladimir Voronkov, United Nations Under-Secretary-General for Counter Terrorism[69]

Attacks on Humans and Communities

The Council of Europe noted how COVID-19 has uncovered the vulnerability of societies to the intentional use of a pathogen or other bioagent, highlighting that such may prove highly effective and cause damage on a far grander scale than traditional terrorist attacks.[70] This is possible because some living organisms have a capacity for amplification and propensity to spread, with drastic effects. Bioterrorism, like all CBRN(e) threats, occurs with little warning. It is often invisible and unknown, as are the perpetrators and their plans.[71]

Historically, several non-state actors have obtained and deliberately used bioagents to injure or kill civilians. In Oregon, a religious commune was responsible for a deliberate outbreak of salmonella that sickened more than 750 people over a month and was part of a larger plan to incapacitate voters for an upcoming local election. In 1993, Aum Shinrikyo attempted to disperse a liquid suspension of Anthrax in Tokyo.[72] In 1995, the group conducted a sarin attack inside the Tokyo subway that killed 13 people and hospitalised thousands. The subway attack followed failed botulism and Anthrax assaults near the Imperial Palace, an airport and two United States military bases, as well as efforts to acquire the Ebola virus.[73,74]

In 2001, an attack using a small amount of Anthrax in powder form caused widespread panic. Distributed in envelopes via the United States Postal Service shortly after 9/11, it caused 22 people to become sick from exposure and 11 were seriously ill. Five died and six recovered following intensive care. A further 31 people tested positive but did not become ill, most likely because of the widespread administration of prophylactic antibiotics, which were administered to tens of thousands of people as a preventative measure. In addition, at least 42 buildings were contaminated with Anthrax spores because of the handling and transportation of envelopes and the easily aerosolised nature of the spores. This demanded a significant and protracted process of decontamination, which was both disruptive and costly.[75]

Recently, Europol noted how technological advances alongside knowledge shared online have reduced barriers to accessing bioagents[76] and their associated costs. To put this into context,

> **the sequencing of the DNA strains used in the Anthrax attacks cost several thousand dollars and took three months to accomplish. Now, a typical microbiology researcher could do the same for approximately $200 in half a day.[77]**

During 2019, a pro-ISIS group launched a campaign promoting the use of bioweapons, including instructions on how to produce and deploy them.[78] Genetic maps of deadly viruses, bacteria and other microorganisms are also available in the public domain, although to reconstruct a virus from a sequence (while theoretically possible) would be highly sophisticated.

COVID-19 has been described as the perfect storm for the spread of misinformation, owing to its inherent and persistent uncertainty. Terrorist groups have been able to capitalise on this through countless forms of propaganda platforms, including social media and the dark web, both of which transcend borders.

Obtaining a sample of a virus, however, is relatively uncomplicated. There has been a case of a malicious organisation managing to access vials of the bubonic plague bacteria, for example.[79]

Terrorist groups have openly spoken of acquiring bioweapons.[80] The logic behind this is clear: if COVID-19, which has a lethality of approximately 1% among those infected, can cause global turmoil, consider an engineered virus as infectious as coronavirus but with the lethality of Ebola.[81] Terrorist groups have also been reported as contemplating the release of a pathogen into local water systems, which could have disastrous consequences.[82] Three jihadist propaganda documents from the series "Knights of Lone Jihad" published in 2017 promoted CBRN(e) food and water contamination as a tactic.
In February 2021, an unidentified computer hacker attempted to poison the water supply of a city in Florida by remotely increasing the amount of sodium hydroxide.[83]

A United Nations report noted that COVID-19 had created a captive audience for terrorist cells. An increase in time spent online has been accompanied by a rise in cybercrime that could also lead to increased connectivity between terrorist and criminal actors. It noted the furthering of terrorist narratives, with a wide variety of terrorist groups integrating COVID-19 into their propaganda, seeking to exploit current events.[84]

Indeed, COVID-19 has been described as the perfect storm for the spread of misinformation, owing to its inherent and persistent uncertainty.[85] Terrorist groups have been able to capitalise on this through countless forms of propaganda platforms, including social media and the dark web, both of which transcend borders.[86]

The upsurge in Islamist extremist activity online and inspired material is further demonstrated by ISIS in its *Al-Naba* edition of 19 March 2020, which explicitly called for attacks while opponents were vulnerable as a result of the pandemic.[87]

The world's focus on COVID-19 may lead terrorists to seek even more attention-grabbing targets or techniques. On 24 March 2020, a white supremacist attempted a car bombing at a Kansas City medical centre. According to reports, the timing of the attack was accelerated following the COVID-19 outbreak as the medical centre now "offered more casualties".[88] There was a further attempt against a hospital ship in the United States, and the arrest in Tunisia of two men who were reportedly planning to infect security forces with COVID-19.[89]

The real or perceived failures of the response to COVID-19 have also provided terrorists with an opportunity to fill a "void" by using public services as a vehicle to accelerate their agendas.[90] Terrorist groups including the Taliban, Hezbollah and al-Shabaab have provided services in lieu of governments, which allow them to acquire and consolidate a form of political legitimacy and expand their footprint. Simultaneously, right-wing extremists project hate, racism and conspiracy theories about the origins and purpose of COVID-19, blaming ethnic or minority groups for the virus. There is a growing and increasingly transnational threat from extreme right-wing terrorism.[91] One of the major fallouts from COVID-19 is the loss of millions of jobs, which fuels uncertainty and anger that far-right extremists may exploit for recruitment.[92]

In the words of the INTERPOL Secretary General, Jürgen Stock, "Terrorists have sought to profit from COVID-19, to make money, strengthen their base and to fuel division".[93]

Although globally the total number of deaths from terrorism has declined, falling by 15% to 13,826 deaths in 2019 over a five-year period,[94] NATO reported that terrorism remains responsible for the death of more Allied citizens than any other security threat in its history.[95] In the West, ISIS directed or inspired at least 78 attacks between 2014 and 2019, resulting in 471 fatalities.[96]

In 2019, Europol noted that a total of 119 completed, failed and foiled terrorist attacks were reported by 13 EU member states[97] and, more recently, attacks have been witnessed in France, Austria and Germany.[98] Speaking in October 2020, the MI5 Director-General, Ken McCallum, cited 27 late-stage terrorist attack plots that were disrupted in Great Britain alone since 2017.[99]

The threat of terrorism hasn't abated, rather it is becoming more complex, with multiple actors of diverging motivation and allegiance.[100]

Concerns about "dirty bombs" being used in urban areas also persist. A sophisticated plot to detonate military-grade explosives on a flight from Australia in 2017 uncovered further plans for a chemical attack in Sydney.[101] Three terrorist plots involving CBRN(e) materials were also disrupted in Paris, Sardinia and Cologne during 2018.[102]

The case in Cologne was a terrorist plot involving ricin. It was the first time an ISIS-affiliated terrorist had successfully produced the bioagent in the West.[103] In addition, there are hundreds of independent biology labs across the globe where individuals or small organisations can conduct their own do-it-yourself biology experiments. There isn't a common regulation for this, and many countries don't consider it to be an illicit act,[104] which creates an exploitative vacuum.

The WHO highlighted that "the use of biological agents is a serious problem, and the risk of using these agents in a bioterrorist attack is increasing".[105] This is endorsed by INTERPOL, which noted that

"the threat from bioterrorism is real, with current reports indicating that individuals, terrorist groups and criminals have both the capability and intention to use biological agents to cause harm to society".[106]

The key message here is that terrorists are likely to develop or obtain chemical and biological weapons,[107] and this threat is accelerating.

© Tomas Oneborg

Attacks on Livestock or Crops

Consideration of bioterrorism typically focuses on direct attacks against human populations. However, many bioagents are zoonotic (a disease that normally exists in animals but that can infect humans) and could have a considerable impact on agriculture as well as on human health.[108]

Urbanisation and the proximity of humans and animals provide a vector for zoonotic diseases. This underlines the fact that human health cannot be separated from the health of plants and animals. Approximately 60% of all human diseases and 75% of all new and emerging infectious diseases are zoonotic in origin.[109]

An attack on livestock or crops could cause significant economic damage, social unrest or loss of confidence in government. "Agroterrorism" could also be effected more easily, requiring less specialised technology or expertise, because of the openness and vulnerability of farming operations.[110,111]

The goal of agroterrorism is generally not to kill animals or plants but to cause the secondary impacts of terror and human health disruption. In 2008, the United States Federal Bureau of Investigation, Food and Drug Administration, Department of Homeland Security and Department of Agriculture, jointly published a "Criminal Investigation Handbook for Agroterrorism",[112] which highlighted its importance. For example, in 2011, a calf's leg was found in silage used to feed heifers on a farm in Northern Ireland, an apparent attempt to deliberately infect the cattle herd with brucellosis, a serious veterinary disease.[113]

Some bioterrorism bioagents in animal populations could spread widely through animal-to-animal transmission and prove difficult to control, thus the concept of "One Health" (interpreting animal and human health as a continuum) is essential. Expansion of public health infrastructure beyond passive surveillance of animal disease towards active surveillance and intervention to detect and control ongoing outbreaks is a step towards this.[114]

One Health

"One Health" is an approach to designing and implementing programmes, policies, legislation and research in which multiple sectors communicate and work together to achieve better public health outcomes. The areas of work in which a One Health approach is particularly relevant include food safety, the control of zoonoses (diseases that can spread between animals and humans, such as flu, rabies and rift valley fever), and combatting antibiotic resistance (when bacteria mutate after being exposed to antibiotics and become more difficult to treat).[115]

Of the highest priority agents identified by the United States Centre for Disease Control and Prevention, the only disease that does not affect animals is smallpox, which was declared as eradicated in the 1970s, thanks to worldwide vaccination.[116] The successful eradication of smallpox brought immediate public health benefits, however the remaining spectre that it could be used maliciously as a bioweapon is a threat that many governments take very seriously, and maintenance of stockpiles of smallpox vaccine persists to varying degrees.

The potential economic impacts must also be realised. The impacts of foot and mouth disease (FMD) – a naturally occurring disease in cattle – in the UK during 2001 were wide-reaching and extended beyond direct impacts to agriculture and the food chain (£3.1 billion). Additional estimates of impacts to the tourism industry because of fewer visits to the countryside were put at between £2.7 and £3.2 billion. Many of the costs to agriculture were met by the government through compensation for slaughter and disposal and towards "clean-up" costs. However, agricultural producers were estimated to have suffered losses of £355 million (20% of the estimated total income from farming in 2001). Overall, the net effect of FMD is estimated to have reduced the gross domestic product in the UK by <0.2% in 2001.[117] The impact of a hostile release of a disease such as FMD, on top of the current economic impacts the world is facing due to the COVID-19 pandemic, might not be so easily managed or absorbed.

In June 2020, identification of a new variant of SARS-CoV-2 in mink in Denmark led to widespread culling across 289 affected farms (17 million mink) after interventions were unable to prevent the spread of infection from farm to farm, or from animals to humans. Mink farming, including import and export, was subsequently banned in Denmark until 31 December 2021. Economic support packages were established for those affected but the full impact will not be known for some time.[118]

The significant economic impacts of avian influenza outbreaks in poultry populations and SARS are also well documented.[119] These were natural outbreaks of animal disease, coupled with relatively low levels of global human illness and death, but there was nevertheless an impact on food supply and major economic ramifications through loss of earning from agriculture and tourism because of travel restrictions.

Approximately

60%

of all human diseases and 75% of all new and emerging infectious diseases are zoonotic in origin.

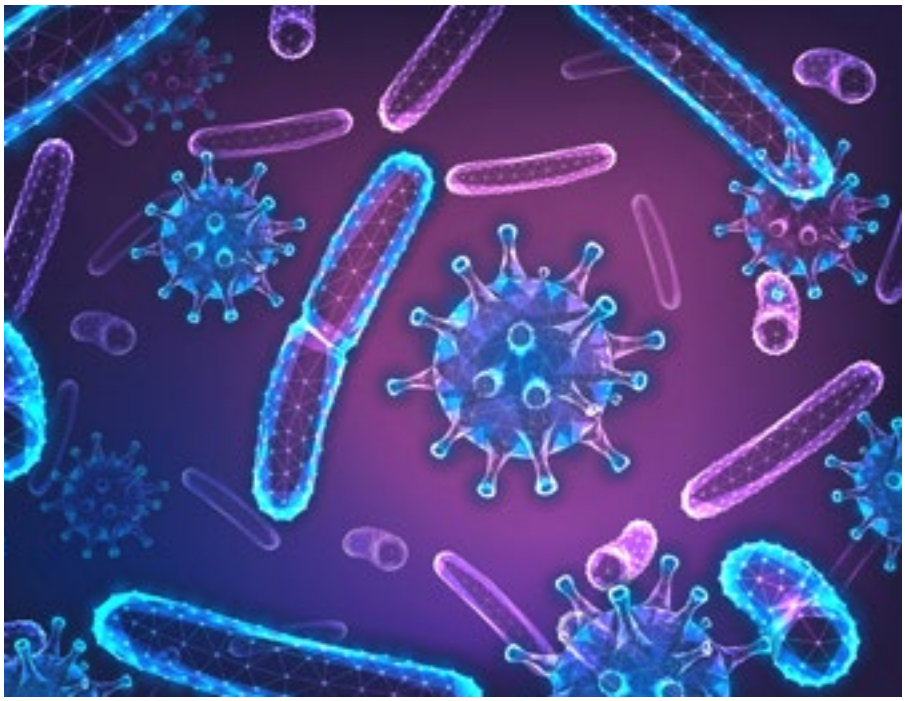
This provides an opportunity to reflect on how animals could be used to spread/act as sentinels for bioagents. For some bioagents, pets, wildlife or domestic livestock could provide humans with early warning of an exposure risk. Of course, the converse is true, with disease potentially manifesting in humans before animals. It is also worth considering how naturally occurring diseases can mutate, as happened with COVID-19. With avian flu, the fear that it might become air transmissible resulted in experiments on its transmissibility between mammals. This was highly debated in the context of biosecurity and biosafety.

The malicious genetic modification of a crop with perhaps reduced resistance could also cause significant impacts on yield. The release of antibiotic/pesticide-resistant crop pathogens could similarly devastate crop foods and, in areas already facing food stress, increase the likelihood or impact of shortages, leading potentially to hunger, famine and even conflict.

The direct and hostile release of genetically modified crops into an area without prior authorisation may also present a threat, as could the sabotage of a previously approved crop.[120] Industrial crops such as rubber or cotton could also be targeted, with significant results.

Extrapolation of the impacts of disease and disruption to animal and plant crops (for food and non-food purposes) could be a secondary target for bioterrorism.

In this respect, terrorists could potentially spread a bioagent over a large geographical area without being detected, causing significant disruption without extensive planning, resources or technical knowledge. In 1918, the German army spread Anthrax and other diseases through imported livestock and animal feed.[121] More than 100 years later, such actions would require relatively little effort,[122] and may be increasingly impactful given crop monoculture.



Summarising the Threat Profile

At the highest level we have entered an era of unprecedented change. The world order is shifting, superpowers are changing and needs and threats are evolving. Regional groupings, founded for peace, are breaking because of increasing geopolitical fragility, and trust in democratic institutions is declining. Demographic shifts are being triggered by climate change and competition for diminishing natural resources, intensified by a backdrop of population growth and urbanisation. This is accompanied by an aging population predominantly in developed nations, and rising numbers of disaffected young people in much of the developing world who will be facing poorer employment prospects and unfulfilled expectations.[123]

This is compounded by the persisting conflict between secularism and commercialism on one side and rigid belief systems on the other, which fuels the pool of disaffected that become vulnerable to radicalisation. In addition, hostile states are using hybrid means to maximise their influence and non-state actors are becoming increasingly powerful.

> **It is predicted that there will be more ungoverned spaces and CBRN(e) capacity will proliferate.[124]**

This high-level view is important because geopolitical fragility, conflict and inequality will continue to create a breeding ground for terrorism. Population growth, migration flows and urbanisation will increase density, creating fertile environments for attacks. The proliferation of bioweapons will also make their use more likely. It is already known that

> **societies' dependence on overwhelmingly complex and interconnected systems increases their vulnerability and susceptibility to biothreats of all kinds, as demonstrated by COVID-19.**

Records show that bioagents have been used intentionally and maliciously throughout history. Historically it has mainly been religiously motivated or right-wing terrorists who have been most attracted to using bioweapons and, in the West, these are currently the dominant terrorist movements. Following COVID-19, the emergence or resurgence of a range of terrorist groups is possible. There are strong long-term concerns that nations weakened by the serious economic consequences of the pandemic will become more vulnerable.[125] Although prohibited under international law, it is likely that some states and non-state actors will continue to develop, stockpile and use chemical and bioweapons.[126]

Bioagents are both economical and difficult to detect, making them appealing to terrorists. A broad range of biological toxins or infectious agents, such as bacteria, viruses and fungi, could be used, all of which are living organisms or replicating entities. This is not to ignore the significant efforts to restrict access to, and deter potential terrorists from bioagents, rather to note that with appropriate access, equipment and knowledge some bioagents may be relatively easy to produce. Unmodified pathogens would also be very dangerous in the context of an intentional release (e.g. Ebola) if cultivation and release were achieved.

This is coupled with rapid scientific and technological advances that can be exploited and may shape an entirely different landscape in the years to come. Biotechnology could enable viruses to be engineered to optimise the impact of bioweapons. Genetic modification could also make pathogens more resistant to medication and vaccines, and could boost transmission and virulence. Synthetic biology could change human physiology in unpredictable ways, such as by engineering autoimmune disorders; attacking the microbiome with significant neurological effects; or making an operative immune to a bioagent. A report on "Advances in Science and Technology in the Life Sciences: Implications for Biosecurity and Arms Control" offers a more technical analysis of these evolving threats.[127]

When bioterrorism is viewed through this lens, many different scenarios are imaginable. Such sophisticated human experimentation is technically much harder to do (enabled by a range of expertise and other technologies) but it still needs to be acknowledged as a threat. Biotechnology presents opportunities to advance the life sciences, but that same technology in the wrong hands could be used to create crippling bioweapons.[128,129]

Technologies including unmanned aerial vehicles (UAVs) or drones, the dark web, malware, synthetic biology and 3D printing have also been highlighted as increasing the risk of non-state actors' access to, and use of, CBRN(e) weapons.[130]

The role of modern technology in terrorism was illustrated by the extreme right-wing terrorist attack on a synagogue in Halle, Germany, in 2019, where the attacker constructed several guns using 3D printing.[131]

Drones are also a prime example of how technological advances have manifested in physical and weaponised form (ISIS first began attacking coalition troops with drones in 2014) and could be used for the dispersal of malicious agents. Cheap, commercially available drones en masse could overwhelm defences.[132] The rapid pace of innovation and easy access to drones means that this threat is likely to grow.[133] One bioterrorism scenario is the airborne dispersion of pathogens over a population. Crop-dusters, for example, are ready-to-use drones able to do exactly this. They are agricultural drones that are pre-configured for spraying operations.

Some nations have adopted bespoke drone guidance in response to both physical attack against a site (e.g. carrying an improvised explosive or chemical/bioagent) and fears of hostile reconnaissance that may then be used to develop an attack plan. The threat posed by the malicious use of drones, the changing threat profile and advances in biotechnology mean that countermeasures must continue to evolve.[134]

Other means of dispersal could include aerosol generators mounted in fixed locations or on vehicles or boats. Agents could also be delivered directly into ventilation or air-conditioning systems, via letters or parcels, or through insects, crops and livestock. Suicide attacks could also be extremely effective for disseminating diseases such as smallpox or Ebola.[135]

A further threat to the biosphere pertains to cyber-biosecurity because of the increasing connectivity and dependence between digitalised platforms and systems. This includes consideration of emerging or converging technologies, like the use of artificial intelligence to predict modifications to pathogens that could cause harm. This requires separate research as part of a wider analysis on the impacts of cybercrime and artificial intelligence on terrorism.

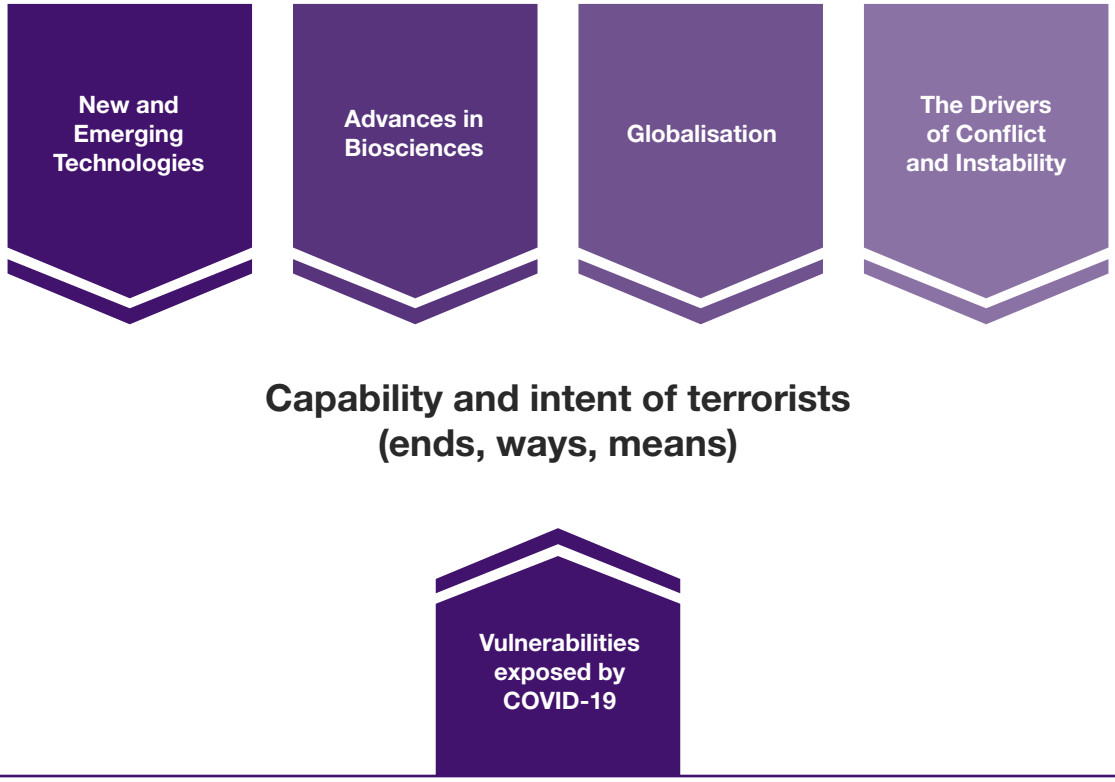
These challenges have been recognised by INTERPOL and the United Nations, which convened a high-level meeting aimed at understanding the transformative ways new and emerging scientific and technological developments are contributing to global society, while also considering their potential misuse by criminals and terrorist groups and how this could be countered. The increased use of the darknet to acquire, transfer or smuggle biological material or weapons was noted as becoming a major concern for the law enforcement community worldwide, as was the rising threat posed by the criminal and terrorist use of drones.[136]

NATO's 2030 strategy highlighted how the evolving modus operandi of terrorists, coupled with the spread of emerging and disruptive technologies, call for adaptive and innovative counter terrorism strategies, means and methods.[140] The convergence of COVID-19 with a lack of global leadership combined with politico-socio-economic instabilities that build upon pre-existing societal grievances[141] may increase the terrorist threat.

This view is endorsed by the European Union's counter terrorism chief, who noted that COVID-19 would exacerbate extremism on both the right and the left, with people driven to their respective ideological corners during this period.[142] There is a real risk that social divisions will intensify, and community tensions will increase,[143] while terrorist groups carve a more hospitable environment for action than before.

As stressed at the beginning of this report, the threat of bioterrorism is generally considered to be relatively low and the intention here is not to overstate this. Rather, the summary offered by the Combating Terrorism Center, an academic institution at the United States Military, neatly sums up the position of this report:

Bioterrorism: An Accelerating Threat



> **"If one considers the interdependencies between human technological advances and the equally impressive progress that biological and health sciences have made... we should already conclude that the likelihood of a future terrorist using a highly potent, clandestinely produced, difficult to detect/identify/track, easily transportable and dispersible, and quite lethal biological weapon is rising significantly".[144]**

CASE STUDY
INTERPOL Bioterrorism Prevention

A major part of INTERPOL's efforts is the facilitation of targeted training for law enforcement and relevant national agencies on how to prevent, prepare and respond to bioterrorism. Their range of capacity building and training activities aim to establish collaboration on the national and regional levels, but also seek to promote a multi-agency approach.[137]

In November 2020, INTERPOL and the United Nations launched a joint initiative to produce a global threat study on non-state actors and their CBRN(e) materials. By developing strategic threat assessments against CBRN(e) using national law enforcement information, this five-year initiative was designed to help the international community counter the threat. It highlighted the value of establishing a region-by-region threat assessment on non-state actors involved in sourcing, smuggling, acquiring or deploying CBRN(e) materials.[138]

INTERPOL's Bioterrorism Prevention Unit's Project Pandora was also established to increase capability of police and intelligence analysts to investigate bioterrorist-related activities using the darknet. This included the development of analytical support and intelligence sharing, by seeking to gather comprehensive data that determines trends and anticipates biothreats. INTERPOL's CBRN(e) and Vulnerable Targets Sub-Directorate also began developing a dedicated Critical Infrastructure Protection Unit regarding the use of drones.[139]

4 Enhancing Preparedness for Bioterrorism

“Global pressures that play out at a city scale such as... disease pandemics, economic fluctuations, and terrorism pose new challenges. The scale of urban risk is... increasingly unpredictable due to the complexity of city systems.”

The Rockefeller Foundation[145]

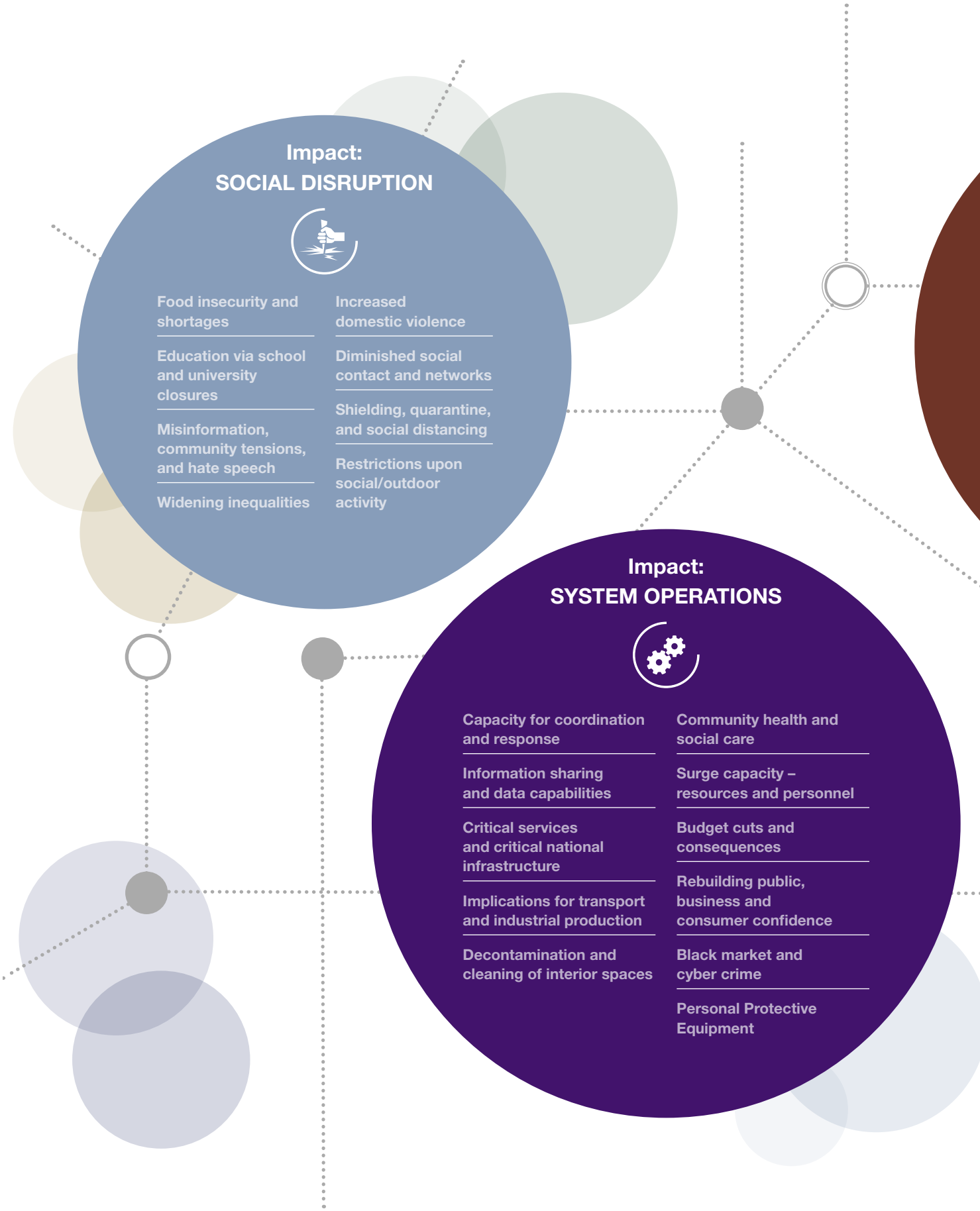
With an estimated 90% of all reported COVID-19 cases, cities and urban areas have been described as the centre of COVID-19, driven by population size and their high-level of global and local interconnectivity. The unprecedented growth of cities in recent decades has intensified several of humanity’s most pressing challenges, heightened by COVID-19. It has demonstrated high levels of disproportionally and deep-rooted inequalities affecting the most vulnerable in society. This shows the critical role local governments have in crisis response and recovery, as well as service delivery, economic and infrastructure development. As noted by the United Nations report “COVID-19 in an Urban World”,

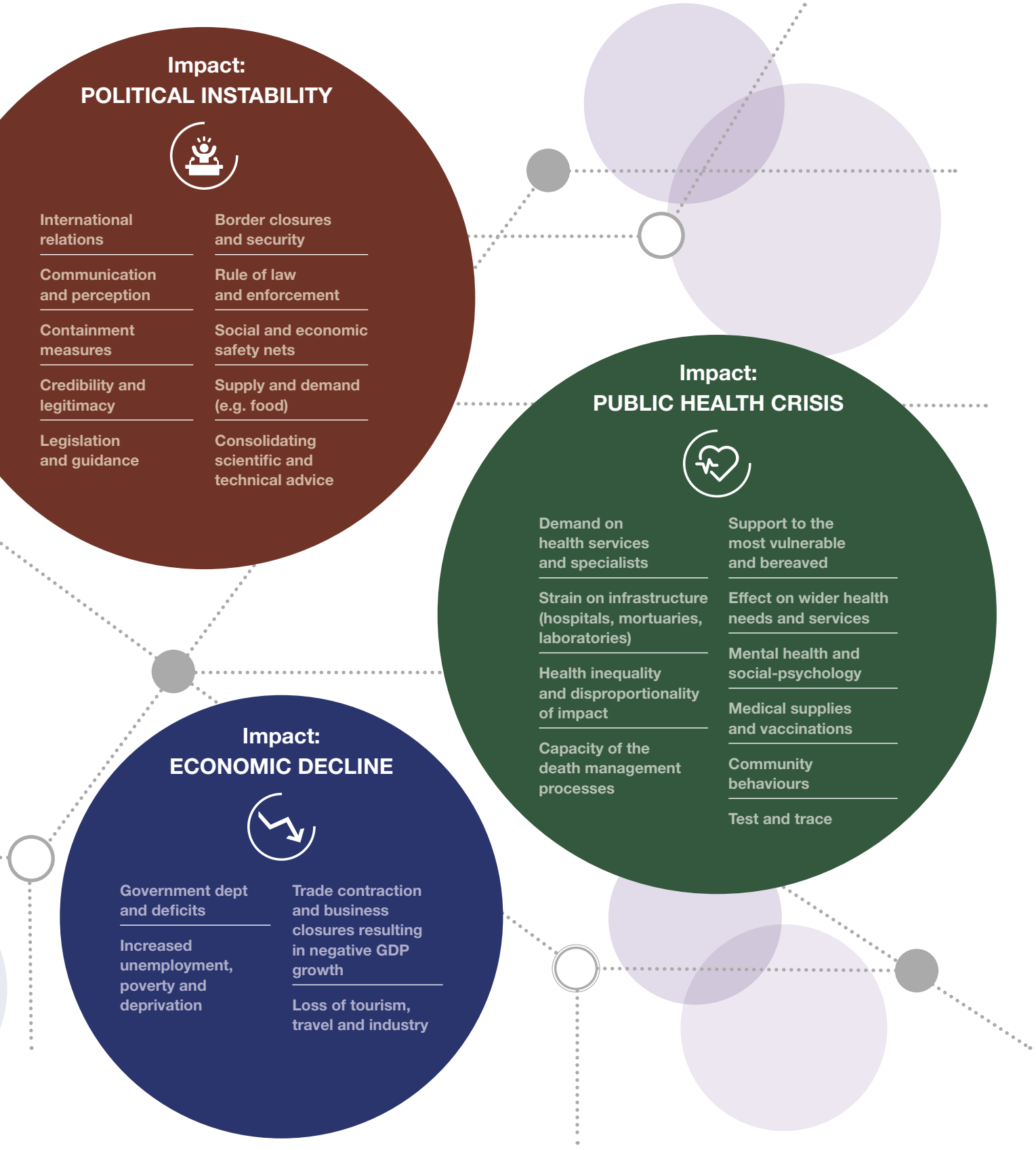
> **there is an urgent need to rethink and transform cities to respond to the reality of COVID-19, potential future pandemics, and by extension, bioterrorism.**

This is about building more resilient, inclusive, socially cohesive and sustainable cities that confront these threats, as well as wider crises (such as the climate change and pollution crises) that challenge the viability of cities.[146] This should encompass the development of policies and approaches that seek to address unequal distributions of wealth, health, prosperity, income and resources. This requires robust developments in terms of national governance and contingencies, city-level policy, multi-agency planning, wider initiatives and local arrangements. Herein is the opportunity to take a high-level view of the impacts and consequences of COVID-19 and translate them into the context of bioterrorism. Assessing vulnerabilities to understand the potential consequences of bioterrorism or public health crises can inform priorities and approaches towards policy and preparedness.

A whole-system approach should seek to improve preparedness and the operational management of complexity and resilience. If risk can be understood as the result of interaction between changing threats or hazards, physical systems and society, it follows that risk also evolves over time. This interplay of physical and behavioural dynamics develops and manifests through the existence of a widespread network of causes and cascading effects.[147] COVID-19, for example, has demonstrated how the nonlinear escalation of secondary emergencies can become crises. The vulnerabilities that cause secondary emergencies to escalate and their respective tipping points or thresholds need to be identified. Understanding this process; the speed at which it can unravel; and the ability to counter it is critical.

Mapping causality and consequence, associated interdependencies and ripple effects can enable the identification of those systems or assets that are vital to the functioning of society. Further analyses are then needed to grasp how resilience, specific to certain sectors or services, could be built. Cities should therefore consider undertaking deeper and more comprehensive analyses that can be tailored towards their own contexts and environments. This system-wide approach is fundamental to understanding resilience.[148,149]


Impact:
SOCIAL DISRUPTION
Food insecurity and shortages
Education via school and university closures
Misinformation, community tensions, and hate speech
Widening inequalities
Increased domestic violence
Diminished social contact and networks
Shielding, quarantine, and social distancing
Restrictions upon social/outdoor activity
Impact:
SYSTEM OPERATIONS
Capacity for coordination and response
Information sharing and data capabilities
Critical services and critical national infrastructure
Implications for transport and industrial production
Decontamination and cleaning of interior spaces
Community health and social care
Surge capacity – resources and personnel
Budget cuts and consequences
Rebuilding public, business and consumer confidence
Black market and cyber crime
Personal Protective Equipment


Impact:
POLITICAL INSTABILITY
International relations
Border closures and security
Communication and perception
Rule of law and enforcement
Containment measures
Social and economic safety nets
Credibility and legitimacy
Supply and demand (e.g. food)
Legislation and guidance
Consolidating scientific and technical advice
Impact:
PUBLIC HEALTH CRISIS
Demand on health services and specialists
Support to the most vulnerable and bereaved
Strain on infrastructure (hospitals, mortuaries, laboratories)
Effect on wider health needs and services
Health inequality and disproportionality of impact
Mental health and social-psychology
Medical supplies and vaccinations
Capacity of the death management processes
Community behaviours
Test and trace
Impact:
ECONOMIC DECLINE
Government dept and deficits
Trade contraction and business closures resulting in negative GDP growth
Increased unemployment, poverty and deprivation
Loss of tourism, travel and industry

The vulnerability map on the previous page demonstrates the volume and complexity of consequences that have been derived from COVID-19, all of which could apply to bioterrorism. COVID-19 epitomises both the transnational dimension of biothreats and the individual as a target in a blatant demonstration that a widened and global security agenda is now a fact of life.[150] These shifting parameters outline the importance of systematic investment as part of a transformational approach, which addresses the systemic nature of risks, including weaponised bioagents.[151]

The need for this has been proven by theoretical models of the deliberate aerosol release of bioagents such as smallpox or Anthrax in urban settings, which have shown that regional infrastructures could rapidly become overwhelmed.[152]

A report from the NATO Defence College noted that the use of weaponised bioagents by terrorist groups had been a growing concern for many years but highlighted how the negative social and economic implications of the COVID-19 crisis could result in growing intent by terrorist groups to use bioagents. As explored above, the potential increase in threat demands that collective capabilities are significantly enhanced.

NATO's report recommended a four-pillar approach:

1. To prevent the increase in intent and capabilities of terrorist entities;
2. To pursue indicators and warnings of bioterrorism activities;
3. To protect civilians and critical infrastructure;
4. To prepare for bioterrorism.[153]

The focus here is preparedness. Preparing for and managing the consequences of a biothreat has many similarities, whether a naturally occurring disease or weaponised bioagent – it still needs coordinating structures, a multi-agency response, communications, healthcare, societal support/behavioural changes etc. The response to biothreats of all kinds would also need to be underpinned by capabilities such as mass-fatality and excess-deaths planning, as well as humanitarian assistance, in addition to operational plans specific to counter terrorism.

In either case there would be significant disruption to communities, businesses and critical services with widespread political, social and economic ramifications. There would be a need to create mechanisms for surge capacity while prioritising support to the most vulnerable people in society. Preparedness in this context should enable early detection and rapid response, coordination and recovery, surge capacity and alternative ways of working. It should seek to develop infrastructure and systems that minimise single points of failure and spread or dilute the threat and associated risks. It must also be about how communities are engaged and influenced as an inherent part of the response.

The importance and complexity of policing in these circumstances should also be noted as a high-profile and sensitive role. During COVID-19, police have been charged with enforcing laws and regulations that have, in some settings, raised questions of legitimacy. Tensions resulting from the pandemic and social lockdowns became interlinked with structural inequalities that perpetuated this. The need to manage spontaneous large-scale public assemblies like protests, celebrations and unlicensed music events added complications.

Some members of the community may call for a robust approach to the policing of public assembly; others see their rights to freedom being infringed if dispersed forcibly by police. Approaches and tactics that enhance perceptions of legitimacy with some communities can ironically undermine them with others, so the balance is difficult to achieve.[154]

This report, however, does not focus on policing and law enforcement. These, and wider considerations including intelligence, surveillance, deterrence and counter terrorism operations, sit within the remit and responsibility of specialist agencies. Rather, the next section distills and converts the vulnerability-mapping analysis into three headline areas for preparedness: political and strategic leadership; multi-agency preparedness and public health; and informing and influencing community behaviours. In doing so, it enables this report to zoom in on some of the most prominent challenges that are within the scope of city authorities to address with a view to enhancing city resilience. It openly leaves wider areas to be considered and developed by the appropriate partners.


FREEDOM
-OVER-
FEAR
FREEDOM
-OVER-
FEAR

> A striking absence of leadership in biosecurity has created additional challenges for city leaders in translating grand strategy, legislation and direction into tangible and meaningful actions at a local level.

Political and Strategic Leadership

Crises that threaten multiple geographical or policy domains – transboundary crises – are much harder to manage than crises that respect borders. These are usually cascading crises, where a crisis in one societal sub-system causes disruptions in others. This generates complex layers of threat, urgency and uncertainty because the more complex a system becomes the harder it is for it to be understood it in its entirety. This is coupled with, and subject to, wider geostrategic realities that may be at play. These require strategic leadership, the overall direction of crisis responses and the political process surrounding these responses.[155]

High-level strategic coordination is, ultimately, a political activity. To create orderly interaction within and among organisations requires delicate choices about power, responsibility, rules of conduct and division of labour.[156] This requires the navigation of various fault lines. It is about organising and safeguarding collaborative processes within networks of actors involved in crisis response and/or recovery. It ranges from the sharing of information to the far-reaching integration of operations in pursuit of defined strategic objectives.[157] Delivering effective strategy is about resolving the tension between foresight and inherent uncertainty.[158]

Bioterrorism, as against COVID-19, would exacerbate this significantly because of the need to navigate between security, investigation, transfer of information and public health. Bringing together policy, legislation and operational delivery across a wide range of complex and specialist areas in this context is key, as is identifying short and long-term issues and interdependencies to frame and solve problems. However, this may be coupled with strategic considerations of interorganisational and intergovernmental politics rather than operational necessities.[159] It may also be complicated by the protracted nature of the incident, like COVID-19, and the need for structures to be flexible to accommodate multiple concurrent strategic risks. Indeed, responding to such outbreaks is a difficult task, one that is inherently political, transcending societies, sectors and agencies.[160]

Coordination challenges have been evident throughout COVID-19, which has, in the view of some, exposed a striking absence of leadership in biosecurity.[161] This has created additional challenges for city leaders in translating grand strategy, legislation and direction into tangible and meaningful actions at a local-level in terms of preparedness and response. Few, if any, governments were fully prepared, and COVID-19 has illuminated significant local, regional and global discrepancies regarding biosecurity.[162]

Preparedness needs to be addressed at all levels. In the case of radiological and nuclear emergencies, the International Atomic Energy Agency would lead the international response. However, there is an absence of a lead agency mandated to coordinate the response to a possible chemical or biological attack at this level.[163] Organisations such as the WHO or the European Centre for Disease Prevention and Control otherwise have a wide-reaching remit across the breadth of communicable (and other) diseases, and consequently can contribute to bioterrorism-prevention activities and knowledge. Mechanisms such as the Global Outbreak Alert Response Network are available to assist with early warnings.[164]

As noted earlier, the geopolitical and legal structures that are in place may help or inhibit the spread of an agent. The strength of public health laws, such as the International Health Regulations (2005) of the WHO,[165,166] public health infrastructure and capacity of public health systems can translate into social impacts that are further influenced by the underlying health and demographics of the targeted or affected populations. This is mirrored at a national level through ensuring appropriate legislation, services and pathways for decision-making and governance.

The success of this is underpinned by investment in public health and emergency response infrastructure, social and economic security, as well as mechanisms for well-informed, transparent and consistent public communications.

> **Public communications are important because accurate and timely messaging can lead to positive behavioural change and save thousands of lives during security crises.[167]**

However, this requires the building and maintenance of trust because trust is considered the primary route to cooperation, and once lost is very hard to regain.[168] The feedback loop provided through public engagement and scrutiny must be viewed as an important tool in driving the performance of strategic leaders.[169]

The ability to create public confidence in the new status quo can make the difference between life and death, breakdown and resilience.[170] Owning the narrative and delivering this effectively to a range of audiences with widely differing needs, views and frames of reference is fundamental. Communications must be evidence-based, rationalised and justified when held to account in a public arena. Actions and decisions must be perceived as reasonable, legitimate and consistent; progress must be visible; and it must also be demonstrated that all is being done to reach solutions as safely, efficiently and effectively as possible. This applies in its own way at a city-level just as it does at the national.

Effective communication is necessary to maintain credibility and navigate how public perception may be shaped by the media and other voices on the political stage. It does not matter that expectations may be misplaced – they are real in their political consequences.[171] Communicating actions and decisions while foreseeing and managing the political consequences is crucial. Communication needs to be done diplomatically, tactfully and in a timely manner. Messages need to be clear, relevant and authoritative, backed by well-informed, evidence-based decisions that have considered all options available. Multiple communication channels are also essential to engage vulnerable and hard-to-reach groups. Only then can the benefits of press releases, formal statements and campaigns, which are inevitably broadcast through mainstream media, truly be harnessed.

Failure to communicate clearly, whether that failure is real or perceived, can cause overwhelming levels of scrutiny and dissatisfaction that is highly damaging for leaders and political administrations at all levels. During COVID-19 many “truths” changed over time as more was known about the virus, and recommendations morphed alongside scientific evidence. Counter-measures like sociallockdowns, for example, decreased when the projected collapse of health care systems did not happen, causing a prevention paradox. With the invisible nature of the threat and its psychological implications, this can fuel the spread of misinformation or a mindset of denial.

In this respect, internal communications are equally important to ensure the safety and welfare of personnel as well as an understanding of an organisation’s strategic direction, associated expectations and how these connect with those of partners and wider societal parameters.

The Operations Department of Munich Police, for example, set up the Coronavirus Control Group with the aim of ensuring the continuity of smooth operations. It was a point of contact for any questions on procedures relating to COVID-19 infections, measures and operational regulations. It served as a coordinating and information-gathering unit and a reporting mechanism for cases of COVID-19 for colleagues within Munich Police.

Organisations needed to invoke business continuity plans, coordinating structures and mechanisms for ensuring staff welfare. In Barcelona, the Fire Prevention, Extinction and Rescue Service included the development of new operational procedures and a training programme for all staff on biothreats.

All these considerations unequivocally apply to bioterrorism, which would have the added complications of time-critical and sensitive counter terrorism operations alongside the increased psychological impact upon society that emerges with malicious acts. This demonstrates the need to ensure that public health and counter terrorism messaging can align.

National arrangements and communications impact upon leadership at regional, local or organisational levels, where leaders must operate within a more granular context in order to protect the public, uphold the law, deliver critical services and manage socio-economic consequences. The layers of governance, infrastructure, systems and services that are intertwined create a nexus of interdependence, just as they do at national and international levels. Although the response to a biothreat requires centralised coordination, public health and security cannot be achieved at one level alone. It requires cross-sector and multi-agency engagement at all levels; the participation and discipline of communities, businesses and service providers; as well as the collective capacities of leadership, communications and law enforcement. National direction requires local implementation and local operations, or city-level complexities, may require national escalation and support.

Ensuring connectivity and alignment between cities, regional authorities and central government is critical for a proactive and complementary response. The importance of enhancing and maintaining links between local and national structures must not be understated. In the response to COVID-19 this has been key, as it would in response to bioterrorism. The biosecurity enterprise is the whole combination of systems at every level of government and the private sector that contribute to protecting nations, cities, and their citizens.

Biosecurity should include bio-surveillance and fusion centres at both national and local levels. These are composed of multi-disciplinary teams that bring together security and public health responses by building teams of synthetic biologists, biotechnology experts, infectious disease experts, public health experts, intelligence experts and counter terrorism experts. They should also include law enforcement, civil protection and operations experts as well as suitably trained urban and transport planners. As biothreats are spread by people in principally urban areas, this additional logistical expertise is essential to working out how to enable necessary, and reduce unnecessary, movement of people and goods.

It is likely that government biosecurity centres at all levels would be modelled after fusion centres such as the UK Joint Terrorism Analysis Centre (JTAC), which "fuses" the combined efforts across different agencies.[172,173,174] The UK government recently established the Joint Biosecurity Centre, which modelled itself using these principles.

This is key to effectively achieving situational awareness (the state of individual and/or collective knowledge relating to past and current events, their implications and potential future developments)[175] and responding to bioterrorism. It also enables joint planning to drive a collective approach towards preparedness and strategic decision-making.

Pooled expertise, resources and infrastructure can be effective at all levels. This requires an open, honest and comprehensive review of national and local structures and how they interrelate, alongside investment in planning, training, arrangements and associated infrastructure.

This would necessitate the comparative development of logistical support and operational capability.

If leaders have the structures in place that enable them to understand quickly and fully the causes, characteristics and consequences of an unfolding crisis, they are more likely to reduce its impact. This has two components: detection (of emerging threats and vulnerabilities) and understanding (of an unfolding crisis).[176] The extraction, management and distilling of information is, of course, a significant challenge that is intensified in dynamic, complex and time-constrained situations such as terrorism or bioterrorism.

The response to COVID-19 has been data-driven on many levels, which required large amounts of information collation and coordination to inform priorities and approaches. COVID-19 is a case in point where the necessary information and data was not always available to authorities (at least at the beginning of the crisis), creating an evidence gap. This is the zone of greatest uncertainty for decision-makers.[177]

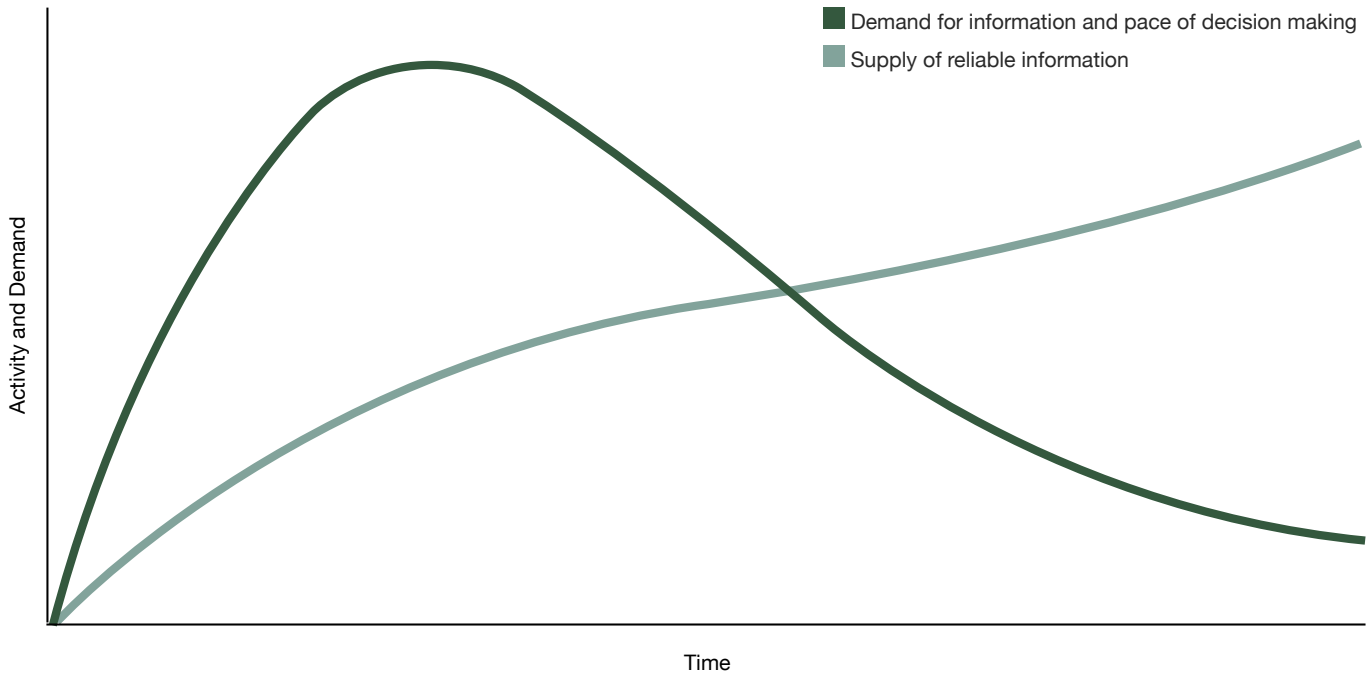
COVID-19 has caused crises within a crisis. Recognising impending crises is what political leaders, policymakers and their systems are expected to do. Separating signals from noise and translating these into tangible priorities is, however, a challenge.[178] It is also subject to circumstance, including the speed of the situation, level of credible information available and capacity to manage the process.

It is reasonable to anticipate similar factors in the context of bioterrorism, albeit in an intensified and more sensitive form.

Decision-making in this context can be difficult, not least because decisions are multi-dimensional; they are likely to contain dilemmas that can only be resolved through trade-offs; involve scarce and critical resources; and they come with major uncertainties and potential implications.[179] In short, they are high pressure and high consequence, further influenced by the peripheral psychological pressures of conformity, groupthink and confirmation bias that add layers of nuance and can derail direction without careful processing. Jointly following decision-making models and taking a proportionate, legal, accountable, necessary and ethical (PLANE) approach towards decisions and actions builds a strong foundation for justification.

Decision-making is based on multiple factors including the information available; impact and scale of the crisis; legislation and plans in place; as well as the knowledge and experience of decision-makers themselves. It follows that strategic decisions may be driven by law and available data. This highlights the importance of structures and mechanisms that facilitate shared situational awareness in order to inform vision, strategy, actions and ownership.

The "Evidence Gap" in Crisis Management



The CTPN report on strategic coordination offered a deeper dive into these considerations, noting the importance of networks, structures and mechanisms. It highlighted the ways in which strategic leadership is particularly important in crisis management to navigate inherently unpredictable, complex and high-impact situations and requires the disciplined calculation of overarching objectives, concepts and resources within acceptable bounds of risk.[180]

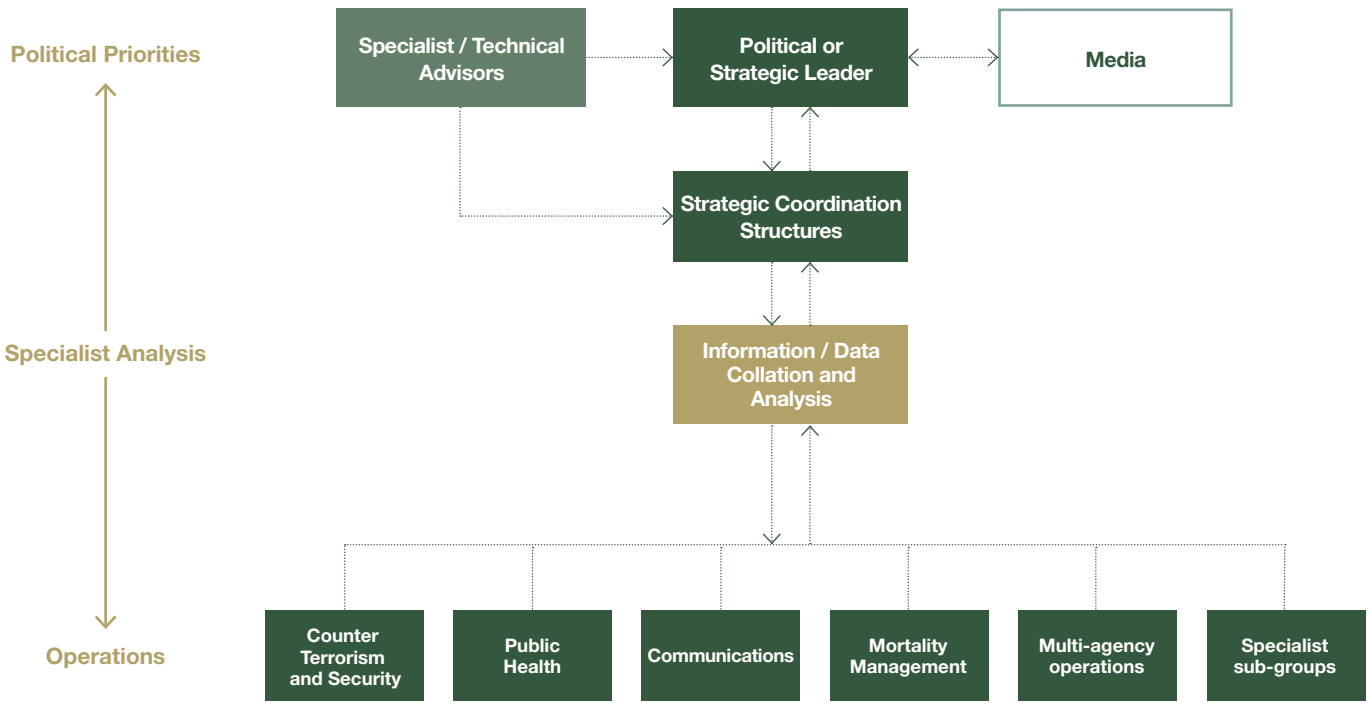
In the context of bioterrorism, the speed at which this needs to be applied would be increased.

It further identified that the success of strategic coordination was often influenced by the level of investment in associated infrastructure; planning, training and exercising; full capability assessments that informed strategic priorities in terms of developing preparedness; and a culture of trust and inclusivity.

> **The importance of partnership working at strategic, tactical and operational levels cannot be underestimated. It is the bond that turns plans into practice.**

This provides a segue into the next section on multi-agency preparedness and public health, where the direction of political and strategic leaders is also necessary to progress this agenda.

Political and Strategic Leadership




History
has its
eyes on
you

CASE STUDY
Montreal's Counter Terrorism Advisory Committee

Montreal's Counter Terrorism Advisory Committee, led by Montreal Police, regularly brings together senior stakeholders from across the police services, emergency medical services, fire department, armed forces, hospitals and public health, as well as transport. Due to the sensitive and strategic nature of the information shared, every member of the committee goes through a security screening process.

The objectives of the group are underpinned by a three-year action plan, which is reported against annually through members' respective chains of command.

The objectives are:

- To enhance the operational preparedness of agencies in relation to terrorist threats, including the development of protocols, response capabilities and procedures, as well as a joined-up approach towards understanding threat levels and field work;
- To establish and maintain strong working relationships and a reliable network that facilitates the exchange of information; provides clarity on partners' responsibilities and area of expertise; and increases collective capacity to purchase equipment;
- To organise both table-top and full-scale simulation exercises to validate protocols, capabilities and interoperability against different scenarios. This is to enable the identification of operational thresholds (e.g. human resources, equipment and capabilities etc.) in order to recognise challenges and find solutions.

Multi-Agency Preparedness and Public Health

Cross-sector and multi-agency preparedness underpins the response to and recovery from any emergency or crisis including pandemics or bioterrorism. It is key to delivering on, and achieving, directions from political and strategic leaders.

> **A cooperative and multi-disciplinary approach that is informed by a well-established layered risk assessment and management structures towards countering biothreats and events is needed to strengthen biosecurity operations.[181]**

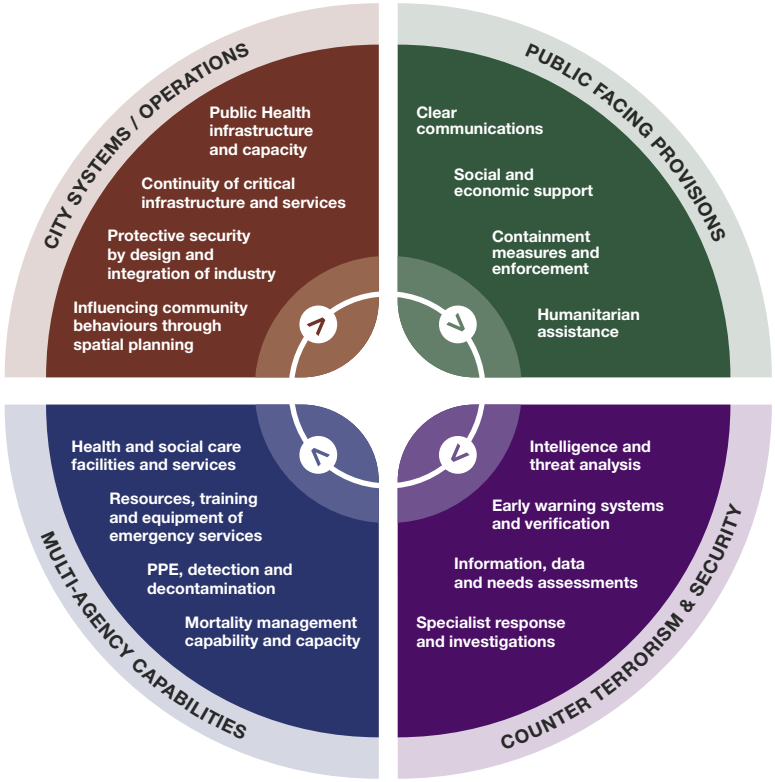
This ranges from ensuring appropriate coordination arrangements, plans and procedures, resources and specialist equipment (e.g. detection, identification and monitoring devices and decontamination units), as well as training and exercising for responders at all levels (operational, tactical and strategic). This may also include greater cooperation in detection and intelligence activities, law enforcement, increased security measures and integrated efforts to counter terrorism, as well as the associated CBRN(e) threats.

CBRN(e) planning is common at international, national and local levels. However, there is a pressing need to increase understanding of the implications and consequences of a bio-attack to inform planning and mitigation measures, response structures and arrangements, as well as longer-term recovery.

Planning should also account for the release of bioagents within health facilities or hospitals, which could significantly impede the response and result in more casualties, fatalities and disruption.

CBRN(e) planning and, in the context of this report, specifically planning for weaponised bioagents, needs to be enhanced. This demands a detailed approach to understand the impacts of various bioagents and how they may play out in different environments. This is necessary to grasp the sometimes-subtle differences in response requirements. This involves the application of lessons from COVID-19 in combination with evidenced-based research and testing of bioagents to develop the planning process and operational capabilities.

Overarching Components of Bioterrorism Preparedness



Building frameworks that bring together counter terrorism and public health structures with those of urban planning and city operations would develop understanding of the bio-preparedness puzzle that needs to connect.

The public environment in which biothreats manifest and spread is also a matter for the design and operation of infrastructure and other operational systems. The bodies and people responsible for these (e.g. transport authorities) need to be integrated into discussions of public health and security. They are key to reducing transmission; a pathogen travels faster on a bus than on its own.

Developing integrated and wider consequence-based planning and arrangements would take this further, as would considering different scenarios and driving these through a comprehensive multi-agency table-top and live exercise programme that incorporates all relevant elements of, and stakeholders for, a bioterrorism and public health response.

The fact that there may be limited prospect of detecting a weaponised bioagent until it has been used in an attack underscores the importance of planning, training and exercising in preparation as well as intelligence-based operational work in prevention.

Intelligence, counter terrorism and law enforcement are critical in prevention, deterrence and bringing offenders to justice. In terms of societal preparedness, however, one of the best defences against biothreats is public health.

This means highly functioning, prepared and responsive public health systems coupled with healthy, highly vaccinated communities.[182] COVID-19 has demonstrated how this demands scrutiny and investment at both national and local levels. Indeed, public health systems cannot predict which virus they will be contending with next and it isn't possible to vaccinate against all biothreats.

If, however, developed public health infrastructure supports capacities to prevent disease, promote health and prepare for crisis, it follows that insufficient public health infrastructure, including healthcare insurance, coupled with the pre-existing conditions of communities, can also make for worse outcomes.[183]

The following two points are, therefore, key:

- Health promotion and health protection go hand-in-hand. Ongoing actions to improve the health of any given population and to strengthen the national health and social care system will decrease the impact of any biothreats that materialise.[184]
- Ensuring robust and resilient healthcare services, hospital and laboratory networks has the dual benefits of readiness in the face of malicious bio-attacks while ensuring an ability to respond to naturally occurring diseases.

Preparedness must therefore drive the public health agenda and incentivise investment in equal access to healthcare. COVID-19 has shown that the people who have been hit the hardest are those with underlying health conditions. Likewise, it has demonstrated that highly specialist health capabilities are required, including epidemiology and microbiology capabilities in order to identify, characterise and respond to the disease; bespoke hospital and intensive care units to treat patients; surge capacity in terms of the wider health system, including the delivery of care in the community; and the development of vaccines and antivirals. The need to erect and resource additional temporary facilities (such as field hospitals and mortuaries) and procure personal protective equipment has provided further challenges. It is far more difficult to react in a time-pressured, politically sensitive environment against a backdrop of significant global demand than it is to respond with proportionate and appropriate preparedness measures in place.

This takes into account the fact that optimal public health is unrealistic, and communities cannot be vaccinated against everything. Robust readiness in healthcare structures, capability, capacity and wider societal systems is fundamental to responding successfully to biothreats, whether natural or malicious, as well as wider demands. Like the need to enhance CBRN(e) planning noted above, there is a clear need to enhance pandemic planning. The two, in terms of biothreats, should be hand-in-glove. This should include detail such as the mapping of hospital and laboratory networks as well as specialist resources in order to understand system capacity and to identify gaps.

Specialist CBRN(e) capabilities are available to varying degrees nationally or within the emergency services. The national CBRN(e) response unit in the Netherlands, for example, also includes mobile – and therefore deployable – laboratories for terrorist attacks. This is for the analysis of objects suspected of containing chemical and/or biological substances and is of biosafety level three specification. The unit is completely self-supporting and integrates different disciplines, enabling significant time-savings to be made in the analysis of an agent.

Infrastructure is the foundation for planning, delivering, evaluating and improving public health. This has been evidenced by a wide range of disparities in health outcomes, raising serious questions around health equality.[185,186,187,188] The success of public health critically depends on the level of cooperation, coordination and investment at the local and national levels,[189] as well as by public authorities and communities themselves. It further relies upon interoperability and early-warning mechanisms. The early identification and assessment of outbreaks with informed public health assessments and modelling that quickly harnesses science, data, experience and expertise through embedded systems and ways of working can provide a central mechanism to fast-track an appropriate response. A bioterrorism response strategy is therefore critical.

CASE STUDY
Bioterrorism Response Strategy

Most cities have some form of CBRN(e) strategic response plan in place, which sets out the command and control structures, response framework and levels of specialist and technical support available, as well as the role and responsibilities of responding agencies.

The City of Boston's strategy includes stakeholders from all levels of government (local, state and federal) and leans heavily on the expertise and responsibilities of public health, emergency services, law enforcement and intelligence agencies.

Coordination for the city strategy falls under the responsibility of Boston's Office of Emergency Management, managed through subcommittees. Funding is supported by the Department of Homeland Security and its Urban Areas Security Initiative. The medical surge subcommittee agreed that sustained investment in dedicated first responder pharmaceutical stockpiles (antivirals and antibiotics, not vaccines) was essential. Sustaining this cache was considered vital to the region's state of preparedness and response operations.

Boston Emergency Medical Service established a protocol that allowed for the timely delivery of supplies to partners immediately following an incident. This project sustains the level of supplies, allowing for the procurement of any pharmaceuticals that will expire and acquiring pharmaceuticals or supplies of protective equipment that become recommended for CBRN(e) incidents.

In response to COVID-19, partners across Greater Manchester came together to support communities and businesses during a complex, sustained and systemic emergency. The city provided a system-wide, multi-agency response that is transferrable to other biothreats. This included:

- The collation, analysis and dissemination of complex data and intelligence, coordinated via a multi-agency data and intelligence cell, to support decision-making;
- Clear political leadership via the COVID-19 Emergency Committee, which included the 10 Greater Manchester political leaders and the Greater Manchester Mayor;
- The use of a multi-agency communications cell to communicate with the public;
- The provision of advice coordinated via a scientific and technical advice cell to help determine risks to public health and outline potential mitigation measures.

CASE STUDY
Intelligence and Early Warning in Boston

The Boston Regional Intelligence Center is a major fusion centre, managed by Boston Police Department and staffed by sworn investigators, civilian intelligence analysts and liaisons from close partner agencies.

Its mission is to reduce crime and prevent acts of terrorism by serving as the central point for the collection, synthesis, analysis and dissemination of strategic and tactical intelligence to law enforcement, intelligence, first responder and private sector partners, and to assist the federal government as a partner for national security.

Liaisons include a medical intelligence analyst who has access to the electronic patient care reporting system, which allows them to monitor unusual spikes in symptoms and notify public safety partners of important trends. The medical intelligence analyst is responsible for liaising with the broader public health community and representing the centre in stakeholder groups and public safety networks responsible for informing and coordinating the city's response to CBRN(e) agents and other health security threats.

Intelligence and early-warning systems are paramount to an effective bioterrorism response. The City of Boston also partners with the Department of Homeland Security's (DHS) Countering Weapons of Mass Destruction Office, among other federal partners. This is to detect, analyse, investigate and mitigate the effects of biothreats through participation in the BioWatch Programme. BioWatch is managed by DHS, supported by other federal agencies and operated by a network of scientists, laboratory technicians, emergency managers, law enforcement officers and public health officials.

The combination of detection, rapid notification, preparedness and planning helps local, state and federal decision-makers take steps to save lives and mitigate damage. The programme provides early warning through accurate detection of biothreats via a network of air-monitoring collectors strategically placed throughout the city. Air samples are routinely processed and analysed by technicians for evidence of bioagents. If a biothreat is identified in an air sample, a notification system will alert local, state and federal subject-matter experts and leadership, who will analyse the threat and evaluate the risk to the community. Boston's BioWatch programme has included a variety of training and exercises to improve plans and procedures related to bioterrorism.

DHS also funded the Securing the Cities Programme that sought to reduce the risk of a successful deployment of a radiological/nuclear terrorist weapon against a major metropolitan area in the United States by establishing sustainable capabilities to detect, analyse, and report nuclear and other radioactive materials.[190,191] A similar approach could be applied to biothreats.

Interoperability between security and public health is critical to managing biothreats. Often operating at local, regional and national levels, healthcare providers have a key role in treatment, preservation of life and navigating the psychosocial impacts upon individuals. State regulation over health is needed to strengthen supply chains and/or domestic infrastructure at all levels (for protective equipment and medical supplies etc.), as well as the flexibility in capacity and expertise to rapidly scale up the development of state-sponsored (rather than market-driven) vaccines. This, of course, opens the debate on the costly stockpiling and storage of supplies versus the risk of ordering supplies as required.

Either way, ensuring health is centrally regulated, funded and coordinated would also reduce the risk of counterfeit medicine, test kits and supplies, which intensify pharmaceutical and supply chain vulnerability. It is worth mentioning that poorer nations and states may not have the funding to develop their own treatments or vaccines. Instead, they might have to wait for generics to be available, the cost of branded products to fall or donor organisations (such as the WHO) to provide supplies. Even within developed countries or cities there can be a disproportionality of access to care or vaccines when offered, with indications of initial lower uptake in some of the more deprived areas and in some minority groups. This expands the inequalities mentioned previously and could fuel the far-right agenda.

Conversely, the vaccine-production process may also create a strategic national security advantage for those that develop it first. It is no surprise, therefore, that

> **some commentators have gone as far as recommending that governments reclassify pandemic countermeasures as a matter of national security in order to enable investment in collective biosecurity.[192]**

When the similarities in consequence management for pandemics and bioterrorism are considered, in many ways this makes sense. In a very real way, end-to-end sovereign vaccine manufacture has featured in discussions around the COVID-19 vaccine and relations between the EU and the UK, following the end of the Brexit transition period.

Experience shows that the label attributed to a crisis (e.g. pandemic or terrorism) normally decides the responsibility for, and therefore the shape of, any given response. However, both pandemics and bioterrorism can have vast and overlapping response and public health implications. They also have extensive implications for infrastructure design and city operations. Therefore, pooling approaches, where feasible, for preparedness and biosecurity would enable the consideration of a more collaborative and comprehensive approach. This is a key point because efficiencies may also be created to offset investments. This goes beyond security and public health, demanding input and expertise from wider partners and academia.

Preparedness must embrace existing and potential opportunities to collaborate and better understand biothreats. This includes a deeper analysis of how pathogens or agents move, react on different surfaces and spread among people. This can subsequently inform multi-agency arrangements as well as city planning and policy, which should integrate industry into the development of counter-measures and prevention solutions. An example would be to review technological solutions such as dry hydrogen peroxide, which could dramatically reduce the spread of pathogens in enclosed facilities. Dry hydrogen peroxide can be extremely effective in microbial reduction by diffusing through the air.

This should further incorporate investment in and support for scientifically based research, the development and delivery of training and a coordinated approach at all levels. It follows that collaboration between public health and local authority partners also needs to be amplified. COVID-19 offers a platform to identify how healthcare systems and the delivery of health and social care services can be improved. It provides stimulus to reconsider shared preparedness measures, such as supplies of protective equipment, and practices to enhance joint operational approaches when the system is under significant pressure.

This is, of course, non-exhaustive and subject to arrangements within the host country, region and city. It is also subject to a local analysis of what worked during COVID-19 and what did not, as well as consultation with the relevant public health leaders and subject-matter experts. It is clear, however, that a full review of infrastructure, systems and services is necessary in order to enhance public health capacity and achieve a fuller understanding of how it would cope with any future pandemic or bio-attack. Public health and security will be the locus of a bioterrorism response, which spans responsibilities at national, city and local levels.

CASE STUDY
Clean Active Ventilation Environment

The CAVE (Clean Active Ventilation Environment) facility is being designed, in response to COVID-19, as a specialised large and controlled interior space in which the effect of air handling on people's health and wellbeing can be studied.

Hosted by University College London to complement its PEARL (Person-Environment-Activity Research Laboratory) initiative, CAVE can directly measure aspects of air quality; the presence and movement of viruses and other small particles within the airstream; the effects on people of different ventilation strategies; and the effects on people of different room shapes, door and window locations and presence or absence of interrupters to air flow (such as internal barriers or objects within the space) that may influence the movement of air.

CAVE is being equipped to study the interactions between exterior and interior environments and can reconstruct a wide range of life-size interior spaces, such as a communal office or waiting room, a clinical surgery, a stairwell or corridor, an airport security channel, public transport, terraced housing and a theatre or venue etc. The facility offers the versatility and ability to separate and independently control internal and external climatic conditions, including temperature and humidity; direction and volume of air movement within the interior space (for example ceiling-to-floor, floor-to-ceiling, laterally through different vents, windows or doors, or combinations of these); simulation of external environmental conditions (not including direct wind effects); and the variable filtration of air supply and recirculation.

CAVE is expected to open towards the end of 2021 to enable the assessment of:

- The movement, resilience and viability of pathogens within the space under different conditions, including the collection of samples for subsequent analysis.

This could include benign viruses or bioagents in order to gain a deeper understanding that informs preparedness for naturally occurring diseases and bioterrorism (note: the CAVE will include a sample handling, preparation and containerisation space, which will be at category biosafety level one incorporating a level two cabinet);

- The responses of people to the different conditions and constraints being applied, including factors such as the ingress of smoke or gases. The facilitation of different "rules of engagement" (for example, direction of movement or physical distancing). Using advanced physiological measures, this would support analyses of behavioural tendencies to inform decisions on the design and operation of internal public spaces.

There are many stakeholders in resilience and preparedness. They interact with each other and are mutually interdependent. Government functions may operate at a national level (e.g. defence and security) but others may be delivered locally (e.g. policing) or may rely on local authorities to supplement them. Some public services are both national and local (the UK's National Health Service is one) and others have policy set at a national level but with most of delivery being decentralised. Then, from a counter terrorism perspective, there may be local, national and international structures.[193]

Major infrastructure services are also of note. Transport, water and energy may be delivered by private entities but are subject to varying degrees of regulation. Other public necessities like food retail are entirely commercial, with some regulations set nationally but enforced locally. All these infrastructure services are characterised by their interface with the general public – both collectively and individually. A holistic view of this landscape is necessary to understand linkages, set priorities for action and enhance preparedness. This would in turn inform policy and arrangements at all levels and reduce the likelihood of failures and crises being propagated from one domain to another with unexpected consequences.[194]

It is already accepted that, in some cases, cities are working within systems and structures that are degenerative or operating beyond their design thresholds.

This increases the likelihood of systemic disruptions and their scale, intensity and duration. This highlights the need to think carefully about properly maintaining, repairing and enhancing city infrastructure so that it operates appropriately and smoothly with the people who use it under adverse circumstances.[195]

> **The development of appropriate infrastructure that is future-proof must become part of the preparedness agenda. Not only will it contribute to city operations and economic prosperity, but it also has the potential to significantly reduce the impact of a range of risks and threats, including public health crisis and bioterrorism.**

The United Nations report on making critical infrastructure resilient takes this further.[196]

This is about taking a long-term and holistic view of preparedness. This means thinking about how the world will be in 10–20 years and beyond, and what this will mean for people and the cities in which they live and work – not just in terms of modernisation and managing population growth, but also in terms of protecting against a range of risks and threats. Investing in appropriate infrastructure that is future-proof; enhancing the resources and capabilities of emergency services; and starting to shift the frame within which communities view threats in order to positively influence behaviour are fundamental. The future has already arrived and cities across the world risk falling behind a dangerous curve.

Informing and Influencing Community Behaviours

Societies, public health organisations and institutions constantly seek new ways to reduce exposure to biothreats. In the UK, well-known communication campaigns such as "Catch It, Bin It, Kill It", and recently "Hands, Face, Space" or "Stay Home, Protect the NHS, Save Lives" have sought to highlight risks and influence public behaviour. Combined with signs, barriers and protective equipment at a street level, these essentially become behaviour-modification programmes with an emphasis on hygiene and sanitation.

Mechanisms of management can range from hand-washing to highly complex vaccines, medical treatments, protective clothing and environmental (air and water) filtering,[197] but their success often hinges on changing how populations perceive the risk, behave in response and subsequently interact with their environment. It also relates back to the degree of confidence the public has in the organisations advising them what to do.

This has most recently been witnessed in the response to COVID-19, where behaviour change through social distancing and other interventions such as isolation have come with huge cost to individuals and societies.[198,199] The application of the Behaviour Change Wheel has been used to identify options to promote social distancing and shielding of vulnerable people, including use of education, persuasion, incentivisation, coercion and enablement.[200] Influencing behaviour, however, has proved difficult in practice. "Social distancing", for example has been a contradiction in terms. Whereas physical distancing means staying a minimum distance away from other people, social distancing implies that people can still come together. If these are confused in their use by officialdom, this extends to the public. People instinctively (and subconsciously) judge the distance they are from another person in social terms, hence the difficulty in maintaining the desired physical distance. Add in layers of constantly changing directives, narratives, mixed messaging and group dynamics, perceptions of risk can quickly become misinformed and diluted.

Perceptions of risk and crises are subject to culture and can be distorted by a range of psychological predispositions and cognitive biases that influence how people think and behave in different situations. This distortion is fuelled by a phenomenon called "availability bias", whereby examples of things that come readily to mind are considered more representative than is actually the case. This means, however, that it can also cause complacency through the "It won't happen to me" mindset. Another source is "optimism bias", which is the tendency to regard ourselves as more capable than we are and therefore, to be overly confident in our ability to cope if the risk does materialise.

Further is "prevent bias", which makes it harder to form sound judgements about how much effort to invest in preventing or preparing for any given crisis.

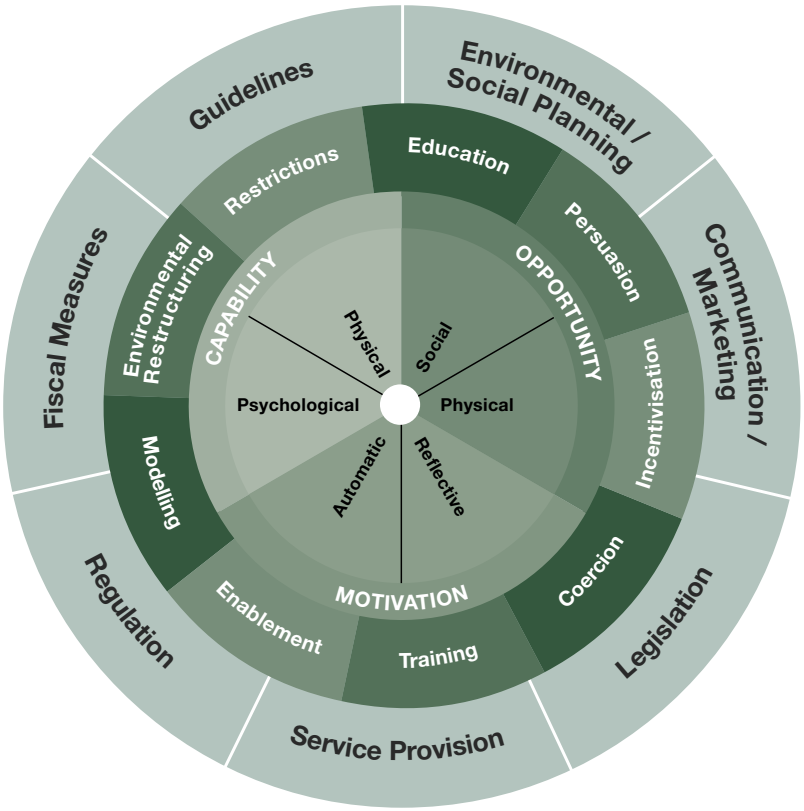
This relates to the inability to understand how risk accumulates over time as people repeatedly expose themselves to the same relatively small risk. For example, the risk of dying in a single car journey or from smoking a single cigarette is tiny, but the cumulative risk from a lifetime of car journeys or smoking is surprisingly large.[201] This is demonstrated further by insufficient preparedness for COVID-19, or the snowballing climate change crisis, and translates to terrorism through the layers of political instability, polarised ideologies, conflict and inequality that manifest globally.

The public behavioural response to extreme events is often mixed.[202] This may be exacerbated in the context of bioterrorism. Exposure or perceived exposure to bioagents, or any CBRN(e) agents, is psychologically demanding because it's involuntary and unfamiliar and has unknown health effects. In general, the long-term implications for children and future generations may also be unknown, which increases public fear and anxiety.

It is recognised that CBRN(e) agents can cause death and injury in strange and prolonged ways,[203] and the psychosocial implications of this cannot be overstated.

Risk communication, perception and behaviour have been emphasised as foundations of effective national security. Risk perceptions influence the psychological and behavioural responses that impact the health, social and economic impacts of extreme events. Some behaviours, such as the adoption of hand- and respiratory-hygiene advice during an infectious disease outbreak like COVID-19, will only have a minor impact on day-to-day life. Others have the potential to have powerful negative impacts. If a small percentage of the population change their behaviour(s) this can shift the demands on the system in quite a large way. This highlights the need for the development of resilient, adaptable response plans and procedures built upon a strong understanding of the relationship between risk communication, perception and behaviour.[204] Enabling active contributions from communities should be part of this.

Behaviour Change Wheel



To change perceptions of risk and influence public behaviour, awareness and understanding need to be raised and consequences realised to infiltrate the collective muscle memory of society.

The role of the public as both a target for terrorism and as an actor in emergency management is particularly relevant in the context of bioterrorism and wider CBRN(e) terrorism. In this respect it has been shown how counter terrorism policies need to include measures that educate and improve the resilience of societies and communities in order to enable them to respond and adapt in instances where preventative measures fail to stop an attack.[205] Mindsets need to be shifted towards personal security, health and hygiene, which can be influenced not only by communications but also through urban design.

Communicable diseases spread because of specific interactions between hosts (the victims), agents (the diseases) and the environment (the conditions that affect the potency of the disease, the ability to fight it and the routes by which diseases are maintained and transmitted among victims).[206] This would also apply to a number of weaponised bioagents.

By designing city spaces, enhancing infrastructure and integrating technological solutions, the behaviours and actions of individuals and societies could be influenced to reduce the spread of biothreats.

Taking a progressive and innovative approach towards informing and influencing community behaviour is necessary against the backdrop of population growth, urbanisation and the evolving threat landscape.

Three headline areas are proposed:
1) shifting the public perception of risk;
2) developing city infrastructure;
3) urban design and spatial planning.

1

COVID-19 must serve as a springboard to create the social structures and fabric that support a collective mindset of health and security. Enabling understanding and influencing the perception of risk through widespread public awareness, education and communication campaigns, as well as innovative mechanisms for warning and informing (for example, signage, mobile apps, alerting systems and online platforms) are key.

Risk communication by public authorities before, during and after such crises may significantly influence their impact. Well-designed and well-timed messages can reduce the uncertainties surrounding the nature, exposure and consequences of particular agents, as well as provide effective behavioural guidance to the public.[207] This is not about designing a culture of security- and health-conscious behaviours, rather it's about proactively providing a framework through which such a culture can emerge.[208]

2

Developing city infrastructure can assist in future-proofing urban environments by serving as force multipliers in terms of city resilience and reducing the impact of biothreats. Consider modern air-conditioning systems that enable the control and filtering of airflow to improve air movement and quality; non-touch facilities (for example lavatories, basins and automated doors) to improve hygiene and sanitation; design of functional systems, and the incorporation of technology such as automated barriers in busy urban areas (such as transport hubs) to reduce crowds and the associated terrorist threat, as well as the likelihood of a pathogen spreading between individuals.

Ticketless services/barriers, for example, are significant because they affect the speed at which people can move through an area, thus reducing density. Such solutions can be integrated into the implementation of long-term transport infrastructure strategies for both transport hubs and the transportation network itself.[209] These types of developments have the potential to reduce multiple threats while enhancing city operations through the upgrading of infrastructure.

3

Urban design and spatial planning can complement this further. By understanding how individuals interact with their environment and each other, and how pedestrians are likely to move through city spaces, the risks associated with densely populated and high-footfall areas (both as targets for terrorism and as vectors for the spread of bioagents) can be reduced.

These dynamics are interconnected with several other fields, including engineering, architecture and sociopsychology, and are becoming increasingly prominent factors in city security. Understanding the psychosocial and institutional factors that explain emotional, cognitive and behavioural responses to biothreats and attacks is essential to enhancing the resilience of the public against bioterrorism.[210]

CASE STUDY
Person Environment Activity Research Laboratory

PEARL (Person-Environment-Activity Research Laboratory) is located at University College London and enables the detailed research of how people interact with their environment. It is a multisensory facility in which any given physical environment (such as an underground station or busy urban area) can be reconstructed inside the building as required.

The walls of PEARL are pierced with 175 million tiny holes to reduce the average reverberation time to less than one second. This enables the creation of soundscapes ranging from a quiet rural or urban space at night to a rock concert, an aircraft taking off nearby or an explosion.

It has an advanced lighting and sound system that can simulate different scenes or environments. The smoke system allows visibility to be altered to replicate fog or smoke; the configurable floor can be set up with different surfaces, gradients and topographies; and an olfaction system can reproduce environmental smells (including cordite, burning flesh, wood smoke, coffee etc.). PEARL can replicate various environments and scenarios – the only facility in the world designed specifically to do this at life scale.

This enables the analysis of people's responses using a range of sensors. These include tracking of eyes and neurological processes, electrodermal activity sensors, heart-rate monitors, oxygen-use monitors and physical motion.

The findings can subsequently inform the design and implementation of infrastructure systems in and between cities. They could also inform the decision-making and responses of emergency services to a terrorist attack, for example, and approaches taken towards influencing both individual and community behaviours.

Employing evidence-based methods to influence urban design and spatial planning needs to go far beyond the traditional approaches of security by design or the management of crowds (in which the density of people is assumed to be high enough to cause continuous interactions, or reactions, with other individuals)[211] in a busy city centre. Rather it should be understood as influencing public behaviour through innovative urban design and spatial planning that incorporates the analyses of individual and crowd interactions and movements with the disciplines of neuroscience, sociopsychology, public health and protective security. The principle here is that

> **the holistic modelling of urban spaces can influence individual and crowd movements and subsequently add an additional layer to increase safety and security.**

The key is to create an environment that manages and channels people's choice of direction, actions and behaviours through its design and aesthetic influence. It is about understanding how people think; the factors that influence their decisions; and then identifying and creating cues that will positively alter that process in order to dilute the risk or impacts of any given threat.[212] This is done by minimising the numbers of people moving through an area at any one time (or identifying the optimal number of people that can move through an area at any one time given the prevailing circumstances); dispersing or diluting crowds to reduce the density; and providing multiple points of access and egress to increase flow.[213]

> **Such approaches can also align with the smart cities agenda by seeking to integrate technology with infrastructure and spatial planning in such a way that could reduce the spread and transmission of a biothreat.**

Cities that develop strategic arrangements and explore policy design and implementation in an integrated manner can use this as a lever in developing resilience against terrorism and public health crises. This is a core principle of the Counter Terrorism Preparedness Network.

In this respect, otherwise costly security measures are more financially viable and seen as an investment if they are embedded into longer-term strategies, such as those relating to the development of infrastructure.[214] Herein is the force multiplier effect, harnessed to strike a healthy balance between safety, security and service as part of long-term city development, regeneration and resilience strategies. The importance of this approach cannot be overstated. In a post-COVID environment, financial viability will underpin all investments. These security measures, therefore, must be holistic and integrated to bring a multitude of benefits.

There is significant scope to streamline and enhance approaches and priorities at a city-policy level. In order to make cities safer, city administrations need to adapt rapidly to new developments in order to respond better to current and future challenges. Harnessing initiatives such as PEARL, can inform approaches through evidence-based research.

Understanding how individuals interact with their environments, group dynamics and, by extension, public behaviours, city systems can be adapted and designed in such a way that significantly builds resilience. A deeper understanding of how bioagents move in different environments and contexts, are transmitted among people and evolve over time can also be applied in such a way that informs the development of infrastructure, city spaces and how public behaviour is influenced. This must be done in tandem with investments in leadership, multi-agency preparedness and public health.

5 Conclusion

> **“Never before has a new world order had to be assembled from so many different perceptions, or on so global a scale. Nor has any previous order had to combine the attributes of the historic balance-of-power systems with global democratic opinion and the exploding technology of the contemporary period.”**
>
> Henry Kissinger[215]

The quote to the left, referring to the wake of the Cold War, is just as true and relevant today. Beyond the immediate human tragedy of the COVID-19 pandemic, economies around the world have ground to a halt, supply chains are destabilised and the cost to governments, businesses and taxpayers will be multiples of what preventive global public health policies would have cost.[216] Furthermore, the disruption to routine public health programmes (such as childhood vaccinations and water, sanitation and hygiene programmes) could secondarily lead to otherwise avoidable harm in some countries. The impact on international security and terrorism is also evident but yet to be fully understood.

This report has brought together the natural phenomenon of COVID-19 with potential terrorist methodologies to consider how bioterrorism could materialise. Inspiration for attacks often comes from what is viewed as effective and available. Therefore, this type of horizon scanning is critical if cities and authorities are to be ahead of the threat.

Global strategic trends are pushing cities towards a significantly more automated world, where new technologies are fusing the physical, digital and biological. The cost of developing bioweapons is likely to fall and advances in genetics and biosciences have increased the risk of their use through new delivery mechanisms that make detection hard.[217]

It has been noted how the economic and social instability arising from COVID-19 has been capitalised upon by terrorists of all forms, who have been able to recognise the destructive power that can be wrought as a result of a global health emergency.[218]

The point, however, is not to overplay the intent or capability of terrorists to develop bioweapons after COVID-19. Bioterrorism is generally considered to be a relatively low-likelihood, high-impact threat (i.e. a relatively improbable event that could have a disproportionately large impact). After all, biothreats are not new and terrorists have simpler, more accessible options at their disposal.

However, bioterrorism has been recognised as a very real threat by international institutions and intelligence networks, and is acknowledged within strategies and risk registers at all levels. Biothreats are becoming increasingly complicated and dangerous. This is coupled with the vulnerabilities illustrated by COVID-19 and global strategic trends, which indicate that many nations and cities may not be sufficiently equipped to handle a bio-attack.

It is therefore necessary to strengthen preventive measures and organise a coordinated response to biothreats and their impacts.[219] It is the duty of the state and its authorities to do so as part of the social contract between the citizen and the state.[220] At the most strategic of levels this must include the intensification of the global counter terrorism effort and consideration of how critical public health capabilities might be prepared and scaled up ahead of time.[221]

The state should also conduct threat assessments and ensure the development of associated strategy[222] that is subsequently shared with relevant actors including city authorities. To be successful however,

> **biosecurity strategy must be sure to integrate traditional threats with those posed by public health crises, to avoid cracks emerging between two governance systems.[223]**

Although there are many overlaps between international, national and local structures in both preparedness and response for public health crises and bioterrorism, it follows that strategies are only worthwhile if they are translated into meaningful actions and operationalised at the local level. Prominence has been given to the role of local multi-agency emergency-planning apparatus on the basis that the response to, and recovery from, an emergency is carried out first and foremost at the local level. It has been highlighted, however, that there can be distinctly uneven levels of resilience and limited capacity across different areas.[224]

Therefore, it is important to understand the vulnerabilities, interdependencies and gaps that must be addressed locally, and how strategy can be translated into practice through a clear, action-orientated plan. Cities are critical building blocks for the successful implementation of grand strategy, highlighted by this report through four overarching areas:

1. **The need to understand causality and consequence. Overall preparedness requires a holistic view of how everything connects and interacts.[225] This translates to cities, which are themselves systems of systems, as a precursor for city resilience.**
2. **The need to incorporate the principles of public health, protective security and social psychology into the infrastructure development and regeneration plans of cities.**
3. **The need for greater strategic and operational integration between public health, security agencies and urban planning at a city-level, coupled with health security intelligence arrangements that incorporate effective early-warning mechanisms.**
4. **The need to develop city-level capabilities in support of strategic leadership, multi-agency arrangements and preparedness, as well as mechanisms to inform and influence public behaviours, particularly in times of crisis.**

In this respect, city administrations and authorities wield significant influence. Cities have a duty to prepare for crises, protect their citizens and safeguard their economies (they account for approximately 80% of global gross domestic product).[226] Urbanisation means that cities will continue to face significant challenges and may become more of a focal point for terrorist activity[227] after COVID-19. Cities must therefore rethink how they plan, build and use their environment,[228] and how preparedness and capabilities can be enhanced.

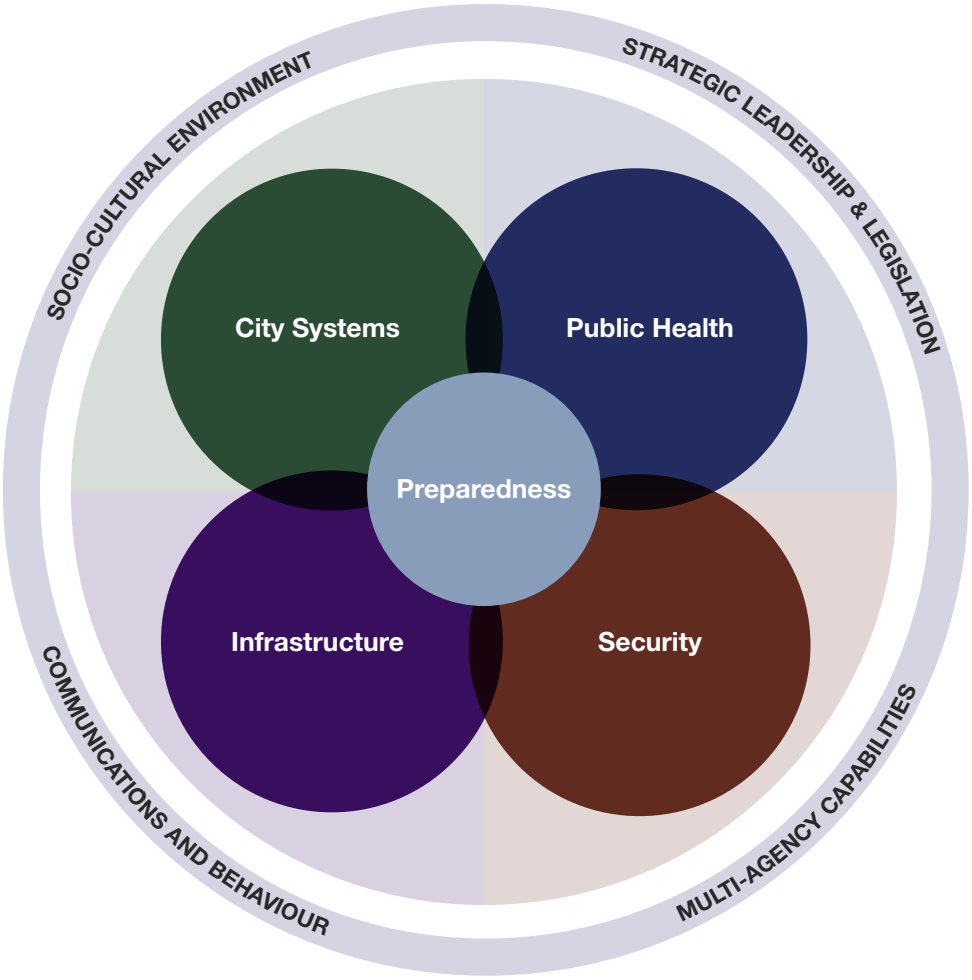
Counter terrorism in this context demands the two-pronged approach of security and development – one requires the other. A comprehensive approach towards security must be accompanied by a developmental strategy that seeks to address political, economic and social issues, both their root causes and system vulnerabilities. A flexible and action-orientated approach, whereby disincentives for terrorism (the rule of law) are combined with social incentives (a life that's worth protecting), is also key to facilitating change. In this sense, a core strength of the city approach is the knowledge and ability to reach and connect with local communities, as well as vulnerable or harder-to-reach groups.

Preparedness for public health crises will inevitably raise capabilities for bioterrorism preparedness and vice versa.

These threats must be considered and planned for in an integrated and simultaneous manner. This principle is the foundation of this report. It has explored the differences between naturally occurring diseases and weaponised bioagents; reviewed the threat of bioterrorism; analysed the vulnerabilities demonstrated by COVID-19 and considered these in the context of a bio-attack to propose a series of recommendations for city authorities.

Ultimately, the core challenge is whether allied networks of counter terrorism, public health, urban planning and resilience professionals can intervene in terrorist efforts, enhance security, and develop the infrastructure, capacity and arrangements of cities to better prepare for and respond to such in the future. To do so, cities must reframe their approaches and weave together initiatives that drive transformative change. This requires consistent cross-sector partnerships at all levels, and a collaborative and action-orientated approach that continually adapts to new realities. The big risk for cities is not adapting, or not adapting fast enough.[229]

The Bio-Preparedness Puzzle




METROPOLITAN
POLICE
© GLA

Recommendations

Note: This is an international report designed for an international audience. It is anticipated and accepted that different recommendations will apply to different cities and organisations subject to context, existing arrangements and any public inquiries.

It is also acknowledged that, at the time of publication, COVID-19 is ongoing, and the full extent of impacts and implications are not yet fully realised. Therefore, these recommendations are non-exhaustive and further scrutiny and insight is required.

1	Cities should consider commissioning or undertaking a review of city-system vulnerabilities through a contextualised and holistic analysis of interdependencies that enables the development of an integrated action plan to be overseen at a strategic level. This should seek to identify and map system risks, pinch points or priority areas that can feed into longer-term city resilience and regeneration strategies.
2	Cities should harness the expertise and facilities of academic partners to undertake evidence-based research and exercises that can inform city policy and urban design. These should include how public health considerations and protective security can be incorporated into city regeneration and infrastructure plans to build preparedness.
3	Cities should consider establishing multi-disciplinary teams that bring together agencies and specialists to drive bio-preparedness and inform decisions and actions in response.
4	Cities should review strategic arrangements to incorporate local lessons from COVID-19 and consider these in the context of bioterrorism to inform any further structural developments or mechanisms that may be required. Also consider reviewing the strategic arrangements of cities/countries that have performed relatively well during the pandemic.
5	Cities should seek to enhance communication and collaboration channels between local and national levels in terms of preparedness, information sharing and response structures. This can vary greatly from country to country and city to city.
6	Cities should connect with national colleagues to review strategic communication plans and mechanisms to include processes for joint public health and counter terrorism messaging.

7	National and local communication leads should consider risk communication and public advice during COVID-19 and how this was perceived. This is with a view to integrating these lessons into	communication campaigns and mechanisms for warning and informing the public in the event of either public health crises or bioterrorism.
8	Cities should develop a high-level framework that consolidates and provides an overview of the counter terrorism, public	health, city operations and communication structures or mechanisms that need to connect to affect a bioterrorism response.
9	Cities should review and develop local CBRN(e) and pandemic plans to consider and apply lessons from COVID-19 in the context of bioterrorism and public health. The importance of engaging and cooperating with the private sector,	especially in the context of bioterrorism, regarding water supplies (scenario of water poisoning) and food retail/supermarkets (scenario of food poisoning) etc. should be noted.
10	Cities should review mass fatality and excess deaths frameworks and capture the operational procedures for establishing	temporary field hospitals and mortuaries to create scalable plans. Consider how these may apply in the context of bioterrorism.
11	Public health and local authority partners should consider opportunities to enhance healthcare systems, the delivery of health	and social care services and the availability of protective equipment, especially when the system is under significant pressure.
12	City administrations and lead agencies should ensure the delivery of a multi-agency table-top and live exercise	programme that incorporates all relevant elements of a bioterrorism response for all levels (strategic, tactical, operational).
13	Cities should continue to share lessons, experiences and practices via existing networks in order to inform the development of arrangements and	infrastructure that will build city-level preparedness and resilience to public health crises and bioterrorism.

6 References

1. United Nations (2020). 'COVID-19 Threatening Global Peace and Security, UN Chief Warns'. (Accessed online.)

2. Pope, A. (2020). 'Mitigating Disasters in a Fractured World', Crisis Response Journal, 15(1), pp. 16-19.

3. Collins, B. (2020). 'Strategic Issues: A Discussion Paper', National Preparedness Commission, p. 4. (Accessed online.)

4. Joint Committee on the National Security Strategy (2020). 'Bio-Security and National Security, First Report of Session 2019-21', House of Commons, p. 3. (Accessed online.).

5. Global Health Security Index (2019). John Hopkins Centre for Health Security, p. 12. (Accessed online.)

6. Collins, B. (2020). 'Strategic Issues: A Discussion Paper', National Preparedness Commission, p. 4. (Accessed online.)

7. Joint Committee on the National Security Strategy (2020). 'Bio-Security and National Security, First Report of Session 2019-21' House of Commons, p. 10. (Accessed online.)

8. Ibid, p. 48.

9. Cruickshank, P. (2020). 'Covid-19 and Counterterrorism', CTCSENTINEL, 13(6). (Accessed online.)

10. European Commission (2020). 'A Counter-Terrorism Agenda for the EU: Anticipate, Prevent, Protect, Respond'. p. 11. (Accessed online.)

11. Currie, C., Denigan-Macauley, M. (2020). 'National Biodefense Strategy: Opportunities and Challenges with Early Implementation', United States Government Accountability Office, p. 1. (Accessed online.)

12. Coppola, D. International Disaster Management (Oxford: Elsevier, 2015), p. 93.

13. Ibid, p. 133.

14. London Resilience (2018). 'Pandemic Influenza Framework, Version 7.0'.

15. London Resilience (2019). 'CBRN(e) Framework, Version 3.1'.

16. Coppola, D. (2015). International Disaster Management (Oxford: Elsevier, 2015).

17. Martin, P., and Giddings, J. (2020). 'Building Better Resilience', National Preparedness Commission, pp. 16-18. (Accessed online.)

18. Centre for Disease Control and Prevention (2019). '2009 H1N1 Pandemic'. Accessed Online.

19. Dawood, F., Luliano, D., Reed, C. et al. (2012). 'Estimated Global Mortality Associated With the First 12 Months of 2009 Pandemic Influenza A H1N1 Virus Circulation: a Modelling Study, The Lancet, 12(9), pp. 687-695. (Accessed online.)

20. World Health Organisation (2020). 'Ebola Then and Now: Eight Lessons from West Africa That Were Applied in the Democratic Republic of the Congo'. (Accessed online.)

21. Boin, A., Hart, P., Stern, E., et al. The Politics of Crisis Management: Public Leadership Under Pressure, (Cambridge: Cambridge University Press, 2017), p. 31.

22. Center for Disease Control and Prevention (2004). 'Public Health Guidance for Community-Level Preparedness and Response to Severe Acute Respiratory Syndrome (SARS)'. (Accessed online.)

23. Coppola, D. (2015). International Disaster Management (Oxford: Elsevier, 2015), p. 93.

24. Pescaroli, G., Alexander, D. (2018). 'Understanding Compound, Interconnected, Interacting, and Cascading Risks: A Holistic Framework', Society for Risk Analysis, p. 2.

25. Townsend-Drake, A. (2020). 'Counter-terrorism in Cities: A Whole-System Approach', Crisis Response Journal, 15(1), pp. 94-95.

26. United Nations Office for Counter Terrorism (2017). 'Ensuring Effective Interagency Interoperability and Coordinated Communication in Case of Chemical and/or Biological Attacks', p. 3. (Accessed online.)

27. Patterson, K., Runge, T. (2002). 'Smallpox and the Native American', American Journal of the Medical Sciences, (April). pp. 216-22. (Accessed online.)

28. Frischknecht, F., (2003). 'The History of Biological Warfare: Human Experimentation, Modern Nightmares and Lone Madmen in the Twentieth Century', EMBO reports, 4(S1), pp. 47-52.

29. Ibid.

30. Thwaite, J., Atkins, H. 'Bacillus: Anthrax; Food Poisoning', Medical Microbiology (18th Edition). Edited by D. Greenwood, M. Barer, R. Slack, W. Irving (Churchill Livingstone, 2012), pp. 237-244.

31. Meselson, M., Guillemin, J., Hugh-Jones, M., et al. (1994). 'The Sverdlovsk Anthrax Outbreak of 1979', Science. (Accessed online.)

32. Frischknecht, F., (2003). 'The History of Biological Warfare', pp. 47-52.

33. Carus, Seth W., (2017). 'A Short History of Biological Warfare: From Pre-History to the 21st Century', Center for the Study of Weapons of Mass Destruction. p. 2.

34. Federation of American Scientists (2011). 'Biowarfare Against Agriculture'. (Accessed online.)

35. World Organisation for Animal Health (2021). 'Eradication Isn't the End of the Rinderpest Story: OIE and FAO Launch Global Action Plan to Keep the World Free of Deadly Cattle Plague. (Accessed online.)

36. Federation of American Scientists (2011). 'Biowarfare Against Agriculture'.

37. Nuclear Threat Initiative (2015).' The Biological Threat: Germs Don't Respect Borders, so Biological Threats – Manmade and Naturally Occurring – Can Quickly Have Global Impacts. (Accessed online).

38. Ackerman, G.,Jacome, M. (2018). 'WMD Terrorism: The Once and Future Threat', PRISM, 7(3). (Accessed online.)

39. Stockhammer, N. (2020). 'COVID-19: Is Bioterrorism on the Rise Now?', European Institute for Counter-Terrorism and Conflict Prevention Policy Brief. (Accessed online.)

40. Peters, A. (2018). 'The Global Proliferation of High-Containment Biological Laboratories: Understanding the Phenomenon and its Implications', Scientific and Technical Review Journal, 37(3), pp. 857-883.

41. Joint Committee on the National Security Strategy (2020). 'Bio-Security and National Security, First Report of Session 2019-21', House of Commons, p. 46. (Accessed online.)

42. Baptista, E., Lew, L., McCarthy, S. et al. (2020). 'The Labs Where Monsters Live', South China Morning Post. (Accessed online.)

43. Ibid.

44. Annan, K. 'Non-Proliferation and Disarmament: Two Sides of a Coin', We the Peoples: A UN for the 21st Century 2014 (United States: Paradigm Publishers, 2006), p. 111.

45. Lauren, P., Craig, G., George, A. Force and Statecraft: Diplomatic Challenges of Our Time (Fourth Edition) (Oxford: Oxford University Press, 2007), p. 275.

46. Rózsa, L., Nixdorff, K. 'Biological Weapons in Non-Soviet Warsaw Pact Countries', Deadly Cultures: Biological Weapons Since 1945. Edited by M. Wheelis, L. Rózsa and M. Dando (Cambridge: Harvard University Press, 2006), pp. 157-168.

47. Perez, M. (2002). 'The Anthrax Attacks 10 Years Later', Annals of Internal Medicine, 156(41-55), pp. 13.

48. McCallum, K. 'MI5 Director General Top Priorities and the Current Threat Landscape', MI5 Secret Service, 14 October 2020. (Accessed online.)

49. Townsend-Drake, A. (2016). 'Civil Protection in an Age of Hyper-Terrorism', Crisis Response Journal, 12(1), pp.56-57.

50. Keen, D. Complex Emergencies (Cambridge: Polity Press, 2008), p. 12.

51. Coppola, D. International Disaster Management (Oxford: Elsevier, 2015). p. 130.

52. INTERPOL (no date). 'Bioterrorism'. (Accessed online.)

53. World Health Organisation (no date). 'Biological Weapons'. (Accessed online.)

54. Joint Committee on the National Security Strategy (2020). 'Bio-Security and National Security, First Report of Session 2019-21'. House of Commons, p. 16. (Accessed online.)

55. Center for Disease Control and Prevention (2018). 'Bioterrorism Agents/Diseases'. (Accessed online.)

56. Kaszeta, D. (2020). 'No, the Coronavirus Is Not a Biological Weapon', Washington Post. (Accessed online.)

57. World Health Organisation (no date). 'Biological Weapons'. (Accessed online.)

58. World Health Organisation (2018). 'Anthrax Fact Sheet'. (Accessed online.)

59. World Health Organisation (2018). 'Botulism Fact Sheet'. (Accessed online.)

60. World Health Organisation (2017). 'Plague Fact Sheet'. (Accessed online.)

61. World Health Organisation (2014). 'Smallpox Fact Sheet'. (Accessed online.)

62. World Health Organisation (2014). 'Ebola Fact Sheet'. (Accessed online.)

63. Beeching, N., Dance, D., Miller, A. (2002). 'Biological Warfare and Bioterrorism', Clinical Review, BMJ 324, pp. 337-338.

64. Lauren, P., Craig, G., George, A. Force and Statecraft: Diplomatic Challenges of Our Time (Fourth Edition) (Oxford: Oxford University Press, 2007), p. 116.

65. United Nations Office for Counter Terrorism (2017). 'Ensuring Effective Interagency Interoperability and Coordinated Communication in Case of Chemical and/or Biological Attacks', p. 3. (Accessed online.)

66. Lauren, P., Craig, G., George, A. Force and Statecraft: Diplomatic Challenges of Our Time (Fourth Edition) (Oxford: Oxford University Press, 2006), p. 120.

67. Cruickshank, P., Rassler, D. (2020). 'A View from the CT Foxhole: A Virtual Roundtable on COVID-19 and Counterterrorism with Audrey Kurth Cronin, Lieutenant General (Ret) Michael Nagata, Magnus Ranstorp, Ali Soufan, and Juan Zarate', CTCSENTINEL, 13(6), p. 4. (Accessed online.)

68. Institute for Economics & Peace (2020). 'Global Terrorism Index 2020: Measuring the Impact of Terrorism', Sydney, p.5. (Accessed online.)

69. INTERPOL (2020), 'INTERPOL and UN Launch Initiative on CBRN(e) Terror Threats'. (Accessed online.)

70. The Council of Europe (2020). 'The Council of Europe Continues Working to Enhance International Co-operation Against Terrorism, Including Bioterrorism'. (Accessed online.)

71. Krieger, K., Brooke Rogers, M. 'Promoting Public Resilience Against Chemical, Biological, Radiological and Nuclear Terrorism', Strategic Intelligence Management. Edited by B. Akhgar and S. Yates (Amsterdam, Netherlands: Butterworth-Heinemann, 2013), p. 83.

72. Takahashi, H., Keim, P., Kaufmann A, et al. (2014). 'Bacillus Anthracis Incident, Kameido, Tokyo, 1993', Historical Review, 10(1), p. 117.

73. Shwartz, M. (2001). 'Biological Warfare: An Emerging Threat in the 21st Century', Stanford News Service. (Accessed online.)

74. Cordesman, A., Burke, A. (2001). 'Asymmetric and Terrorist Attacks with Biological Weapons', Center for Strategic and International Studies. Washington DC. (Accessed online.)

75. Kaszeta, D. (2016). 'Decontamination of Buildings after an Anthrax Attack', Journal of Terrorism and Cyber Insurance, 1(1), pp. 47-60.

76. Europol (2020). 'European Union Terrorism Situation and Trend Report 2020', p. 21. (Accessed online.)

77. Warmbrod, K. L., Revill, J., Connell. N. (2020). 'Advances in Science and Technology in the Life Sciences: Implications for Biosecurity and Arms Control'. Geneva, Switzerland, p. 5.

78. Europol (2020). 'European Union Terrorism Situation and Trend Report 2020', p. 21. (Accessed online.)

79. Sagan, S., Waltz, K. The Spread of Nuclear Weapons: An Enduring Debate (Third Edition) (New York: W.W. Norton & Company, 2013), p. 117.

80. Ackerman, G.,Jacome, M. (2018). 'WMD Terrorism: The Once and Future Threat', PRISM, 7(3). (Accessed online.)

6 References
continued

81. Walsh, P. (2020). 'Rethinking Bioterrorism Post COVID-19', Global Network on Extremism and Technology. (Accessed online.)

82. Stockhammer, N. (2020). 'COVID-19: Is Bioterrorism on the Rise Now?', European Institute for Counter-Terrorism and Conflict Prevention Policy Brief. (Accessed online.)

83. BBC (2021). 'Hacker Tries to Poison Water Supply of Florida City'. (Accessed online.)

84. United Nations Security Council Counter-Terrorism Committee Executive Directorate (June 2020). 'The Impact of the COVID-19 Pandemic on Terrorism, Counter-Terrorism and Countering Violent Extremism'. (Accessed online.)

85. United Nations Security Council Counter-Terrorism Committee Executive Directorate (June 2020). 'The Impact of the COVID-19 Pandemic on Terrorism, Counter-Terrorism and Countering Violent Extremism'. (Accessed online.)

86. Townsend-Drake, A. (2016). 'Civil Protection in an Age of Hyper-Terrorism', Crisis Response Journal, 12(1), pp. 56-57.

87. Silke, A. (2020). 'COVID-19 and Terrorism: Assessing the Short- and Long-Term Impacts', Pool Re. (Accessed online.)

88. Ibid.

89. United Nations Security Council Counter-Terrorism Committee Executive Directorate (June 2020). 'The Impact of the COVID-19 Pandemic on Terrorism, Counter-Terrorism and Countering Violent Extremism'. (Accessed online.)

90. Ibid.

91. UN Security Council CTED (2020). 'Trend Alert: Member States Concerned by the Growing and Increasingly Transnational Threat of Extreme Right-Wing Terrorism'. (Accessed online.)

92. Cruickshank, P., Rassler, D. (2020). 'A View from the CT Foxhole: A Virtual Roundtable on COVID-19 and Counterterrorism with Audrey Kurth Cronin, Lieutenant General (Ret) Michael Nagata, Magnus Ranstorp, Ali Soufan, and Juan Zarate', CTCSENTINEL, 13(6), p. 3. (Accessed online.)

93. Stock, J. (2020). 'INTERPOL Secretary General – Terrorist Groups Using COVID-19 to Reinforce Power and Influence'. INTERPOL (December 2020). (Accessed online.)

94. Institute for Economics & Peace (2020). 'Global Terrorism Index 2020: Measuring the Impact of Terrorism'. Sydney, pp. 5-12. (Accessed online.)

95. NATO (2020). 'NATO 2030, United for a New Era', p. 32. (Accessed online.)

96. Institute for Economics & Peace (2020). 'Global Terrorism Index 2020: Measuring the Impact of Terrorism'. Sydney, pp. 5-12. (Accessed online.)

97. Europol (2020). 'European Union Terrorism Situation and Trend Report 2020', p. 11. (Accessed online.)

98. Sabbagh, D., Grierson, J. (2020). 'UK Terror Threat Upgraded to Severe After France and Austria Attacks', The Guardian. (Accessed online.)

99. McCallum, K. (2020). 'MI5 Director General Top Priorities and the Current Threat Landscape', MI5 Secret Service, 14 October 2020. (Accessed online.)

100. Europol (2019). 'European Union Terrorism Situation and Trend Report 2019', p. 4. (Accessed online.)

101. BBC (2019). 'Australian Brothers Guilty of IS Plane Bomb Plot'. (Accessed online.)

102. Laurens, G., Lenssen, M., Townsend-Drake, A., Coaffee, J. (2019). 'Protecting Major Events and Crowded Places', Counter Terrorism Preparedness Network, p. 31..

103. Flade, F. (2018). 'The June 2018 Cologne Ricin Plot: A New Threshold in Jihadi Bio Terror', CTCSENTINEL, 11(7). (Accessed online.)

104. European Centre for Disease Prevention and Control (2017). 'RAPID RISK ASSESSMENT: Risk Related to the Use of 'Do-It-Yourself' CRISPR-associated Gene Engineering Kit Contaminated with Pathogenic Bacteria'. (Accessed online.)

105. World Health Organisation (no date). 'Biological Weapons'. (Accessed online.)

106. INTERPOL (no date). 'Bioterrorism'. (Accessed online.)

107. UK Ministry of Defence (2018). 'Global Strategic Trends: The Future Starts Today' (Sixth Edition), p.138. (Accessed online.)

108. Beeching, N., Dance, D., Miller, A. (2002). 'Biological Warfare and Bioterrorism', Clinical Review, BMJ, 324, p. 336.

109. Joint Committee on the National Security Strategy (2020). 'Bio-Security and National Security, First Report of Session 2019-21', House of Commons, p.47. (Accessed online.)

110. Wheelis, M., Casagrande, R., Madden, L. (2002). 'Biological Attack on Agriculture: Low-Tech, High-Impact Bioterrorism', BioScience, 52(7), pp. 569–576. (Accessed online.)

111. Federation of American Scientists (2011). 'The Threat of Agro-Terrorism'. (Accessed online.)

112. Federal Bureau of Intelligence (2008). 'Criminal Investigation Handbook for Agroterrorism'. (Accessed online.)

113. Federation of American Scientists (2011). 'The Threat of Agro-Terrorism'. (Accessed online.)

114. World Health Organisation (2017). 'One Health'. (Accessed online.)

115. Ibid.

116. Center for Disease Control and Prevention (2018). 'Bioterrorism Agents/Diseases'. (Accessed online.)

117. Thompson, D.K., et al. (2003). 'Economic Costs of the Foot and Mouth Disease Outbreak in the United Kingdom in 2001', Revue scientifique et technique (International Office of Epizootics), (21), pp.675-87.

118. World Health Organisation (2020). 'SARS-CoV-2 Mink-Associated Variant Strain – Denmark'. (Accessed online.)

119. McLeod, A., Morgan, N., Prakash, A. (no date). 'Economic and Social Impacts of Avian Influenza', Food and Agricultural Organisation. (Accessed online.)

120. Mueller, S. (2019). 'Are Market GM Plants an Unrecognized Platform for Bioterrorism and Biocrime?', Frontiers in Bioengineering and Technology. (Accessed online.)

121. Roffey, R., Tegnell, A.,, Elgh, F. (2002). 'Biological Warfare in a Historical Perspective'. Clinical Microbiology and Infection. 8(8), pp. 450-454. (Accessed online.)

122 Coppola, D. International Disaster Management (Oxford: Elsevier, 2015), p. 135.

123. Collins, B. (2020). 'Strategic Issues: A Discussion Paper', National Preparedness Commission, p. 6. (Accessed online.)

124. Ibid.

125. Silke, A. (2020). 'COVID-19 and Terrorism: Assessing the Short- and Long-Term Impacts', Pool Re. (Accessed online.)

126. UK Ministry of Defence (2018). 'Global Strategic Trends: The Future Starts Today' (Sixth Edition), p. 141. (Accessed online.)

127. Warmbrod. K. L., Revill. J., Connell. N. (2020). 'Advances in Science and Technology in the Life Sciences: Implications for Biosecurity and Arms Control'. Geneva, Switzerland.

128. GAO (2017). 'Biodefense: Federal Efforts to Develop Biological Threat Awareness', United States Government Accountability Office. (Accessed online.)

129. Warmbrod, K. L., Revill, J., Connell. N. (2020). 'Advances in Science and Technology in the Life Sciences: Implications for Biosecurity and Arms Control'. Geneva, Switzerland.

130. Koblentz, G. (2020). 'Emerging Technologies and the Future of CBRN Terrorism,' The Washington Quarterly, 43(2), pp. 177-196. (Accessed online.)

131. European Commission (2020). 'A Counter-Terrorism Agenda for the EU: Anticipate, Prevent, Protect, Respond'. p. 3. (Accessed online.)

132. UK Ministry of Defence (2018). 'Global Strategic Trends: The Future Starts Today' (Sixth Edition), p. 143. (Accessed online.)

133. European Commission (2020). 'A Counter-Terrorism Agenda for the EU: Anticipate, Prevent, Protect, Respond'. p. 5. (Accessed online.)

134. Laurens, G., Lenssen, M., Townsend-Drake, A., Coaffee, J. (2019). 'Protecting Major Events and Crowded Places', Counter Terrorism Preparedness Network, p. 31.

135. Beeching, N., Dance, D., Miller, A. (2002). 'Biological Warfare and Bioterrorism', Clinical Review, BMJ, 324, p. 336.

136. INTERPOL (2018). 'International Experts Meet on Potential Threat Posed by New Technologies'. (Accessed online.)

137. INTERPOL (no date). 'Bioterrorism: Capacity Building and Training'. (Accessed online.)

138. INTERPOL (2020). 'INTERPOL and UN Launch Initiative on C8RN(e) Terror Threats'. (Accessed online.)

139. INTERPOL (2018). 'International Experts Meet on Potential Threat Posed by New Technologies'. (Accessed online.)

140. NATO (2020). 'NATO 2030, United for a New Era', p. 32. (Accessed online.)

141. Cruickshank, P., Rassler, D. (2020). 'A View from the CT Foxhole: A Virtual Roundtable on COVID-19 and Counterterrorism with Audrey Kurth Cronin, Lieutenant General (Ret) Michael Nagata, Magnus Ranstorp, Ali Soufan, and Juan Zarate', CTCSENTINEL, 13(6), p. 3. (Accessed online.)

142. Ibid.

143. Collins, B. (2020). 'Strategic Issues: A Discussion Paper', National Preparedness Commission, p. 4. (Accessed online.)

144. Cruickshank, P., Rassler, D. (2020). 'A View from the CT Foxhole: A Virtual Roundtable on COVID-19 and Counterterrorism with Audrey Kurth Cronin, Lieutenant General (Ret) Michael Nagata, Magnus Ranstorp, Ali Soufan, and Juan Zarate', CTCSENTINEL, 13(6), p. 5. (Accessed online.)

145. The Rockefeller Foundation (2014). 'City Resilience Framework', p. 3. (Accessed online.)

146. United Nations (2020). 'Policy Brief: COVID-19 in an Urban World', pp. 2-4. (Accessed online.)

147. Pescaroli, G., Alexander, D. (2018). 'Understanding Compound, Interconnected, Interacting, and Cascading Risks: A Holistic Framework', Society for Risk Analysis, pp. 1-6.

148. Martin, P., Giddings, J. (2020). 'Building Better Resilience', National Preparedness Commission, p. 16. (Accessed online.)

149. United Nations (2020). 'Comprehensive Response to COVID-19: Saving Lives, Protecting Societies, Recovering Better'. (Accessed online.)

150. Tardy, T. (2020). 'COVID-19: Shaping Future Threats and Security Policies', COVID-19: NATO in the Age of Pandemics. Edited by T. Tardy, NATO Defence College. Rome. Issue 9. pp. 14-15. (Accessed online.)

151. Cook, R., Penzini, S. 'How Covid-19 Unveils the Systemic Nature of Risks', Crisis Response Journal, 15(4), pp. 12-13.

152. Beeching, N., Dance, D., Miller, A. (2002). 'Biological Warfare and Bioterrorism', Clinical Review, BMJ, 324, p. 338.

153. Iftimie, I. A. (2020). 'The Implications of COVID-19 for NATO's Counter-Bioterrorism', COVID-19: NATO in the Age of Pandemics. Edited by T. Tardy, NATO Defence College. Rome. Issue 9. pp.51-59. (Accessed online.)

154. UK Scientific Advisory Group for Emergencies (2020). 'Public Disorder and Public Health – Contemporary Threats and Risks', prepared by Scientific Pandemic Influenza Group on Behaviours (SPI-B), policing and security sub-group. (Accessed online.)

155. Boin, A., Hart, P., and Stern, E., et al. (2017). The Politics of Crisis Management: Public Leadership Under Pressure (Cambridge: Cambridge University Press, 2017), pp. 3-12.

156. Ibid, p. 71.

157.Ibid, p. 63.

158. UK Ministry of Defence (2018). 'Global Strategic Trends: The Future Starts Today' (Sixth Edition), p. 3. (Accessed online.)

159. Boin, A., Hart, P., Stern, E., et al. (2017). The Politics of Crisis Management: Public Leadership Under Pressure (Cambridge: Cambridge University Press, 2017), p. 39.

160. Coppola, D. International Disaster Management (Oxford: Elsevier, 2015), pp. 94-95.

161. Joint Committee on the National Security Strategy (2020). 'Bio-Security and National Security, First Report of Session 2019-21', House of Commons, p. 3. (Accessed online.)

162. Ibid, p. 8.

163. United Nations Office for Counter Terrorism (2017). 'Ensuring Effective Interagency Interoperability and Coordinated Communication in Case of Chemical and/or Biological Attacks', p. 3. (Accessed online.)

164. Ibid p. 14.

165. Andrus, J.K., Aguilera, X., Oliva, O., Aldighieri, S. (2010). 'Global Health Security and International Health Regulations', BMC Public Health 10. (Accessed online.)

166. World Health Organisation (no date). 'International Health Regulations'. (Accessed online.)

167. Joint Committee on the National Security Strategy (2020). 'Bio-Security and National Security, First Report of Session 2019-21', House of Commons, p. 21. (Accessed online.)

168. Rogers, B., Pearce, J. (2013). 'Risk Communication, Risk Perception and Behaviour as Foundations of Effective National Security Practices', Strategic Intelligence Management. Edited by B. Akhgar and S. Yates (Amsterdam: Butterworth-Heinemann, 2013), p. 70.

169. Krieger, K., Brooke Rogers, M. 'Promoting Public Resilience against Chemical, Biological, Radiological and Nuclear Terrorism', Strategic Intelligence Management. Edited by B. Akhgar and S.Yates (Amsterdam: Butterworth-Heinemann, 2013), p. 82.

170. Boin, A., Hart, P., Stern, E., et al. (2017). The Politics of Crisis Management: Public Leadership Under Pressure (Cambridge: Cambridge University Press, 2017), p. 3.

171. Ibid, p.13.

172. Cruickshank, P., Rassler, D. (2020). 'A View from the CT Foxhole: A Virtual Roundtable on COVID-19 and Counterterrorism with Audrey Kurth Cronin, Lieutenant General (Ret) Michael Nagata, Magnus Ranstorp, Ali Soufan, and Juan Zarate', CTCSENTINEL, 13(6), p. 3. (Accessed online.)

173. United States Department for Justice (2011). 'Health Security: Public Health and Medical Integration for Fusion Centers'. (Accessed online)

174. National Bio-Surveillance Integration Center (2012). 'Strategic Plan', United States Department for Homeland Security. (Accessed online.)

175. Slettenmark Slettenmark, O., Fetz, M., Townsend-Drake, A., Moffett, H., Therrien, M.C. (2019). 'Strategic Coordination', Counter Terrorism Preparedness Network, p. 18.

176. Boin, A., Hart, P., Stern, E., et al. (2017). The Politics of Crisis Management: Public Leadership Under Pressure (Cambridge: Cambridge University Press, 2017), p. 23.

177. MacFarlane, R., Leigh, M. (2014). 'Information Management and Shared Situational Awareness', Emergency Planning College, p. 6. (Accessed online.)

178. Boin, A., Hart, P., Stern, E., et al. (2017). The Politics of Crisis Management: Public Leadership Under Pressure (Cambridge: Cambridge University Press, 2017), p. 44.

179. Ibid, p. 51.

180. Slettenmark, O., Fetz, M., Townsend-Drake, A., Moffett, H., Therrien, M.C. (2019). 'Strategic Coordination', Counter Terrorism Preparedness Network, pp. 13-16.

181. White House (2018). 'National Biodefense Strategy', p. 8. (Accessed online.)

182. Joint Committee on the National Security Strategy (2020). 'Bio-Security and National Security, First Report of Session 2019-21', House of Commons, p. 33. (Accessed online.)

183. Office of Disease Prevention and Health Promotion (2020). 'Public Health Infrastructure'. (Accessed online.)

184. Joint Committee on the National Security Strategy (2020). 'Bio-Security and National Security, First Report of Session 2019-21', House of Commons, p. 35. (Accessed online.)

185. Azar, K.M., Shen, Z., Romanelli, R.J., et al. (2020). 'Disparities in Outcomes Among COVID-19 Patients in A Large Health Care System in California', Health Affairs, 39(7).

186. Ssentongo, P., Ssentongo, A.E., Heilbrunn, E.S., et al. (2020). 'Association of Cardiovascular Disease and 10 Other Pre-existing Comorbidities with COVID-19 Mortality: A Systematic Review and Meta-analysis', Plos One, (15)8.

187. Karagiannidis, C., Mostert, C., Hentschker, C., et al. (2020). 'Case Characteristics, Resource Use, and Outcomes of 10,021 Patients with COVID-19 Admitted to 920 German Hospitals: An Observational Study', The Lancet Respiratory Medicine, 8(9), pp. 853-862.

188. Shadmi, E., Chen, Y., Dourado, I. et al. (2020). 'Health Equity and COVID-19: Global Perspectives', International Journal for Equity in Health, 19(1), pp. 1-16.

189. Nascimento, D. (2020). 'Vaccine Investment as a National Security Matter', Forbes. (Accessed online.)

190. Homeland Security and Emergency Management Agency (no date). 'Securing the Cities Program'. (Accessed online.)

191. Laurens, G., Lenssen, M., Townsend-Drake, A., Coaffee, J. (2019). 'Protecting Major Events and Crowded Places', Counter Terrorism Preparedness Network, p. 32.

192. Nascimento, D. (2020). 'Vaccine Investment as a National Security Matter', Forbes. (Accessed online.)

193. Collins, B. (2020). 'Strategic Issues: A Discussion Paper', National Preparedness Commission, pp. 8-9. (Accessed online.)

194. Ibid.

195. UKCRIC (2020). 'Rethinking Infrastructure and Cities for a Covid-19 World: A UKCRIC Prospectus', pp. 1-9. (Accessed online.)

196. Panda, A., Ramos, N. (2020). 'Making Critical Infrastructure Resilient: Ensuring Continuity of Service – Policy and Regulations in Europe and Central Asia'. United Nations Office for Disaster Risk Reduction. (Accessed online.)

197. Coppola, D. International Disaster Management (Oxford: Elsevier, 2015), pp. 94-95.

198. West, R., Michie, S., Rubin, G.R., Amlôt, R. (2020). 'Applying Principles of Behaviour Change to Reduce SARS-CoV-2 Transmission', Nature Human Behaviour, pp. 451-459. (Accessed online.)

199. Michie, S., West, R., Rogers, M.B., et al. (2020). 'Reducing SARS-CoV-2 Transmission in the UK: A Behavioural Science Approach to Identifying Options for Increasing Adherence to Social Distancing and Shielding Vulnerable People', British Journal of Health Psychology, 25(4), pp. 945-956. (Accessed online.)

200. Michie, S., van Stralen, M.M., West, R. (2011). 'The Behaviour Change Wheel: A New Method for Characterising and Designing Behaviour Change Interventions', Implementation Science, 6, Article 42.

201. Martin, P., Giddings, J. (2020). 'Building Better Resilience', National Preparedness Commission, pp. 10-12. (Accessed online.)

202. Rogers, B., Pearce, J. 'Risk Communication, Risk Perception and Behaviour as Foundations of Effective National Security Practices', Strategic Intelligence Management. Edited by B. Akhgar and S. Yates (Amsterdam: Butterworth-Heinemann, 2013), p. 82.

203. Krieger, K., Brooke Rogers, M. 'Promoting Public Resilience against Chemical, Biological, Radiological and Nuclear Terrorism', Strategic Intelligence Management. Edited by B. Akhgar and S. Yates (Amsterdam: Butterworth-Heinemann, 2013), p. 81.

204. Rogers, B., Pearce, J. 'Risk Communication, Risk Perception and Behaviour as Foundations of Effective National Security Practices', Strategic Intelligence Management. Edited by B. Akhgar and S. Yates (Amsterdam: Butterworth-Heinemann, 2013), pp. 66-71.

205. Krieger, K., Brooke Rogers, M. 'Promoting Public Resilience against Chemical, Biological, Radiological and Nuclear Terrorism', Strategic Intelligence Management. Edited by B. Akhgar and S. Yates (Amsterdam: Butterworth-Heinemann, 2013), pp. 75-78.

206. Coppola, D. International Disaster Management (Oxford: Elsevier, 2015), p. 352.

207. Krieger, K., Brooke Rogers, M. 'Promoting Public Resilience against Chemical, Biological, Radiological and Nuclear Terrorism', Strategic Intelligence Management. Edited by B. Akhgar and S. Yates (Amsterdam: Butterworth-Heinemann, 2013), p. 83.

208. Martin, P., Giddings, J. (2020). 'Building Better Resilience', National Preparedness Commission, p. 17. (Accessed online.)

209. Laurens, G., Lenssen, M., Townsend-Drake, A., Coaffee, J. (2019). 'Protecting Major Events and Crowded Places', Counter Terrorism Preparedness Network, p. 29.

210. Krieger, K., Brooke Rogers, M. 'Promoting Public Resilience against Chemical, Biological, Radiological and Nuclear Terrorism', Strategic Intelligence Management. Edited by B. Akhgar and S.Yates (Amsterdam: Butterworth-Heinemann, 2013), p. 79.

211. Laurens, G., Lenssen, M., Townsend-Drake, A., Coaffee, J. (2019). 'Protecting Major Events and Crowded Places', Counter Terrorism Preparedness Network, p. 28.

212. Ibid, pp. 19-22.

213. Townsend-Drake, A. (2020). 'Counter-terrorism in Cities: A Whole-System Approach', Crisis Response Journal (15)1, pp. 94-95.

214. Laurens, G., Lenssen, M., Townsend-Drake, A., Coaffee, J. (2019). 'Protecting Major Events and Crowded Places', Counter Terrorism Preparedness Network, p. 29.

215. Lauren, P., Craig, G., George, A. Force and Statecraft: Diplomatic Challenges of Our Time (Fourth Edition) (Oxford: Oxford University Press, 2007), p. 111.

216. Nascimento, D. (2020). 'Vaccine Investment as a National Security Matter', Forbes. (Accessed online.)

217. UK Ministry of Defence (2018). 'Global Strategic Trends: The Future Starts Today' (Sixth Edition), pp. 13-18. (Accessed online.)

218. Walsh, P. (2020). 'Rethinking Bioterrorism Post COVID-19', Global Network on Extremism and Technology. (Accessed online.)

219. The Council of Europe (2020). 'The Council of Europe Continues Working to Enhance International Co-operation Against Terrorism, Including Bioterrorism'. (Accessed online.)

220. Collins, B. (2020). 'Strategic Issues: A Discussion Paper', National Preparedness Commission, p. 4. (Accessed online.)

221. Joint Committee on the National Security Strategy (2020). 'Bio-Security and National Security, First Report of Session 2019-21', House of Commons, p. 19. (Accessed online.)

222. HM Government (2018). 'UK Biological Security Strategy'. (Accessed online.)

223. Joint Committee on the National Security Strategy (2020). 'Bio-Security and National Security, First Report of Session 2019-21', House of Commons, p. 40. (Accessed online.)

224. Ibid, p. 28.

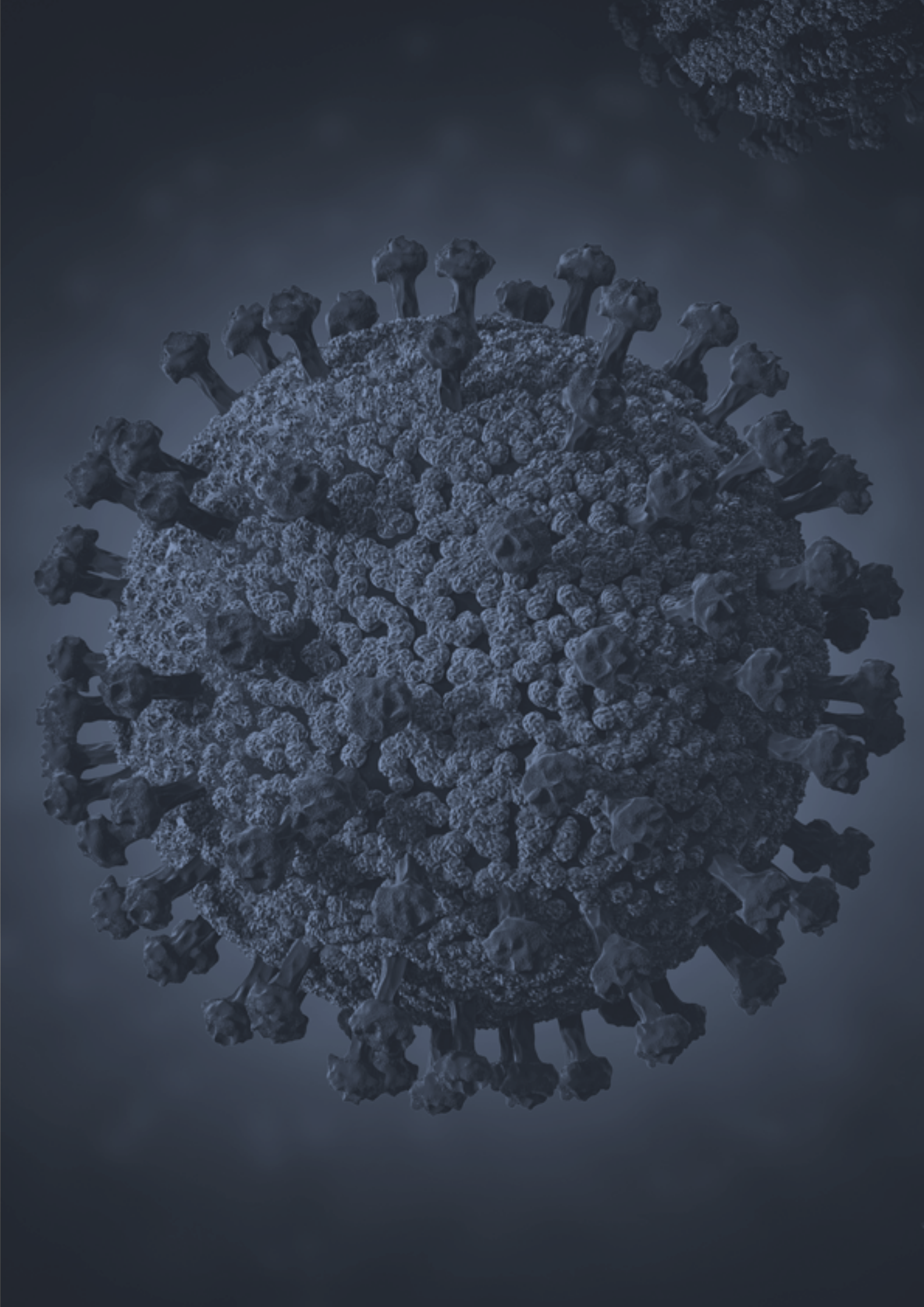
225. Collins, B. (2020). 'Strategic Issues: A Discussion Paper', National Preparedness Commission, p. 10. (Accessed online.)

226. United Nations (2020). 'Policy Brief: COVID-19 in an Urban World', p. 3. (Accessed online.)

227. Townsend-Drake, A. (2020). 'Counter-terrorism in Cities: A Whole-System Approach', Crisis Response Journal (15)1, pp. 94-95.

228. UKCRIC (2020). 'Rethinking Infrastructure and Cities for a Covid-19 World: A UKCRIC Prospectus', pp. 1-9. (Accessed online.)

229. Townsend-Drake, A. (2020). 'Counter-terrorism in Cities: A Whole-System Approach', Crisis Response Journal (15)1, pp. 94-95.



CTPN
COUNTER TERRORISM
PREPAREDNESS NETWORK