Comparing responses to natural, accidental and deliberate biological events

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Summary
Disease outbreaks – whether naturally occurring, or resulting from the unintentional or deliberate release of pathogens or/and toxins – can have significant consequences in terms of human, economic, environmental and material costs and put a serious strain on the state’s capacity to adequately respond to threats to public, animal or plant health. This paper aims to compare responses to natural, accidental and deliberate biological events. The author examines the characteristics of each type of biological event and reviews relevant international mechanisms for addressing disease outbreaks. The paper further examines the prerequisites for an effective disease response, regardless of whether the biological event has occurred naturally, is the result of an accident or has been caused deliberately.

Keywords

Introduction
Disease outbreaks – whether naturally occurring, or resulting from the unintentional or deliberate release of pathogens or toxins – can have significant consequences in terms of human, economic, environmental and material costs and put a serious strain on a state’s capacity to adequately respond to threats to public, animal or plant health. The 2014–2015 Ebola virus outbreak in West Africa, which killed more than 11,000 people and affected several countries, is a case in point. This outbreak underscored the need both to strengthen national capacities in disease prevention, surveillance and response, and to enhance international coordination and multisectoral cooperation in providing assistance. The rapid spread of infective and contagious biological agents across continents, including severe acquired respiratory syndrome (SARS) in 2003 and avian influenza in 2005, has epitomised the assertion that ‘pathogens know no borders’.

In 2007, a laboratory leakage at the Pirbright facility near Guildford, Surrey, in the United Kingdom (UK), led to a foot and mouth disease (FMD) outbreak totalling at least £150 million in clean-up costs and economic losses (1). Six years earlier, in 2001, another FMD outbreak in the UK, which had started on a pig farm in the southern part of the country, spread quickly, lasting for some 32 weeks and amounting to £6 billion in direct and indirect costs (2). During the same year, the ‘anthrax letters’ attack in the United States (US) killed six people and resulted in hundreds of millions of dollars of decontamination costs (3). Besides human and animal deaths, and losses in economic, infrastructural and monetary terms, the psychological impact and possible social and political implications of biological events can hardly be overstated. Widespread fear, stigmatisation and demands for quick solutions are just a few of the factors that shape the context of an outbreak response.

The purpose of this paper is to compare the response to natural, unintentional and deliberate biological events. The next section gives a brief overview of natural, accidental and intentional biological releases. In the ‘Responding to biological events: international mechanisms’ section the author presents a review of various international instruments and stakeholders which could have a bearing on or be involved in an outbreak response. The ‘Comparing
responses to natural, accidental and deliberate biological events’ section, then looks into the prerequisites for an effective disease response, regardless of whether the biological event is naturally occurring or has been caused accidentally or deliberately. In particular, this section argues in favour of a holistic approach in responding to biological events, whereby international coordination and cross-sectoral collaboration can play a key role in strengthening capacities for preparedness, surveillance and detection.

**Natural, accidental and deliberate biological events**

The World Health Organization (WHO) defines a disease outbreak as ‘the occurrence of disease in excess of what would normally be expected in a defined community, geographical area or season’ (4). An outbreak may be restricted to a specific geographical area, or spread across borders to several countries; its duration may vary from a few days to weeks or months, or even years. However, a single case of a contagious disease long absent from a population, or triggered by an agent not typically recognised in that community or locale, as well as the emergence of a previously unknown disease, may also be categorised as an outbreak that needs to be reported and investigated (4).

Most disease outbreaks confirm the widely cited assertion that ‘nature is the biggest bioterrorist’ (5). Indeed, the 2003 SARS outbreak, the 2009 H1N1 influenza pandemic, the emergence of Middle East Respiratory Syndrome (MERS) and, most recently, the spread of Zika virus all confirm this trend.

Accidental biological events are constituted of actions or occurrences that may lead to the unintentional release of pathogens in quantities and circumstances that pose a risk to public, animal or plant health. Examples of such events include but are not limited to:

- industrial accidents involving a leak from a biological containment facility
- accidents at military-research, production and storage facilities for biological weapons
- conflict situations in which a biological agent is released because of collateral damage to an industrial plant, or a research, manufacturing or military facility
- accidents during the transportation of biological agents for industrial or military purposes
- natural disasters, such as an earthquake or tsunami, causing damage to an industrial plant or military storage facility
- contamination from previous incidents (e.g. sites of industrial accidents), or from locations formerly used for the production, storage or testing of biological weapons (6).

While both the practice and technology of ensuring the safe handling of biological agents within research facilities have improved significantly over the past few decades, the risk of laboratory accidents or safety lapses due to human error is very real. In 2014, reports of scientists at US facilities being potentially exposed to live anthrax and avian influenza triggered an internal investigation and a review of measures to strengthen biosafety culture and practices (7). The following year, work at nine biodefence facilities in the US was temporarily halted after live anthrax was discovered outside a containment area at the US Army’s Dugway Proving Ground (8).

Deliberate biological events involve the intentional release of biological agents, whether by states, non-state armed groups or criminals, in order to cause injury and death and generate fear and panic in individuals, groups or the local population. Examples of such biological events are:

- the dispersal of biological agents as liquids, aerosols or solids in the air or on the ground, using munitions, explosives or other means of dispersal, leading to contamination over widespread areas or within confined spaces or buildings;
- the use of biological agents in an armed conflict or other violent situations through purpose-built military weapons or improvised devices, with or without explosives;
- the use of biological agents for the small- or large-scale contamination of food or water supplies;
- the targeted delivery of biological agents to individuals or groups, for example by post, leading to the contamination of individuals and buildings (e.g. by anthrax spores), or the use of biological agents to poison individuals (6).

Under the 1925 Geneva Protocol, the use of biological agents for hostile purposes during an armed conflict is explicitly prohibited (9), and the Protocol has the standing of customary international law. The 1975 Biological and Toxin Weapons Convention (BTWC) bans the development, stockpiling, acquisition and retention of biological agents of types and quantities that have no justification for peaceful, protective or prophylactic purposes (10). As of September 2017, there were 179 States Parties to the Convention; six states had signed but not ratified the Convention; and 11 states had neither signed nor ratified the Convention. UN Security Council Resolution 1540, adopted unanimously in 2004, specifically addressed the threat of non-state actors acquiring weapons of mass destruction (WMD), including biological weapons, by calling upon states to adopt appropriate regulatory and other measures to prevent biological proliferation (11).
Still, the hostile misuse of biological agents constitutes a multifaceted risk, which can hardly be overstated. In 2014, a laptop with instructions on how to weaponise bubonic plague from animals was reportedly seized from a territory in the Syrian Arab Republic controlled by the Islamic State of Iraq and Levant (ISIL) (12). Back in 2001, the anthrax case in the US drew attention to the ‘insider threat’, whereby researchers with legitimate access to pathogens and toxins may take advantage of their position for nefarious purposes.

Responding to biological events: international mechanisms

A rapid and timely response to health emergencies requires that information on their occurrence is communicated quickly and effectively. Under Article 6 of the 2005 International Health Regulations (IHR), ‘[e]ach State Party shall notify [the World Health Organization], by the most efficient means of communication available, by way of the National IHR Focal Point, and within 24 h of assessment of public health information, of all events which may constitute a public health emergency of international concern within its territory in accordance with the decision instrument, as well as any health measure implemented in response to those events’ (13).

To ensure the availability of information and the coordination of response operations, WHO has established a comprehensive global alert and response system. The system is designed to serve the following primary functions:

– event-based surveillance, multi-hazard rapid risk assessment and event-based risk communications
– crucial information and communications platforms for decision support
– operations and logistics platforms for any WHO response to international public health risks (14).

Among the key elements of the system are the Global Outbreak Alert and Response Network (GOARN), the Strategic Health Operations Centre (SHOC), and the Public Health Emergency Operations Network (EOCNET).

The Global Outbreak Alert and Response Network was established in 2000 by WHO in collaboration with its partners, ‘to ensure that countries have rapid access to the most appropriate resources and experts for the identification, assessment, and response to public health emergencies of international importance’ (15). GOARN is a multidisciplinary technical collaboration of more than 200 institutions and networks and, since its creation, GOARN has coordinated over 130 operations. The network has also developed the Guiding Principles for International Outbreak Alert and Response, a consensus document which aims to improve the delivery of international assistance to support local efforts and promote the highest standards of professional performance in the field (15).

The WHO Strategic Health Operations Centre (SHOC) is responsible for monitoring global health events around the clock, as well as for facilitating international collaboration during public health emergencies and daily operations. SHOC is also tasked with providing technical support and guidance to states and regions in setting up their emergency operation centres (16).

The Public Health EOCNET was established in 2012, with the goal of strengthening the capacity of public health emergency operation centres (EOCs) in individual Member States by providing support and identifying and promoting best practice. By design, EOCs are physical or virtual structures intended to coordinate operational information and resources for the strategic management of public health events and emergencies. Many Member States are establishing EOCs in order to meet their obligations under the 2005 IHR and to strengthen coordination and communication for an effective public health response (17).

The principal international agency tasked with monitoring and overseeing activities related to the protection of animal health is the World Organisation for Animal Health (OIE). Under the Terrestrial Animal Health Code (Terrestrial Code), Member Countries are obliged to report animal health events in a timely manner. As specified in Article 1.1.3. of the Terrestrial Code, Veterinary Authorities shall […] send to the Headquarters:

i) in accordance with relevant provisions in the disease-specific chapters, notification, through the World Animal Health Information System (WAHIS) or by fax or email within 24 h, of any of the following events:

– first occurrence of a listed disease, infection or infestation in a country, a zone or a compartment;
– recurrence of a listed disease, infection or infestation in a country, a zone or a compartment following the final report that declared the outbreak ended;
– first occurrence of a new strain of a pathogenic agent of a listed disease, infection or infestation in a country, a zone or a compartment;
– a sudden and unexpected change in the distribution or increase in incidence or virulence of, or morbidity or mortality caused by, the aetiological agent of a listed disease, infection or infestation present within a country, a zone or a compartment;
– occurrence of a listed disease, infection or infestation in an unusual host species' (18).
The World Animal Health Information System serves as a 'clearing house' for real-time data on animal diseases. All relevant information is processed there and the results are made available to the international community. WAHIS fulfills two main functions serving as:

- an early-warning system about relevant epidemiological events
- a surveillance system which monitors the presence or absence of OIE-listed diseases (19).

In 1994, the Food and Agriculture Organization of the United Nations (FAO) established the Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases (EMPRES). The FAO's Animal Production and Health Division is tasked with coordinating the animal disease component of EMPRES, which provides information, training and emergency assistance to countries to prevent, contain and control the world's most serious livestock diseases, while also carrying out surveillance for newly emerging pathogens (20).

In 2006, to maximize regional and national capacities in the fight against transboundary animal diseases (TADs), the OIE and FAO jointly launched the Global Framework for Progressive Control of Transboundary Animal Diseases (GF–TADs). The GF–TADs initiative aims to support strategic regional cooperation by:

i) 'improving national knowledge and information/data retrieval systems on disease in support of early warning, on animal production, on land use, on animal and product movement, and related factors that affect or threaten animal health;

ii) strategic use of quality vaccines – where such vaccines exist and enabling research where they do not;

iii) improved diagnostic laboratory performance at national level and support for reference laboratories through technology transfer, and internal and external quality control;

iv) technical guidance in the establishment of regional initiatives ensuring collaboration across borders; and,

v) implementation of national Good Emergency Management Practices that include early detection, reporting and counter-epizootic measures' (21).

The Global Early Warning System for major animal diseases including zoonoses (GLEWS) emerged in 2006 as a joint effort between FAO, the OIE and WHO and a major contributor to GF–TADs. Ever since its creation, GLEWS has served as an important mechanism for bringing together data, expertise, functional networks, operational systems and stakeholders to enhance interagency collaboration and support Member Countries in detecting, preventing and controlling threats to animal and public health and the food chain. More recently, GLEWS has evolved into GLEWS+, which has three main goals:

- to systematically link areas such as wildlife health, food and biological threats
- to drive more advanced cross-sectoral risk assessment when a need is identified
- to provide more opportunities for participation by a broader range of stakeholders via specific working groups established to examine priority areas (22).

It is worth noting that, under the IHR, Member Countries are required to notify WHO of any public health event 'which may constitute a public health emergency of international concern', irrespective of its origin or source (Article 7) (13). In case of a suspected deliberate release of biological agents, any affected state may request that the UN Secretary-General's Mechanism (UNSGM) for Investigation of Alleged Use of Chemical and Biological Weapons is triggered. The UNSGM grants the UN Secretary-General the authority to carry out an investigation (including dispatching a fact-finding team to the site/s of the alleged incident/s) and to report on its outcome to all UN Member States. The primary purpose of the UNSGM is to ascertain, in an objective and scientific manner, whether a violation of the 1925 Geneva Protocol has taken place (9, 23).

The 1975 BTWC also makes provision for actions that may be taken by any State Party if another State Party is suspected of carrying out illicit activities. For example, Article VI of the Convention states that:

i) 'any State Party to this Convention which finds that any other State Party is acting in breach of obligations deriving from the provisions of the Convention may lodge a complaint with the Security Council of the United Nations (UN). Such a complaint should include all possible evidence confirming its validity, as well as a request for its consideration by the Security Council.

ii) each State Party to this Convention undertakes to cooperate in carrying out any investigation which the Security Council may initiate, in accordance with the provisions of the Charter of the UN, on the basis of the complaint received by the Council. The Security Council shall inform the States Parties to the Convention of the results of the investigation' (10).

In addition, under Article VII of the BTWC, States Parties are required to provide assistance to any State Party which may have been exposed to an attack or a threat of an attack involving biological weapons:
'Each State Party to this Convention undertakes to provide or support assistance, in accordance with the United Nations Charter, to any Party to the Convention which so requests, if the Security Council decides that such Party has been exposed to danger as a result of violation of the Convention.'

Comparing responses to natural, accidental and deliberate biological events

Whereas the primary objective during a biological event is to contain the disease through health measures, in certain cases the authorities may face the need to adopt additional approaches in responding to disease outbreaks – not least if there is a suspicion that these outbreaks may have been accidentally or intentionally triggered. A Working Paper, called 'Specificities of the response to natural and intentional disease outbreaks', which was submitted by France to the Preparatory Committee of the Eighth Review Conference of the BTWC in 2016, outlined three sets of differences to be considered: namely, technical aspects, organisational issues, and investigation and response (24).

With regard to technical aspects, the Working Paper underscores the fact that an intentional outbreak would probably present challenges both in terms of diagnostics and the treatment of victims. For example, 'the biological agents used in the attack could be modified in order to fool detection and diagnosis systems'. Among the possible factors impacting on the treatment of victims, the Working Paper lists the following.

- A deliberate attack could target a large number of people simultaneously, as opposed to a natural epidemic spreading gradually;
- The use of some specific means of dissemination would be a compounding factor. By causing serious and sudden outbreaks of infectious diseases, it could overwhelm the reaction capacity of the public health systems;
- Depending on the method of delivery chosen to spread the pathogen, an intentional outbreak, unlike a natural outbreak, could lead to large-scale contamination of premises and equipment, not only of people;
- An intentional outbreak may rely on modified agents.'

In terms of organisational issues, the Working Paper points out that:

‘An intentional outbreak should be considered first and foremost as an attack. It is therefore likely that the targeted State would take military and security measures in order to ensure its own defence. […]

The fact that a biological weapon attack has taken place, or even the suspicion that a biological weapon attack has taken place, would also lead potential assistance providers to take organizational measures in order to be prepared to face such an attack, should it happen on their territory, or should they be affected.’

In regard to investigation and response, the Working Paper notes that a suspected intentional disease outbreak would require ‘both a national and an international investigation’ to be carried out, ‘in order to ascertain the facts […] and possibly to try and identify the perpetrators’. Both fact-finding activities and national criminal investigations would rely upon ‘forensic capacities and specialised laboratories with state-of-the-art analytical techniques’.

Effective response to biological events: the need for an integrated approach

Pathogens recognise no borders and, in a densely globalised international environment, air travel and trade may facilitate the spread of a disease even before its nature and source have been established. Just as the natural evolution of pathogens cannot be curtailed, so the spectrum of human-made threats continues to expand. The global diffusion of capabilities and expertise promises tremendous health, socio-economic and environmental benefits; yet it also breeds risks and insecurities ranging from technical malfunction to human error to illicit activities.

At the same time, the costs and level of expertise required to manipulate pathogenic or toxic agents are constantly decreasing, and the ‘Dark Net’ opens up an immense array of possibilities for accessing toxic substances and hazardous materials quickly and easily. Moreover, it is not difficult to imagine that even natural disease outbreaks involving pathogens of bioterrorism concern may be taken advantage of by those with malevolent intentions, to acquire biological samples or cultures (25). Such a complex spectrum of biological threats with no single focal point requires a multifaceted and multi-layered, internationally coordinated set of measures which allow states to respond to biological events effectively and efficiently, regardless of their cause.

Effective disease response is underpinned by a robust preparedness and surveillance effort, as well as established channels of communication and coordination among the different levels of respondents (first, second, third, etc.).
The scene of a biological event is not the place for stakeholders to exchange business cards; on the contrary, cross-sectoral and inter- and intra-agency collaborative relationships need to be fostered and sustained on a day-to-day basis, to enable a rapid and systematic deployment of resources in case of an emergency. States must focus on preparing multidisciplinary teams which can tap diverse areas of expertise, including – but not limited to – health, agriculture, research, industry, law enforcement, security and academia. Facilitating dialogue among professionals from various fields and allowing them to exchange knowledge and share their experiences and lessons learned is crucial for underscoring what their particular role during a biological event is expected to be and how best they can contribute to mitigating any negative consequences and potential risks that arise from it. Strengthening capacities in such areas as diagnostics, detection, bio-risk management and biosecurity; building partnerships between the scientific and security communities; and combining flexible ‘bottom-up’ and ‘top-down’ approaches to disease prevention can go some way to enhancing the resilience of countries and regions in a health emergency. Taken together, these approaches could help to promote health security, stability and prosperity.

The need for cross-sectoral collaboration in disease response is reflected by various international initiatives. One such initiative is the Global Health Security Agenda (GHSA), which is discussed in some detail in this issue of the Review (26). Launched in 2014, the GHSA seeks to bring together relevant stakeholders, including states, international organisations and non-governmental organisations (NGOs), to promote the vision of a ‘world safe and secure from global health threats posed by infectious diseases’ (27). The GHSA is composed of a three-tiered framework: prevent–detect–respond, comprising 11 action packages, with three of those focused on enhancing disease response capacities:

- the EOCs action package
- an action package that links public health with legislation and multisectoral rapid response
- a medical countermeasures and personnel deployment action package (28).

The International Federation of Biosafety Associations (IFBA) has launched a new certification programme for bio-risk management, biosafety and biosecurity professionals worldwide. This programme is in accord with the IFBA’s chief mission of achieving ‘safe, secure, and responsible work with biological materials’ by advancing the body of knowledge and increasing competency in the field of biosafety, biosecurity and bio-risk management. Certified individuals bring increased value to their employers by demonstrating competence to carry out their responsibilities and by achieving high standards of excellence, professionalism and continuous learning (29). Among the areas in which the IFBA offers professional certification is biosecurity. It is important to note that the exam which practitioners will be required to take in order to become certified biosecurity professionals covers a broad range of issues which extends beyond laboratory biosecurity. Those who hold this certification possess the knowledge and skills in sufficient degree to securely manage biological risks in the laboratory, in healthcare facilities, during a field response to disease outbreaks and in other settings where biological materials are handled. The exam in biosecurity covers the following domains:

- Domain A: Biosecurity conventions, guidelines and standards
- Domain B: Biosecurity risk assessment and programme management
- Domain C: Physical biosecurity measures
- Domain D: Pathogen accountability
- Domain E: Personnel reliability
- Domain F: Dual use and bioethics (30).

In order to provide improved support to its Member Countries in ensuring the safety and security of biological materials and emerging technologies, which have the potential to be used for criminal purposes, the International Police Organization (Interpol) has created Operation S3OMMET (safe, secure surveillance of microbiological material and emerging technologies) (31). The project has taken the format of a series of regional workshops, which bring together law enforcement officers, biosafety experts, academic representatives and public health officials. Among its main objectives are:

- the assembly of multiagency representatives to work together to ensure the protection of biosciences from malicious activity;
- allowing Interpol Member Countries a forum in which to raise their concerns and discuss the support they need to improve safety, security and surveillance within the biosciences and related emerging technologies;
- providing ongoing support and guidance to targeted regions and individual countries related to safeguarding the biosciences;
- empowering targeted regions to form close links and work more closely together in the future;
- the design and implementation of a comprehensive Programme Evaluation system;
- assessing a country’s capacity to support future risk-reduction work and identify gaps where assistance can be provided (31).

Apart from Operation S3OMMET, in 2015 Interpol, in collaboration with the OIE, FAO and national authorities,
Comparaison entre les réponses apportées aux événements biologiques d’origine naturelle, accidentelle ou délibérée

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Résumé
Tous les foyers de maladie, qu’ils soient d’origine naturelle ou qu’ils résultent de la libération accidentelle ou délibérée d’agents pathogènes et/ou de toxines dans l’environnement ont potentiellement un coût humain, économique, environnemental et matériel important, tout en provoquant parfois lourdement les capacités des États à répondre aux menaces qui pèsent sur la santé humaine, animale et végétale. Cet article a pour objet de comparer les réponses formulées respectivement lors d’événements biologiques d’origine naturelle, accidentelle ou délibérée. L’auteur examine les caractéristiques de chaque catégorie d’événement biologique et décrit les mécanismes pertinents mis en œuvre à l’échelle internationale pour faire face aux foyers. Elle étudie en outre les conditions préalables qui conditionnent l’efficacité des réponses à la survenue...
Comparación de las respuestas a episodios biológicos de origen natural, accidental o deliberado

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Resumen
Los brotes de enfermedad, ya sean de origen natural o resultantes de la liberación intencionada o fortuita de patógenos y/o toxinas, pueden tener importantes consecuencias desde el punto de vista de su costo humano, económico, ambiental y material y ejercer una gran presión sobre la capacidad del Estado para responder debidamente a las amenazas sanitarias, zoosanitarias o fitosanitarias. La autora compara entre sí las respuestas que se han dado a episodios biológicos de origen natural, accidental y deliberado. Tras repasar las características de cada tipo de suceso biológico, examina los correspondientes mecanismos internacionales para afrontar brotes infecciosos. Asimismo, se detiene en los requisitos previos para responder eficazmente a una enfermedad, con independencia de que su aparición obedezca a factores naturales, resulte de un accidente o tenga causas deliberadas.

Palabras clave

References


