MEETING OF STATES PARTIES TO THE BIOLOGICAL WEAPONS CONVENTION

SIDE-EVENT ON:

BIORISK ASSESSMENT
INTEGRATED APPROACHES FOR UNDERSTANDING COMPLEX THREATS

5 DECEMBER 2018 • GENEVA • SWITZERLAND
Often the term risk is used, while people are in fact talking about threats.

- Threat: The possibility that something goes wrong or is used for malign purposes,
- Risk: “Classically“ a term linking threats to likelihood and consequences

\[ R = L \times C \]

That includes time and the question, how often we expect an event to occur.
Characteristics of the agent,
Environmental factors,
Facts about the population,
Risk perception in a society,
Means to prepare and respond to a risk,
...
Various data formats (scaling), and methods required for information gathering from a multitude of disciplines.
1. Introduction (G. Jeremias)

2. Risk in context (J. Opper)

3. Challenges for an Integrated Biorisk Assessment:
   - Assessing emerging bio-technology (M. Himmel)
   - Assessing infectious disease outbreaks (M. Himmel for S. Fraas)
   - Assessing social disruption (H. Sarwary)
   - Assessing response capabilities (H. Martin)

4. Conclusion & Discussion (G. Jeremias)
• Dimensions: uncontested.
• Graph does show no risks: Either sources/triggers or consequences.
Risk assessment needs to define its scope

• Here: Timely limited scenarios of infectious disease or intoxications that have the potential to cause security threats
  • Excludes permanent catastrophes such as HIV, malaria, ...
  • Includes plant and animal disease with these characteristics.
• Approx. 1.500 human pathogens, (plus similar numbers of animal and plant pathogens),
• Each causing different dynamic situations and using different mechanisms: contamination, infections with different disease patterns,
• List of pathogens that deserve special attention are available (e.g. by WHO, CDC, RKI), but characteristics of many are unknown (new or altered pathogens).

Diversity and dynamics distinguish biological events from other scenarios, such as floods etc.
Introduction

REQUIREMENTS FOR RISK ASSESSMENT IN THE BWC

• If a risk assessment mechanism is developed in the BWC it is up to the Member States to decide about its scope,

• Focus only on intentional dimension?
  – Central aim of the treaty,
  – Parallels to verification of absence: uncover what possibly will never occur. Aim of verification, though: political judgements about single states, while risk assessment has a more general view,

• Arguments for a broader scope of bio risk assessment in the BWC:
  – Security threats from accidental or natural events,
  – Building capacities to distinguish in between,
  – Learn about potentials for misuse,…
The problem of uncertainty and ignorance

Verification in preventive arms control and risk assessment have in common that there is no possibility for a 100% perfect assessment: Both of them have to work with blurry information.

Gap of what we want to know and what we can know.

Risk: Realisation of a threat in time, including its consequences (and the calculation of dynamic development up to a certain point in time, e.g. end of an outbreak),

Risk formula (R=L*C) from insurance mathematics:

Useful where there are great numbers: frequent occurrence and known average consequences: provides „statistical truth“,

If we have few or no information about likelihood, or consequences – or both, the formula does not generate a less exact estimation, but would generate: nothing.

This includes the majority of biological risks, including ALL cases of intentionally caused disease.
• Common tricks in dealing with uncertainty in risk assessment: Changing the time scale
  – In very long periods of time even the most unlikely events will occur: L=1
    • Then you are only interested in consequences.
  – Or: assumption that the likelihood of an event in the foreseeable future is almost not existent („rest risk“)
    • Then you are only interested in consequences.

Develop worst case scenarios. Always an option for decision makers – but rather threat assessment than risk assessment.
• Some information are simply not existing, you can dig as deep as you want, and think as hard as you can: The information are not there.
  – This includes ignorance: e.g. the occurrence of disease (except from frequently occurring disease)
  – And uncertainty: e.g. how much does DURC contribute to the enhancement of risk?

• Often used method: ask many experts (Delphi survey):
Example for the limits of Delphi:

Boddie, Gronvall et al. (2015): Survey about the likelihood of a bioterror attack within the next years.

- 58 experts being asked,
- Answers ranged in between 1 percent and 100 percent likelihood, with a statistical mean of 57 percent.
- My translation: We have no clue — and this is due to the non existence of the information.

Similar: Estimation of likelihood of lab-accidents by Gryphon scientific.
The problem of uncertainty and ignorance

- Some information are simply not existing, you can dig as deep as you want, and think as hard as you can: The information are not.
  - This includes ignorance: e.g. the occurrence of disease
  - And uncertainty: e.g. how much does DURC contribute to the enhancement of risk?

- Delphi surveys and other methods to deal with uncertainty and ignorance with limits

- But the deficient availability of information shall not justify the end of risk assessment,

Need an adapted understanding of risk,
And an interdisciplinary endeavour to identify what this can be...
WHAT IS RISK

– “Risk refers to uncertainty about and severity of the events and consequences (or outcomes) of an activity with respect to something that humans value.”

– Social Technology

– Reduces uncertainty about the future

– Likelihood and outcome of an event
WHAT IS THE FUNCTION OF RISK

- Factor as base for decision making
- Choosing between different options
- Worth of one option
- Distribution of resources
How do we approach risk?

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<td>- Relies on Expert Assessment</td>
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SOCIAL POLITICAL FACTORS IN RISK ASSESSMENT

- Assessments take place in scenarios
- Contain assumptions about the future
- Future is unknown
- Expectations about the future are always present
REFERENCES

1 Aven, Terje; Renn, Ortwin (2009): On risk defined as an event where the outcome is uncertain. In: Journal of Risk Research 12 (1), S. 1–11. DOI: 10.1080/13669870802488883.
ASSESSING BIOTECHNOLOGICAL ASPECTS
“Setting the frame”

- Biological risks: Risks for humans, animals, plants etc. to get harmed by biological agents

- (Bio-) Technologies may increase the potential of biological agents to cause harm, but ...

- … other technologies might contribute too (spray drying, aerosolization, mass production, …)
Developments in biotechnology with relevance to the BTWC include:

- Synthetic biology
- Systems biology
- Nanobiotechnology
- Genome editing
Genome Editing - Background

- Use of biotechnological tools for manipulating genomic information (DNA)

- Basis: naturally occurring genome modification mechanisms (example: CRISPR-Cas system)

- Targets: single DNA elements (nucleotides) or whole genes
Genome Editing – Fields of Application

- Biomedical problems: Novel gene therapies (currently under development! e.g., CCR5 gene > HIV)

- Human enhancement?: Optimized body functions? Still science fiction, but hot topic in bioethics!

- Gene Drives: Inheritable genetic elements design to deliver “gene cargo”/fulfil certain functions > e.g. elimination of malaria by causing sterility of female mosquitoes (biosafety & biosecurity implications?)
- **Genome Editing – Risk Assessment**
  - Classical genetic engineering applied since 1970ies
  - BWC: “enabling techniques” > Could contribute to the generation and optimization of biological warfare agents
  - Creation of novel biological warfare agents?
  - New CRISPR-Cas technique thought to be superior due to high efficiency, high precision, low costs, ease of use...
Genome Editing – Risk Assessment

- Use of model organism *Burkholderia glumae* (plant pathogen) for the analysis of critical steps in genome editing

- How to analyse genome editing efficiency? Any detectable trace after completion of genome editing procedure?

- Bacteria as convenient model > high generation frequency, high through-put screening possible
Genome Editing – Risk Assessment

- Analysis of scientific literature regarding CRISPR-Cas
- Key benefit: direct access to lab & hands-on experience
- Development of criteria for the description of critical experimental steps
- Applications: biological arms control, “civil security” research
Interplay between sub-projects

- Features of pathogens important to know for modelling infectious disease outbreaks > part of biorisk assessment

- Literature-based characterisation of pathogens / toxins (generation of “fact sheets”)

- Descriptions & parameters must be directly accessible for mathematical modelling

- Exchange of information within research group
MIRKO HIMMEL (FOR SIMON FRAAS)

ASSESSING INFECTIOUS DISEASE OUTBREAKS
CLADE X EXERCISE AS WORK TEMPLATE

- CLADE X exercise: developed and conducted by Johns Hopkins Center for Health Security, Baltimore, USA

- 8 different categories defined
- Model follows one single direction
- Exposed people may suffer from either mild or severe infection

Head of sub-project: Dr Simon Fraas

Reference: http://www.centerforhealthsecurity.org/our-work/events/2018_clade_x_exercise/
Modelling of Infectious Disease Outbreaks

CLADE X EXERCISE AS WORK TEMPLATE

Each category reflected by one variable ("letter code")

- Susceptible (S)
- Exposed (E)
- Infected mild (Im)
- Infected severe (Is)
- Convalescent (C)
- Hospitalized (H)
- Recovered (R)
- Dead (D)

Head of sub-project: Dr Simon Fraas
Modelling of Infectious Disease Outbreaks

CLADE X EXERCISE AS WORK TEMPLATE

Mathematical solution: system of ordinary differential equations (ODEs)

Benefit: each equation represents one single function value ("susceptible", dS etc.) monitored over time (dt)

Head of sub-project: Dr Simon Fraas
Modelling of Infectious Disease Outbreaks

INTEGRATIVE APPROACH

\[ \frac{dS}{dt} = -\frac{\beta S(I_M + e_M l_M + e_H H)}{N} \]

\[ \frac{dE}{dt} = \frac{\beta S(I_M + e_M l_M + e_H H)}{N} - (1 - \theta)k_1 E - \theta k_2 E \]

**Biological properties of pathogen or toxin**
(required for beta-factor estimation/calculation)

\[ \frac{dl_M}{dt} = (1 - \theta)k_1 E - \gamma l_M \]

\[ \frac{dl_s}{dt} = \theta k_2 E - \alpha_1 l_s \]

\[ \frac{dc}{dt} = \gamma l_M + (1 - \delta)\alpha_2 H - \rho C \]

\[ \frac{dH}{dt} = \alpha_1 l_s - (1 - \delta)\alpha_2 H - \delta \alpha_2 H \]

\[ \frac{dR}{dt} = \rho C \]

\[ \frac{dD}{dt} = \delta \alpha_2 H \]

Head of sub-project: Dr Simon Fraas
Modelling of Infectious Disease Outbreaks

INTEGRATIVE APPROACH

\[ \frac{dS}{dt} = -\frac{\beta S(I_S + e_MI_M + e_HI_H)}{N} \]

\[ \frac{dE}{dt} = \frac{\beta S(I_S + e_MI_M + e_HI_H)}{N} - (1 - \theta)k_1E - \theta k_2E \]

\[ \frac{dI_M}{dt} = (1 - \theta)k_1E - \gamma I_M \]

\[ \frac{dI_S}{dt} = \theta k_2E - \alpha_1I_S \]

\[ \frac{dC}{dt} = \gamma I_M + (1 - \delta)\alpha_2H - \rho C \]

\[ \frac{dH}{dt} = \alpha_1I_S - (1 - \delta)\alpha_2H - \delta_2H \]

\[ \frac{dR}{dt} = \rho C \]

\[ \frac{dD}{dt} = \delta_2H \]

Historical epidemiological data

Head of sub-project: Dr Simon Fraas
Modelling of Infectious Disease Outbreaks

INTEGRATIVE APPROACH

\[
\frac{dS}{dt} = -\frac{\beta S(E + eM + eH)}{N}
\]

\[
\frac{dE}{dt} = \frac{\beta S(E + eM + eH)}{N} - (1 - \theta)K_1E - \theta K_2E
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Socio-disruptive effects

Head of sub-project: Dr Simon Fraas
Modelling of Infectious Disease Outbreaks

INTEGRATIVE APPROACH

Resources
(e.g. capacity of PHS)

Head of sub-project: Dr Simon Fraas
Modelling of Infectious Disease Outbreaks

INTEGRATIVE APPROACH

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\]

Biorisk governance
(Strategies for mitigation, prevention, preparedness)

Head of sub-project: Dr Simon Fraas
Modelling of Infectious Disease Outbreaks

INTEGRATIVE APPROACH

Life Sciences

Epidemiology

Social Science

Disaster Management

Political Science

BIGAUGE interdisciplinary research group

Head of sub-project: Dr Simon Fraas
HARES SARWARY

ASSESSING SOCIAL DISRUPTION
1. Introduction – Mass disruption?

2. Cases of biological events:
   1. Anthrax letters 2001

3. What do we understand about disruption?

4. Connection of disruption, risk perceptions and preparedness.
Bioweapons referred to as the poor man’s nuclear weapon. \(^1,^2\)

Heavily linked with the notion of disruption and sometimes called a „Weapon of Mass Disruption“. \(^1,^3,^4\)

What is exactly meant by disruption?

- Concept not easily defined, what exactly is disrupted and how?
- Often focus is society: what are the assumptions about society and effects on it and what is perceived as disruption?

What is meant when one talks about __social__ disruption?
The prime example case of bioterrorism, regularly cited. Death toll of 5; 22 infected. 5

Indication of lasting disrupting effects despite no mass casualties.

What disrupting impacts are mentioned?

- Disruption of the postal system. 1
- Economic damages of decontamination, ca. $250-$320 million dollars. 1, 5
- Media coverage, fear and uncertainty, national and international.
Assessing social disruption

EXAMPLE CASE: ANTHRAX LETTERS 2001

A NATION CHALLENGED on an Antibiotic

BY TAMAR LEWIN SEPT. 27, 2001

Many New Yorkers — and others stocking up on Cipro, an antibiotic.

Most scientists say that the exposure to anthrax, a powerful weapon,

But Sebastian Manciamei, Manhattan’s Upper East Side doctor, said he was more and more.

Mr. Manciamei added, “We have ordered 3,000 and sold out. At the Village Pharmacy and at Silkes said that enough people come in to place an extra order.

Duct tape sales rise amid anthrax fear

From Jeanne Meserve

WASHINGTON (CNN) -- Americans have been quick to heed the U.S. government's advice to prepare for terror attacks, emptying hardware store shelves of duct tape.

On Tuesday, less than 24 hours after U.S. Fire Administrator David Paulison described a list of useful items, stores in the greater Washington, D.C. area reported a surge in sales of plastic sheeting, duct tape, and other emergency items.

Duct tape, Paulison said, can be helpful after a biological, chemical or radiological attack.

A Lowe’s hardware store in Alexandria, Virginia, said every roll of duct tape has been sold. Another Alexandria Home Depot store reported sales of duct tape tripled overnight.

Everything that was on that newcast, we

Officials calm German anthrax fear

November 2, 2001 Posted: 2:52 PM EST (1952 GMT)

BERLIN, Germany -- Official Berlin laboratory said on a letter and two packages tested positive for anthrax, but did not confirm the bacteria failed to demonstrate further testing.

“We have only negative results,” Health Minister Ulla Schmidt, who had been tested, said Thursday in a telephone interview. The Associated Press

“There is no evidence of an examination further, but we do not want an alert for the time being.”

The suspect packages — a letter to a German employment office in the northern state of Schleswig Holstein and two parcels found in the northern state of Schleswig Holstein, tested positive for anthrax in preliminary tests and were sent to Berlin for examination.
Exceptional case in recent history – death toll 11,325; total cases 28,652.  
Regarded as an international emergency and security crisis.  
Disrupting impacts:  
- Reported loss of trust in institutions.  
- Economic impact – e.g. loss of household income; GDP.  
- International media coverage – reactions and fear in general public around the world.
Assessing social disruption

EXAMPLE CASE:

EBOLA EPIDEMIC 2014-2016

In Dallas Schools, Fear of Possible Ebola Exposure

By Manny Fernandez, Kevin Sack and Marc Santora

Oct. 2, 2014

DALLAS — There is Ebola, and then there is fear of Ebola.

For the thousands of parents and schoolchildren in the Dallas area, it is a concern that they wrestled with on Thursday morning, learning that five school-age children had had contact with someone ill with the disease.

In Europe, Fear of Ebola Exceeds the Actual Risks

By Andrew Higgins

Oct. 17, 2014

BRUSSELS — After more than a decade working as a charity director setting up schools in West Africa, Miriam Mason-Sesay got an unpleasant surprise recently when she returned to Britain and could not find a school willing to teach her own 9-year-old son.
Some similarities what areas can be referred to when one tries to identify social disruption – but what is specifically understood to be affected can vary vastly.

Complex concept – very different facets could be taken into account – for inclusion in risk assessment a more concise concept is necessary.

However even then – how to operationalize, scale and parameterize the social disruption? Generalization and prediction difficult – but “thick description“ and revealing of assumptions is possible.
Why do certain cases seem to provoke more reactions than others? — Certain factors (e.g. novelty) can influence perceptions of risks.

Events also affect perceptions – can shape how a concept like social disruption is framed and conceived.

Past events and perceptions possible influence on supposedly “objective” assessments.

Thus: they also can influence the expectations and preparedness regarding future events.


Weblinks:


HELGE MARTIN

ASSESSING RESPONSE CAPABILITIES
Assessing response capabilities

**RISK MANAGEMENT CYCLE**

![Diagram of the risk management cycle with stages: Early warning, Emergency relief, Reconstruction, Preparedness, Risk analysis, Disaster management, Disaster preparedness.]

Assessing response capabilities

GETTING THE FULL PICTURE

OVERALL RESPONSE = PERFORMANCE

TECHNICAL RESOURCES
- CBRN protection equipment
- Laboratories
- Isolation units
- etc.

KNOWLEDGE & INFORMATION
- Awareness
- Detection
- Handling of infectious patients
- etc.

INCIDENT MANAGEMENT
- Coordination
- Communication
- Logistics
- etc.
Complex networks of different actors with no formal relationship

- Governmental agencies
- Non-governmental organizations
- Civil society
- Private businesses
- Academia

Structured and possibly siloed by levels and sectors
Assessing response capabilities

MULTI-LEVEL GOVERNANCE

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<th>Food Safety</th>
<th>Animal health</th>
<th>Environmental</th>
<th>Agricultural</th>
<th>Fire &amp; rescue</th>
<th>Civil protection</th>
<th>Law enforcement</th>
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Georgetown University Center for Global Health Science and Security & Talus Analytics:

Stakeholders in a Deliberate Biological Event

Source: dbe.talusanalytics.com
Multi-agency management as a crucial response factor

- Systematic assessment of multi-agency management
  - Policies & legal frameworks
  - Joint emergency management plannings
  - Unified command systems / joint incident coordination mechanisms
  - Overarching risk and crisis communication strategies
  - (Technical) interoperability & standardization
  - Consultations in “times of peace”, joint trainings & exercises

More realistic picture of the response networks capabilities
Assessing response capabilities

REFERENCES

CONCLUSION
„Classical“ risk model with limits: ignorance, uncertainty and diverse information formats.

Risk is inextricably linked to the wider context of the analyzed events.

Biotechnological risks should be addressed by meta-studies as well as lab-based procedures.

Mathematical modelling allows assessment of possible outcomes of natural or intentional infectious disease outbreaks.

Social disruption – various possible areas to include in concept – assumptions about it have to be revealed.

Multi-agency coordination needs to be assessed.
QUESTIONS & DISCUSSION

THANK YOU FOR YOUR KIND ATTENTION

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