CBW Magazine

Journal on Chemical and Biological Weapons

Summer / January-June 2021

ISSN: 0974-0619

EDITORIAL 3

INVITED ARTICLES 4

Towards an Aspirational (Ethical) Code under the Biological and Toxin Weapons Convention: Engaging the Life Science Community

Malcolm Dando, Tatyana Novossiolova, Michael Crowley and Lijun Shang

VIEW POINT 24

Unprecedented Environmental Impacts of Chemical and Biological Warfare: A Critical Appraisal

Dr. Dhanasree Jayaram and Yashaswini Patel

OPINION 29

Role of Internet of Things in Biological Warfare

Utkarsha Mahajan

COVER STORY 35

Pervasive Geopolitics, Elusive Science: The Quest for the Origins of SARS CoV-2

Anand V.

CHEMICAL AND BIOLOGICAL NEWS 40

MANOHAR PARRIKAR idsa

MANOHAR PARRIKAR INSTITUTE FOR DEFENCE STUDIES AND ANALYSES

मनोहर पर्रिकर रक्षा अध्ययन एवं विश्लेषण संस्थान

CBW Magazine

Journal on Chemical and Biological Weapons

Volume 14 Number 1-2 Jan-Jun 2021

ISSN: 0974-0619

Copyright © Manohar Parrikar Institute for Defence Studies and Analyses, New Delhi.

EDITORIAL 3

INVITED ARTICLE 4

Towards an Aspirational (Ethical) Code under the Biological and Toxin Weapons Convention: Engaging the Life Science Community

Malcolm Dando, Tatyana Novossiolova, Michael Crowley and Lijun Shang

VIEW POINT 24

Unprecedented Environmental Impacts of Chemical and Biological Warfare: A Critical Appraisal

Dr. Dhanasree Jayaram and Yashaswini Patel

OPINION 29

Role of Internet of Things in Biological Warfare

Utkarsha Mahajan

COVER STORY 35

Pervasive Geopolitics, Elusive Science: The Quest for the Origins of SARS CoV-2

Anand V.

CHEMICAL AND BIOLOGICAL NEWS 40

Editorial

Executive Editor

Ajey Lele

Guest Editor

Kritika Roy

The COVID-19 scenario continues to get grimmer as researchers continue to discover new strains of COVID-19. Simultaneously, the vaccination drive has gained some momentum. Yet experts claim it would be long before the ongoing COVID threat is normalized. WHO did produce a report this March which did not fully uncover the virus's origin but called a lab leak "unlikely". Understanding the gravity of the situation, the current US administration has taken a renewed interest in strengthening and redoubling efforts to trace its origin. As researchers have pointed out the inability to understand the origins of COVID-19 would put the world at risk of future outbreaks. Dr Anand V., in this edition, has articulated "Pervasive Geopolitics, Elusive Science: The Quest for the Origins of SARS CoV-2" which provides insights into the investigation done by the WHO and the current geopolitical clout regarding COVID-19's origin.

Furthermore, Dr Malcolm Dando & et al. highlighted the importance of engaging the life science community for articulating an aspirational (ethical) code under the BTWC in a more detailed manner within national and professional settings. Despite the existence of several mechanisms and frameworks that regulate the use and production of CBWs, they continue to exist and pose risk to environmental and human health. In this context, the article "Unprecedented Environmental impacts of Chemical and Biological Warfare," by Dr Dhanasree Jayaram and Ms Yashaswini Patel attempts to analyse the environmental implications of chemical and biological warfare, by delving into historical examples, and providing an overview of futuristic implications from an environmental point of view. Technology, that has been used to combat the deadly outbreak could also become the source to unleash bio-warfare – the so called dual edged sword. In this regard, Ms Utkarsha Mahajan has noted the role of IoT and the future risks and prospects of this technology. This issue also comprises other features like Chemical and Biological News. With our readers' feedback, we wish to publish issues in the future that focus on a subject of particular concern. Contributions and feedback are welcome and can be addressed to: cbwmagazineeditor@gmail.com.

Invited Article

Towards an Aspirational (Ethical) Code under the Biological and Toxin Weapons Convention: Engaging the Life Science Community

Malcolm Dando, UK
Tatyana Novossiolova, Bulgaria
Michael Crowley, UK and Lijun Shang, UK

Summary

It is unclear at present how the proposal by China and Pakistan for an Aspirational (Ethical) Code under the BTWC will be taken forward through to the 9th Review Conference of the Convention in 2022. However, some difficult questions will have to be addressed for this process to be successful in producing a code that can then be implemented in more detailed codes of conduct and codes of practice in national and professional settings after the Review Conference. This paper addresses one such question: How might the Aspirational Code proposed by China and Pakistan in 2018 best be modified to make it easy to engage the life science community?

1. Introduction

The development of effective approaches and mechanisms for the governance of dual-use life sciences research – benignly intended research which could also be misused for hostile purposes, including the development of novel biological and toxin weapons – is an essential element of strengthening the international norm against biological weapons enshrined in the 1975 Biological and Toxin Weapons Convention (BTWC). Life sciences stakeholders, for example in academia, industry, or government have a fundamental role to play in the governance of dual-use life sciences research, not least because they are on the frontlines of driving innovation. The 2019 *Guidelines for Responsible Conduct in Veterinary Research* published by the World Animal Health Organisation (OIE) underscore that the "responsibility for the identification, assessment and management of dual-use implications rests to differing degrees across many stakeholders throughout the research life cycle": e.g. researchers, institutions, grant and contract funders, companies, educators, scientific publishers and other communicators, and regulatory authorities.[1] Fostering a culture of trust, personal responsibility, accountability and transparency that champions ethics in the workplace is an important prerequisite for the development and implementation of sustainable approaches and measures for the management of dual-use life sciences research.[2]

The utility of aspirational codes, such as codes of ethics and more detailed codes of conduct for promoting a shared recognition of and compliance with professional norms and ethics principles has been observed in different fields of professional practice, for example in medicine and biomedical research.[3] States Parties to BTWC have also noted the value of fostering a culture of responsibility amongst relevant national life sciences professionals and the voluntary development, adoption and promulgation of codes (of conduct)[*] with relation to strengthening the national implementation of the Convention.[4] During the current BTWC inter sessional meetings, codes and biological security education are being considered by the BTWC Meeting of Experts on Review of Developments in the Field of Science and Technology Related to the Convention.[5] In 2018, China and Pakistan tabled a joint proposal for the development of a code for biological scientists under the BTWC.[#] This proposal builds upon an earlier Working Paper that China submitted in 2015 ahead of the Eighth Review Conference of the BTWC.[6] Given the far-reaching implications of the COVID-19 global pandemic, the importance of engaging life sciences stakeholders with the prevention of biological threats and the risk of deliberate disease is likely to receive considerable attention at the 9th Review Conference of the BTWC.[7]

Exactly how the question of the further development of the code will be handled by States Parties in the lead up to the Review Conference, at the Review Conference and during the next inter sessional meetings after the Review Conference is not clear at this stage. However, some of the difficulties in achieving an agreement and getting it implemented in more detailed national and professional codes of conduct based on the aspirational code in diverse national and professional settings can be envisaged. One such difficulty, given the other pressures they experience, will be in getting life scientists to accept that the code is both relevant to their work and can be practically implemented within their concept of responsible conduct of research. Hence, it is essential to consider practical options for maximising the engagement of life science stakeholders both with the development and the promulgation of the proposed code.

The aim of this paper is to make suggestions about how the proposed China-Pakistan code might best be modified in order to be as easily acceptable as possible to the life science community. The paper is organised in the following sections: Section 2 gives a brief history of the work on codes for life scientists within the meetings of States Parties to the BTWC and presents the proposed China-Pakistan code; Section 3 provides an overview of the origins and development of the *Hague Ethical Guidelines* for chemists under the CWC; and Section 4 present a summary and analysis drawn from the vast general literature on how codes should be developed and implemented. This then leads in Section 5 to a comparative analysis of the original 2005 *Statement on Biosecurity* by the Inter Academy Panel, the *Hague Ethical Guidelines* and the proposed China-Pakistan code in the light of the preceding sections; and thus, in conclusion in Section 6 to some ideas about how the proposed China-Pakistan code might best be modified and what practical steps for its implementation could be considered.

2. Codes under the BTWC

The code proposed by China and Pakistan was first put forward by China at a BTWC meeting in 2015 and was then revised at a major international meeting of experts in Tianjin China before being put forward again in 2018.[8] This revised version of the code is shown in Table 1.

TABLE 1. The Code for Biological Scientists under the Biological Weapons Convention Proposed by China and Pakistan in 2018

States Parties to the Biological Weapons Convention recommend that biological scientists and research institutions shall follow the hereinafter code of conduct when conducting bio-science research and other related activities.

1. Ethical standard: Respect human life. Respect the dignity of humanity, and always revere life and consciously protect human rights. Respect social ethics, morality and social norms and traditions. Consciously maintain a harmonious relationship between humankind and the ecological environment. Constantly pay attention to the protection of the ecological environment. Consciously abide by legal regulations and standards governing scientific research. Refrain from behaviors intentionally or unintentionally ignoring laws and regulations and circumventing supervision.

2. Research integrity: Hold an attitude of rigor and integrity when conducting research. When conducting scientific research which is still controversial, researchers and institutions should fully consider the potential ethical and moral risks, strive to ensure that all those who may be affected benefit directly or indirectly from the research, and try to minimize possible hazards of the research.

3. Respect for the object of research: Respect the object of bio-science research, including human and non-human organisms. In researches involving the human subject, the legal rights and privacy of the human subject shall be fully protected, and his or her right of informed consent be guaranteed.

4. Process management for science research: Enhance risk control during the formulation and implementation of a bio-science research project. Conduct sufficient assessment and feasibility study on the possible threats the research process or outcomes may cause to health and society. Establish effective prevention and emergency response plans to mitigate relevant risks, and put in place a whole-process oversight mechanism on the research projects.

5. Constraint on the spread of research outcome: Strike a balance between public security and the freedom of research and speech. Use accurate and clear language when disseminating research outcomes to avoid misunderstanding from the general public. Limit or prohibit the dissemination of academic achievements which might be abused by non-state actors or pose threats to public health. The academic community shall publicly denounce academic misconduct in bio-research.

6. Popularization of science and technology: Attach great importance to popularization of biotechnology. Biological scientists have an obligation to educate the general public on bio-science and technology. When doing so, they are encouraged to make use of modern media and hi-tech means, to introduce both the positive impact and the potential risks of the bio-science development in an objective and comprehensive manner, and to assuage panic among the general public due to lack of information. Oppose fabrication of biotechnology events inconsistent with facts and news hyping.

7. Institution's role: Strengthen oversight of scientific institutions. Institutions shall conduct real-time monitoring and periodical assessment of research activities to mitigate potential risks and threats. Establish independent risk review committees within the institutions composed of scholars from relevant fields. Improve evaluation mechanism on publication of bio-science results.

8. Education and training: Scientific community and professional associations should play an active role in education and training. Increase public awareness of the Convention, and establish a safe education and training system for all parties involved in biotechnology research. Biological scientists should be encouraged to engage in dialogue and cooperation with social scientists, philosophers and anthropologists, so as to have a better understanding of the possible ethical and social implications of relevant biological research and its outcome.

9. Awareness and engagement: Biological scientists should be fully aware of the potential threats of dual-use research to human society, ecological environment and economic security. It is advocated to promote the peaceful application of biological research achievements, to prevent the abuse and misuse of biological products, scientific knowledge, technology and equipment, and to consciously resist any unethical scientific conducts that are harmful to human society.

10. International exchanges: Actively participate in international cooperation in the field of bio-science and technology research. Actively explore models and avenues for sharing bio-science achievements. Biological scientists around the world are encouraged to work closely for progress and innovation in bio-science and technology through learning from and inspire each other, with a view to promote the well-being and health of humankind.

Source: China and Pakistan, 2018[9]

The China-Pakistan code is an important initiative that will hopefully encourage increased substantive and sustained engagement by an ever-growing and more diverse number of States through relevant BTWC meetings and mechanisms. It builds on previous presentations and discussions under the BTWC,[10] and has also been extensively discussed by both BTWC State Parties and the broader life science community since its first presentation.

The value of codes of conduct in engaging life scientists with biological security issues has been recognised by BTWC States Parties. As part of the Intersessional Programme of Work agreed by the Fifth Review Conference of the BTWC, in 2003-2005 States Parties to the BTWC considered, *inter alia,* the topic of "content, promulgation, and adoption of codes of conduct for scientists".[11] As part of the Intersessional Programme of Work agreed by the Sixth Review Conference of the BTWC, in 2007-2010 States Parties considered the topic of "adoption and/or development of codes of conduct with the aim of preventing misuse in the context of advances in bio-science and bio-technology research with the potential of use for purposes prohibited by the Convention."[12] As part of the Intersessional Programme of Work agreed by the Seventh Review Conference of the BTWC, in 2012-2015 the topic of "voluntary codes of conduct and other measures to encourage responsible conduct by scientists, academia and industry" was considered by States Parties under the Standing Agenda Item on the "Review of developments in the field of science and technology related to the Convention."[13] During the current Intersessional Process 2018-2020, States Parties have agreed to consider the topic of the "development of a voluntary model code of conduct for biological scientists and all relevant personnel."[14]

At the 2008 Meeting of Experts, the Netherlands presented a Working Paper that reported on the development of a *national code of conduct* for biosecurity that had been developed by the Royal Netherlands Academy of Arts and Sciences (KNAW).[15] There are two importat features of the Netherlands Working Paper

Table 2: Main Elements of the Netherlands National Code of Conduct for Biosecurity

Basic Principles
Target Group
Rules of conduct
Raising awareness
Research and publication policy
Accountability and oversight
Internal and external communication
Accessibility
Shipment and transport

Source: Netherlands, 2008[16]

The first point of importance is that the Working Paper carefully distinguished between different kinds of codes and their functions. This differentiation was set out as in Table 3. The Netherlands paper drew this differentiation from a paper by the Sociologist Professor Brain Rappert.[17] Rappert argued that it was critical to differentiate between these different kinds of codes because discussions would become impossibly muddled if people were talking about different kinds of code. As indicated in the Working Paper, the Netherlands national code of conduct was "to be seen as a contribution to awareness raising".[18]

TABLE 3: Types of Codes and their Functions

Type	**Name**	**Main Aims**
Aspirational codes	Code of Ethics	Alert; set realistic or idealistic standards
Educational/Advisory codes	Code of Conduct	Provide guidelines, raise awareness & debate; foster moral agents
Enforceable codes	Code of Practice	Prescribe or proscribe certain acts

Source: Brian Rappert, 2004[19]

The second feature of interest is that the Netherlands code was developed after a *Statement on Biosecurity* that had been published by the Inter Academy Panel in 2005. The Statement which by then had been endorsed by 68 National Academies was included as an annex to the Working paper as shown in Table 4. It is clear that this was an Aspirational (Ethical) Code similar to the Hippocratic Oath and not a detailed code of conduct or code of practice.

TABLE 4: Statement on Biosecurity of the Inter Academy Panel

1. **Awareness**. Scientists have the obligation to do no harm. They should always take into consideration the reasonably foreseeable consequences of their own activities. They should, therefore: 1) always bear in mind the potential consequences - possibly harmful - of their research and recognize that individual good conscience does not justify ignoring the possible misuse of their scientific endeavour; 2) refuse to undertake research that has only harmful consequences for humankind.
2. **Safety and Security**. Scientists working with agents such as pathogenic organisms or dangerous toxins have a responsibility to use good, safe and secure laboratory procedures, whether codified by law or by common practice.
3. **Education and Information**. Scientists should be aware of, disseminate and teach the national and international law and regulations, as well as policies and principles aimed at preventing the misuse of biological research.
4. **Accountability**. Scientists who become aware of activities that violate the Biological and Toxin Weapons Convention or international customary law should raise their concerns with appropriate people, authorities and agencies.
5. **Oversight**. Scientists with responsibility for oversight of research or for evaluation of projects or publications should promote adherence to these principles by those under their control, supervision or evaluation.

Source: IAP, 2005[20]

The *Netherlands National Code of Conduct for Biosecurity* itself, for example, was taken into account in a *Code of Conduct for Biological Resource Centres* presented by the Global Biological Resource Centres Network (GBRCN) in an NGO Statement at the Seventh Review Conference of the BTWC in 2011.[21] However, it is quite clear that there was not a large-scale implementation of such codes derived from the Netherlands code and the principles set out and agreed by many National Academies. *The major likely cause of this failure is almost certainly the enormous amount of effort that is necessary to engage the life science community in the process of effectively developing and implementing such codes.* As a Working Paper by Australia put it at the 2005 BTWC meeting:[22]

> "Amongst the Australian scientific community, there is a low level of awareness of the risk of misuse of the biological sciences to assist in the development of biological or chemical weapons. Many scientists working in 'dual-use' areas simply do not consider the possibility that their work could inadvertently assist in a biological or chemical weapons programme. For most of these researchers, biological weapons

issues may seem irrelevant and therefore strong advocacy is required to overcome natural resistance or ignorance…"

Therefore, the Working Paper continued:

> "…Introducing Codes of Conduct that highlight these issues is an important step in raising awareness. However, it is not enough simply to put such Codes in place. *Without effective measures to educate scientists about the existence and importance of such Codes, attitudes and awareness will remain largely unchanged."* (Emphasis added)

In drawing these conclusions together Australia's view was based on an extensive public awareness and communication strategy that it had employed in order to impress on the general population and scientific community of the importance of its quarantine policy to keep the country free of foreign species.

Contemporaneous and subsequent initiatives supporting such codes were undertaken by a wide range of scientific associations and organizations, including the American Society of Microbiology, the US National Academy of Sciences, the UK Royal Society, the International Centre for Genetic Engineering and Biotechnology, the International Union of Biochemistry and Molecular Biology and the International Council for the Life Sciences.[23] These activities have been complemented and stimulated by the ICRC as well as the work of individual scientists and academics.[24]

Further work, prior to and during the 2012-2015 BTWC Intersessional Process, to develop and promulgate codes for life scientists as well as associated policies on for example biosecurity, was undertaken in different States including Indonesia and Malaysia.[29] Consideration should also be given to the full range of Statements and Working Papers submitted by States and relevant reports and materials civil society scientific associations during or on the margins of MSPs and MXs.[26]

3. The Hague Ethical Guidelines under the CWC

In comparison to the time and energy expended by a diverse range of organizations in the life sciences, the chemical science community's efforts to develop codes were (initially at least) more limited and mainly focused upon the activities of the International Union of Pure and Applied Chemistry (IUPAC).[27] In 2004, the IUPAC President and the Director-General of the OPCW agreed on a joint project on chemistry education, outreach and the professional conduct of chemists. This led to a joint IUPAC/OPCW international workshop in 2005, which concluded that codes were needed for all those engaged in science and technology using chemicals, so as to "protect public health and the environment and to ensure that [such] activities … are, and are perceived to be, in compliance, with international treaties, national laws and regulations such as those relating to illicit drugs, chemical and biological weapons, banned and severely restricted chemicals."[28] The workshop also concluded that such codes were "complementary to national implementing legislation for the CWC" and would "help to achieve in-depth compliance throughout academia, industry, and government of those engaged in science and technology using chemicals". They would also "extend awareness of the general-purpose criteria of both the CWC and the BTWC and thus help ensure its effective implementation". The workshop recommended that IUPAC should develop a model code of principles as well as draft elements for codes that might be promulgated to IUPAC national adhering authorities (NAOs) and associate national adhering authorities (ANAOs), urging them to review any existing codes to ensure these elements are included.[29] IUPAC and its Committee on Chemical Research Applied to World Needs (CHEMRAWN) subsequently initiated a project to develop such a code.[30] The group tasked with this project subsequently concluded that rather than drafting a single formal code, it would be more effective and persuasive to develop guiding principles, that is an Aspirational (Ethical) Code, that should then be considered by those developing any future codes of conduct for specific associations or other bodies. This reflected the view that codes are more likely to be accepted and implemented if they are developed by those to whom they will apply, thereby fostering a sense of 'ownership' amongst practitioners.[31]

In December 2014, in his *Statement* to the 19th CWC Conference of States Parties (CSP), the German Ambassador introduced his country's proposal for a "Hippocratic Oath" for chemists. Whilst acknowledging the importance of action and responsibility by States, he stated:

> "In order to free the world entirely of the danger of chemical weapons, we also have to appeal to the responsibility of individuals…who have the capability to develop and produce chemical weapons. This is the reason why Germany has submitted the proposal of a code [of conduct] for chemical professionals…. Similar to the Hippocratic oath…this concise text could lay the moral basis for the work of chemical professionals."[32]

The Conference formally:

> "**welcomed** the initiative for a text of ethical guidelines for chemical professionals related to the Convention" it further "**invited** the [OPCW's Technical] Secretariat to inform the Council of its efforts for the advancement of the initiative and its objectives in close collaboration with relevant professional and chemical industry organisations", and finally "**encouraged** States Parties to discuss the matter further."[33] (bold highlighting as original)

The German government subsequently provided dedicated funding for two workshops held in 2015 to explore these issues and develop an ethical guidelines text.[34] This project was supported and organised under the auspices of the Scientific Advisory Board of the OPCW; and the work was undertaken by an independent international group of scientists from the chemical industry and academia in 24 countries and from all world regions. This participatory approach of reaching an agreement could usefully be applied in the further development of a code under the BTWC. The independent group worked "to define and harmonize key elements of ethical guidelines as they relate to chemical weapons based on existing codes." [35] As part of this process, the group and the Technical Secretariat of the OPCW compiled and analysed a non-exhaustive collection of codes of ethics and conduct (and related guidelines).[36]

The resulting *Hague Ethical Guidelines,* echoing previous IUPAC thinking, are a set of principles — an Aspirational (Ethical) Code — that can be used to support both the development of new codes, and also to review existing codes, in order to ensure they align with the provisions of the CWC. The drafters note that "A code need not mention chemical weapons or the CWC to support its basic goals, and provisions may need to be tailored for particular sectors or circumstances, while still reflecting the fundamental values."[37] However, it should also be noted that whilst this referred to the range of codes informed by the guidelines, the introductory paragraphs contained in both the *Hague Guidelines Brochure* and the relevant promotional pages of the OPCW website clearly situate the guidelines as measures to promote adherence to the CWC.

The *Hague Ethical Guidelines* have subsequently been disseminated widely to professional societies, academia and industry organisations throughout the world. They have been endorsed by IUPAC and the International Council of Chemical Associations (ICCA).[38] Furthermore, in April 2016, the American Chemical Society (ACS) gathered 30 scientists from 18 countries for a workshop in Kuala Lumpur, Malaysia to collaboratively draft an actionable *Global Chemists' Code of Ethics* (GCCE), which was guided in part by The *Hague Ethical Guidelines*. This process was coordinated with assistance and support from the U.S. Department of State's Chemical Security Program (CSP) and Pacific Northwest National Laboratory (PNNL). [39]

The *Hague Ethical Guideline* as shown on the OPCW website are listed in Table 5. It should be noted that the OPCW continues to promote and promulgate these guidelines, particularly through the work of the Advisory Board on Education and Outreach (ABEO).

TABLE 5: The Hague Ethical Guidelines

The Key Elements Achievements in the field of chemistry should be used to benefit humankind and protect the environment. *1. Sustainability* Chemistry practitioners have a special responsibility for promoting and achieving the UN Sustainable Development Goals of meeting the needs of the present without compromising the ability of future generations to meet their own needs. *2. Education* Formal and informal educational providers, enterprise, industry and civil society should cooperate to equip anybody working in chemistry and others with the necessary knowledge and tools to take responsibility for the benefit of humankind, the protection of the environment and to ensure relevant and meaningful engagement with the general public. *3. Awareness and Engagement* Teachers, chemistry practitioners, and policymakers should be aware of the multiple uses of chemicals, specifically their use as chemical weapons or their precursors. They should promote the peaceful applications of chemicals and work to prevent any misuse of chemicals, scientific knowledge, tools and technologies, and any harmful or unethical developments in research and innovation. They should disseminate relevant information about national and international laws, regulations, policies and practices. *4. Ethics* To adequately respond to societal challenges, education, research and innovation must respect fundamental rights and apply the highest ethical standards. Ethics should be perceived as a way of ensuring high-quality results in science. *5. Safety and Security* Chemistry practitioners should promote the beneficial applications, uses, and development of science and technology while encouraging and maintaining a strong culture of safety, health, and security.

6. Accountability

Chemistry practitioners have a responsibility to ensure that chemicals, equipment and facilities are protected against theft and diversion and are not used for illegal, harmful or destructive purposes. These persons should be aware of applicable laws and regulations governing the manufacture and use of chemicals, and they should report any misuse of chemicals, scientific knowledge, equipment and facilities to the relevant authorities.

7. Oversight

Chemistry practitioners who supervise others have the additional responsibility to ensure that chemicals, equipment and facilities are not used by those persons for illegal, harmful or destructive purposes.

*8. Exchange of Information*Chemistry practitioners should promote the exchange of scientific and technical information relating to the development and application of chemistry for peaceful purposes.

Source: OPCW, 2015[40]

4. Key Considerations in the Development and Implementation of Codes

Codes of conduct and codes of ethics are essential elements of professional culture, as they outline a set of shared principles and norms that practitioners agree to abide by. These principles and norms reflect both the way a given profession has evolved and the way it related to its broader social milieu. By design, codes of conduct and codes of ethics are self-governance instruments that enable practitioners in different domains to maintain a certain degree of autonomy in their affairs and preserve the integrity of their professional culture.[41] Hence, the processes of developing and amending existing codes of conduct and codes of ethics are deliberative processes that primarily involve representatives of the respective professional domain. It follows from here that the process of developing an Aspirational (Ethical) Code of Conduct for Life Scientists within the framework of the BTWC should ensure the active engagement of life science stakeholders in academia, industry, and government. As life science, stakeholders will also be the ones directly involved in the implementation of the code, so it is vital that they take ownership of the development process and view the code as an integral element of their professional practice.

As regards the practical development of codes, there is a vast literature devoted to the questions of how these should be developed and implemented. We do not need to go into great detail here as it was done thoroughly by the OPCW in its work on the *Hague Ethical Guidelines*. However, in the presentations by the OPCW's Scientific Advisory Board to the BTWC, the importance of the resources available in the *Ethics Codes Collection* at the Illinois Institute of Technology was acknowledged.[42] This contains, for example, a guide to developing an effective code of conduct with a list of 15 points that need to be checked.[43] We have extracted some of the points to be checked that seem to be most relevant here in Table 6.

TABLE 6: Best Practices Checklist for Developing an Effective Code of Conduct

- Are the code's provisions in line with the goals of the organization's overall ethics program?
- Does the code use clear, concise language that can be easily understood by employees at all levels of the organization?
- Does the code adequately address all areas that impact the organization, particularly those areas that offer the highest potential for risk?
- Are appropriate training methods being used, both during the code implementation phase as well as on an ongoing basis?
- Does the code include a decision tree or similar mechanism to guide employees when faced with an ethical dilemma?
- Does the code include relevant examples, case studies, or real-world scenarios that employees typically face on a daily basis?
- Is top leadership on board with the code development process, and has it been consulted as the process unfolds?
- Has input been sought from employees and stakeholders during the information gathering process?

Source: Lighthouse, 2013[44]

The collection of material on the Illinois website also includes a long article devoted entirely to the question of how to write a code.[45] One particular section asks what should be said about each element (termed a standard) in the code. These requirements are set out in Table 7.

TABLE 7: Key Components for each Element of the Code

1. Provide a rationale to explain the need for the element.
2. Provide a clear definition of the element.
3. Provide clear guidance through examples so that people understand their responsibilities.
4. Discuss additional resources for information.

Source: Martens, 2005[46]

It may appear that this is too detailed for an Aspirational (Ethical) Code but the general point stands: it is necessary to have a very clear idea of what is stated about each element of the code and why it is stated. This is particularly relevant here as it is clearly not easy to communicate ethical and security issues to practicing life scientists.

5. Comparison of the IAP Statement, the Hague Ethical Guidelines and the Proposed Code

Despite the differences in the issues addressed and the methodologies employed, it is useful for our purposes to compare the elements in these three Aspirational (Ethical) Codes: the proposed China-Pakistan code under the BTWC (Table 1); the IAP *Statement on Biosecurity* (Table 4); and the *Hague Ethical Guidelines* under the CWC (Table 5), and to investigate where and why they are similar or different.

5.1 The Elements of the Code and their ordering

On the OPCW website, the *Hague Ethical Guidelines* are contextualised by an introductory text setting out their nature and purpose i.e. "a set of ethical guidelines informed by the Chemical Weapons Convention", intended "to promote a culture of responsible conduct in the chemical sciences and to guard against the misuse of chemistry", whilst a more extensive introduction is provided in the OPCW's *Hague Guideline Brochure*.[47] The framing on the website is reminiscent of the introduction to the 2008 Netherlands national code of conduct which began by stating that:

> "The aim of this Code of Conduct is to prevent life sciences research or its application from directly or indirectly contributing to the development, production or stockpiling of biological weapons, as described in the Biological and Toxin Weapons Convention (BTWC), or to any other misuse of biological agents and toxins."[48]

An analogous approach would also seem to be sensible for an Aspirational (Ethical) Code as it meets the need of ensuring that the objective of having the code is clearly understood from the very outset without having to have a separate justification in each element of the code.

It should also be noted that the elements of the *Hague Ethical Guidelines* are directly focused on the chemical practitioner and what he or she should do. By contrast, the elements of the proposed code under the BTWC frequently do not focus directly on the life science practitioner. Indeed, after a long paragraph of introduction, the elements are clearly stated to be aimed at "biological scientists and research institutions" in a short paragraph immediately prior to the elements. For comparison under the *Hague Ethical Guidelines* "chemical practitioners" are mentioned in elements 1, 3, 5, 6, 7 and 8; and additionally, "education providers" (i.e., chemists) are mentioned in element 2. Only element 4 on ethics does not take this general approach. It would seem sensible to consider the approach of the guidelines in any revision of the proposed code. We suggest that the effectiveness of the China-Pakistan code to promote awareness and change behaviour would be significantly increased if it were reframed so that most elements specifically addressed its key audience: individual life science practitioners in academic, industry, or government settings. However, it is important that the elements of the code directed at research institutions and other entities are preserved, as they help underscore the role that organisational culture plays in reinforcing and strengthening professional norms and practices.

It is also clear that some elements of the guidelines and the proposed code relate to the same issue: so element 1 of the code on Ethical standard covers the same topic as element 4 of the guidelines on Ethics; element 8 of the code on Education covers the same issue as element 2 of the guidelines on Education; element 9 of the code on Awareness and engagement covers the same element 3 of the guidelines on Awareness and engagement; element 10 of the code on International exchanges covers the same issue as element 8 of the guidelines on Exchange of information. While it is not quite so easy to see just from the titles, there are also commonalities between element 2 of the code on Research integrity and element 5 of the guidelines on Safety and security, between element 4 of the code on Process management for science research and element 7 of guidelines on Oversight and also between element 7 of the code on Institution's role and element 6 of the guidelines on Accountability. These corresponding elements are set out in Table 8.

TABLE 8: Corresponding Elements of the China Pakistan Code and the Guidelines

CHINA PAKISTAN CODE	HAGUE *GUIDELINES*
Element 1: Ethical standards	Element 4: Ethics
Element 8: Education and training	Element 2: Education
Element 9: Awareness and engagement	Element 3: Awareness and engagement
Element 10: International exchanges	Element 8: Exchange of information
Element 2: Research integrity	Element 5: Safety and security
Element 4: Process management	Element 7: Oversight
Element 7: Institution's role	Element 6: Accountability

These commonalities are to be expected in the closely related fields of chemistry and the life sciences. There are also elements in which the code and the guidelines differ, and again these are understandable. The guidelines start with element 1 on Sustainability and must relate to concerns about achieving the UN Development Goals without despoiling the environment with dangerous chemicals. Safely achieving these goals is just as important in regards to the life sciences, but element 3 of the code on Respect for the object of research relates to the more likely possibility of life scientists being involved in research on animals and human beings. The code also has two more elements than the guidelines and these two elements – 6 on the Popularisation of science and technology and 5 on Constraint on the spread of research outcome – relate to the problem of both publicising the gains to society from scientific advances and preventing the misuse of such gains.

Finally, it is clear from the diversity of codes under the BTWC put forward since 2005[49] that it will not be easy to find agreement on the elements that should be in a code. One way that may help to decide what should be the elements might be to ask what would be the simplest way forward? For example, given that the OPCW has made important progress in developing, disseminating and promoting the *Hague Ethical Guidelines* and has resources available to foster further action, notably through its ABEO, and that there is a clear ongoing integration (convergence) of chemistry and the life sciences that will continue well into the future, it may be sensible for the aspirational code's drafters and the BTWC States Parties more generally to consider the potential scope for synergy in the promotion of ethical guidance amongst the chemical and life science communities. This may be facilitated by examining how best to reinforce the common messages from both codes, which in turn may, in part, be aided by examining the possible structural alignment of the two codes by reordering certain elements of the proposed aspirational code so that they fit more closely to the order of the guidelines. The two extra elements of the code on information spread and constraint could then come at the end. The ordering of the elements of such a rearranged code is set out in Table 9.

TABLE 9: A Rearrangement of the Elements of the Proposed Aspirational Code

Introduction: Annunciating the role and purpose of the Code in promoting respect for the BTWC
Element 1: Ethical Standards
Element 2: Education and training
Element 3: Awareness and engagement
Element 4: Respect for the object/subject of research
Element 5: Research integrity
Element 6: Process management for dual-use science research
Element 7: Institution's role/Oversight
Element 8: International exchanges
Element 9: Constraint on the spread of research
Element 10: Popularisation of science and technology

We also think that the position of education and awareness and engagement is well placed as elements 2 and 3 of the code as there is considerable later evidence that Australia (see Section 2) was completely correct in its 2005 judgement that without systematic awareness-raising and extensive educational foundation no code is going to be effectively implemented and really affect the behaviour of people for the common good.[50]

5.2 The Content (Wording) of the Elements of the Code

Turning then to what might be the *content* of each of the elements in the code, it is easy to see that there is a very close resemblance in the elements of the *IAP Statement on Biosecurity* and the *Hague Ethical Guidelines* as shown in Table 10.

Table 10: Comparison of the Elements of the IAP Statement and the Hague Ethical Guidelines

IAP STATEMENT	*HAGUE GUIDELINES*
1. Awareness	3. Awareness and Engagement
2. Safety and Security	5. Safety and Security
3. Education and Information	2. Education/8. Exchange of Information
4. Accountability	6. Accountability
5. Oversight	7. Oversight
	1. Sustainability
	4. Ethics

So, the *Hague Ethical Guidelines* have the extra elements of Sustainability (1) and Ethics (4) and have separated Exchange of Information (8) from Education (2). The inclusion of Sustainability is understandable as the issue of sustainable development had loomed much larger in 2015 than in 2005, and the same might well be said in regard to Ethics. The wording of the common elements in the IAP Statement and the Hague Guidelines are set out in Table 11.

Table 11: Wording for the Common Elements of the IAP Statement and the Hague Guidelines

The elements of the IAP *Statement on Biosecurity* are shown first with the Element shown in **bold** and the Element from the *Hague Ethical Guidelines* with the Element shown in *italics*.

1. Awareness. Scientists have the obligation to do no harm. They should always take into consideration the reasonably foreseeable consequences of their own activities. They should, therefore:

1) always bear in mind the potential consequences - possibly harmful - of their research and recognize that individual good conscience does not justify ignoring the possible misuse of their scientific endeavour;

2) refuse to undertake research that has only harmful consequences for humankind.

3. *Awareness and Engagement Teachers, chemistry practitioners, and policymakers should be aware of the multiple uses of chemicals, specifically their use as chemical weapons or their precursors. They should promote the peaceful applications of chemicals and work to prevent any misuse of chemicals, scientific knowledge, tools and technologies, and any harmful or unethical developments in research and innovation. They should disseminate relevant information about national and international laws, regulations, policies and practices.*

2. Safety and Security. Scientists working with agents such as pathogenic organisms or dangerous toxins have a responsibility to use good, safe and secure laboratory procedures, whether codified by law or by common practice.

5. *Safety and Security Chemistry practitioners should promote the beneficial applications, uses, and development of science and technology while encouraging and maintaining a strong culture of safety, health, and security.*

3. Education and Information. Scientists should be aware of, disseminate and teach the national and international law and regulations, as well as policies and principles aimed at preventing the misuse of biological research.

2 *Education Formal and informal educational providers, enterprise, industry and civil society should cooperate to equip anybody working in chemistry and others with the necessary knowledge and tools to take responsibility for the benefit of humankind, the protection of the environment and to ensure relevant and meaningful engagement with the general public.*

8. *Exchange of Information Chemistry practitioners should promote the exchange of scientific and technical information relating to the development and application of chemistry for peaceful purposes.*

4. **Accountability. Scientists who become aware of activities that violate the Biological and Toxin Weapons Convention or international customary law should raise their concerns with appropriate people, authorities and agencies.**

6. *Accountability Chemistry practitioners have a responsibility to ensure that chemicals, equipment and facilities are protected against theft and diversion and are not used for illegal, harmful or destructive purposes. These persons should be aware of applicable laws and regulations governing the manufacture and use of chemicals, and they should report any misuse of chemicals, scientific knowledge, equipment and facilities to the relevant authorities.*

5. **Oversight. Scientists with responsibility for oversight of research or for evaluation of projects or publications should promote adherence to these principles by those under their control, supervision or evaluation.**

7. *Oversight Chemistry practitioners who supervise others have the additional responsibility to ensure that chemicals, equipment and facilities are not used by those persons for illegal, harmful or destructive purposes.*

Given that all of this wording has already been widely accepted within the scientific community it would seem sensible to use such wording in the revised aspirational code under the BTWC where that is appropriate.

6. Conclusions

We suggest that in the further discussions of the Aspirational (Ethical) Code under the BTWC and the development of the proposal by China and Pakistan it would be useful to consider the following ideas:

1. All of the elements of the code should have wording (content) that is as short and concise as possible so that the whole code is easily understood and remembered by practicing scientists.

2. The code should be introduced by a very concise statement of its purpose analogous to that used in the national code of conduct developed by the Royal Netherlands Academy of Arts and Sciences in 2008.

3. As far as is possible, the elements of the code should focus on the 'science practitioner' in an analogous way to the way that the *Hague Ethical Guidelines* for the Chemical Weapons Convention focus on the 'chemical practitioner.'

4. While it might be difficult to achieve a consensus on the elements of a universal biological security code and their contents, there is sufficient commonality in the elements and contents in the existing codes related to the BTWC for a compromise solution to be possible.

5. Because of the continuing integration of the chemical and biological sciences the order of the elements of the aspirational code should be aligned as far as possible with the order of the comparable elements in the *Hague Ethical Guidelines*.

6. In order to emphasise the necessity of regular, mandatory, certificated courses in biological security for all life science

practitioners to underpin the code, education and awareness-raising should be placed high on the order of the elements of the code just after the ethics element.

7. Advantage should be taken of the fact that the wording in the IAP *Biosecurity Statement* and the *Hague Ethical Guidelines* is widely known within the scientific community to use the wording in these two documents where it is appropriate in the Aspiration (Ethical) Code under the BTWC.

8. In order to facilitate the effective promulgation and consequent implementation of the proposed Aspirational (Ethical) Code under the BTWC, it is important to ensure that life science stakeholders are actively engaged in the process of the development of the code as in the participatory approach used to develop the *Hague Ethical Guidelines*.

Acknowledgements

This paper was funded by London Metropolitan University via the *Research England QR Fund* and by *the Joseph Rowntree Charitable Trust*. It was produced as part of a wider project on *Strengthening the Chemical and Biological Weapons Conventions*. We would like also to thank the five UK and international colleagues who kindly commented on the final draft of this paper.

Contributors

Malcolm Dando*: Leverhulme Emeritus Fellow, Division of Peace Studies University of Bradford, Bradford, UK. mrdando@Bradford.ac.uk*

Tatyana Novossiolova*: Research Fellow, the Law Program of the Center for the Study of Democracy, Bulgaria. tatyana.novossiolova@csd.bg*

Michael Crowley*: Senior Visiting Research Fellow, Division of Peace Studies University of Bradford, Bradford, UK. m.j.a.crowley1@bradford.ac.uk*

Lijun Shang*: Professor of Biomedical Sciences, School of Human Sciences, London Metropolitan University, London, UK. L.shang@londonmet.ac.uk*

Endnotes:

[*] The terminology traditionally used for codes is confusing as 'code of conduct' is sometimes used to cover different kinds of codes – aspirational, conduct and practice, and the particular type of code - of conduct - that gives guidance on appropriate behaviour in the workplace. We have sought to avoid confusion in the rest of this paper by using just the word 'code' to cover codes in general and 'code of conduct' to refer only to codes that give guidance in the workplace.

[#] For reasons explained in the paper, we describe this as an Aspirational (Ethical) Code similar to the Hippocratic Oath and the Hague Ethical Guidelines for chemists.

[1] World Organisation for Animal Health (2019), *Guidelines for Responsible Conduct in Veterinary Research: Identifying, Assessing, and Managing Dual Use*, https://www.oie.int/fileadmin/Home/eng/Our_scientific_expertise/docs/pdf/BTR/A_GUIDELINES_VETERINARY_RESEARCH.pdf.

[2] World Health Organisation (2020), *WHO guidance on implementing regulatory requirements for biosafety and biosecurity in biomedical laboratories- a stepwise approach*, 6 December, https://www.who.int/publications/i/item/who-guidance-on-implementing-regulatory-requirements-for-biosafety-and-biosecurity-in-biomedical-laboratories—a-stepwise-approach.

[3] Revill, J. and Dando, M. R. (2006) A Hippocratic Oath for life scientists. *EMBO reports*, 7, 555 – 560.

4 Eighth Review Conference of the States Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction (2017) *Final Document of the Eighth Review Conference*, BWC/CONF.VIII/4. United Nations, Geneva, 11 January.

5 Meeting of the States Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction (2017) *Report of the Meeting of States Parties*, BWC/MSP/2017/6. United Nations, Geneva, 19 December.

6 China (2015) *Proposal for the development of the template of biological scientist code of conduct under the Biological Weapons Convention*, BWC/MSP/2015/WP.9. United Nations, Geneva, 15 December.

https://documents-dds-ny.un.org/doc/UNDOC/GEN/G15/285/28/pdf/G1528528.pdf?OpenElement

7 Shang, L. (2021) *Biological and Chemical Security After COVID-19: Options for Strengthening the Chemical and Biological Weapons Disarmament and Non-Proliferation Regimes*. London Metropolitan University, London. January.

8 China and Pakistan (2018) *Proposal for the Development of a model code of conduct for biological scientists under the Biological Weapons Convention*. BWC/MSP/2018/MX2/WP.9. United Nations, Geneva, 9th August.

9 China and Pakistan (2018) *Proposal for the Development of a Model Code of Conduct for Biological Scientists under the Biological Weapons Convention*, BWC/MSP/2018/MX.2/WP.9. United Nations, Geneva,9 August. Available at https://undocs.org/en/BWC/MSP/2018/MX.2/WP.9

10 See, for example, Chile et al. (2014) *Code of Conduct for Scientists,* BWC/MSP/2014/WP.6, United Nations, 2 December, https://undocs.org/es/BWC/MSP/2014/WP.6.

11 Fifth Review Conference of the States Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction (2002). *Final Document,* BWC/CONF.V/17, United Nations, Geneva, https://undocs.org/BWC/CONF.V/17.

12 Sixth Review Conference of the States Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction (2006). *Final Document,* BWC/CONF.VI/6, United Nations, Geneva, https://documents-dds-ny.un.org/doc/UNDOC/GEN/G07/600/30/PDF/G0760030.pdf?OpenElement.

13 Seventh Review Conference of the States Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction. (2011). *Final Document,* BWC/CONF.VII/7, United Nations, Geneva, https://documents-dds-ny.un.org/doc/UNDOC/GEN/G12/600/60/pdf/G1260060.pdf.

14 Biological and Toxin Weapons Convention (2021). Science and Technology under the Biological Weapons Convention, https://www.un.org/disarmament/biological-weapons/science-and-technology.

15 Netherlands (2008) *Development of a Code of Conduct on Biosecurity*. BWC/MSP/2008/MX/WP.8. United Nations, Geneva, 30 July.

16 https://www.knaw.nl/en/news/publications/a-code-of-conduct-for-biosecurity

17 Brian Rappert (2004) *Towards a life sciences code: countering the threats from biological weapons*. Strengthening the Biological Weapons Convention, Briefing Paper 13, Second Series. Department of Peace Studies, University of Bradford, https://bradscholars.brad.ac.uk/handle/10454/795

18 Netherlands (2008) *Development of a Code of Conduct on Biosecurity*. BWC/MSP/2008/MX/WP.8. United Nations, Geneva, 30 July.

19 Brian Rappert (2004) *Towards a life sciences code: countering the threats from biological weapons*. Strengthening the Biological Weapons Convention, Briefing Paper 13, Second Series. Department of Peace Studies, University of Bradford, https://bradscholars.brad.ac.uk/handle/10454/795

20 https://www.interacademies.org/statement/iap-statement-biosecurity

21 Rhode, C. *et al* (2013) Code of Conduct on Biosecurity for Biological Resource Centres:

procedural and implementation. *International Journal of Systematic and Evolutionary Microbiology*, 63, 2374 – 2382.

22 Australia (2005) *Raising Awareness: Approaches and Opportunities for Outreach*. BWC/MSP/2005/MX/WP.29, United Nations, Geneva, 21 June.

23 American Society of Microbiology, *Code of Ethics* (Revised and approved by ASM Council in 2005, Washington, DC; Royal Society, *The Roles of Codes of Conduct in Preventing the Misuse of Scientific Research*. RS Policy Document 3/05. London: Royal Society, 2005.

24 See, for example, Revill, J. and Dando, M. A Hippocratic Oath for Life Scientists, *EMBO Reports*, volume 7, 2006; Atlas, R. and Somerville, M. Life Sciences and Death Science: Tipping the Balance towards Life with Ethics, Codes and Laws, pp.15-30, in McLeish, C. and Rappert, B. *A Web of Prevention*

Biological Weapons, Life Sciences and the Governance of Research, Taylor & Francis Group, London, 2007

25 See, for example, Science and Technology Research Institute for Defence (STRIDE) et al. (2015), *Workshop on the Development of a National Code of Conduct for Biosecurity within the Framework of the Biological and Toxin Weapons Convention*, Academy of Sciences, Malaysia.

26 See for example: BWC Implementation Support Unit. (2008). *Developments in Codes of Conduct since 2008*. BWC/MSP/2008/MX/INF.2. 26 June, United Nations, Geneva. https://meetings.unoda.org/section/bwc-mx-2008-documents/

27 For further discussion of the role of IUPAC and the broader chemical science community in preventing misuse of the chemical sciences see: Crowley, M. *Chemical Control*, Palgrave Macmillan, 2015, pp.241-257; Crowley, M. Dando, M. and Shang, L, *Preventing Chemical Weapons: Arms Control and Disarmament as the Sciences Converge*, Royal Society of Chemistry, 2018, in particular chapter by Bowman, K, Hay, A and Husbands, J., pp.517-535.

28 Pearson, G. and Mahaffy, P. (2006) Education, Outreach, and Codes of Conduct to Further the Norms and Obligations of the Chemical Weapons Convention (IUPAC Technical Report), *Pure and Applied Chemistry*, 78, p. 2186.

29 Pearson, G. and Mahaffy, P. (2006) op.cit., p. 2186

30 IUPAC Project: CHEMRAWN XVIII – Ethics, Science and Development, http://www.iupac.org/web/ins/2009-013-1-021

31 See Pearson, G., Becker, E. and Sydnes, L. Why Codes of Conduct Matter, *Chemistry International*, volume 33, number 6, November–December 2011, pp.7-11. See also: IUPAC, *Statement by Prof. Alastair W. M. Hay and Prof. Graham S. Pearson on Behalf of the International Union of Pure and Applied Chemistry to the Meeting of Experts, BTWC Meeting of Experts*, 2008; Bowman, K, Hay, A and Husbands, J. (2018) op.cit, p.527.

32 Germany (2015) *Statement by Ambassador Christoph Israng at the 19th Session of the Conference of the States Parties*. Organisation for the Prohibition of Chemical Weapons, The Hague, 21 January 2015.

33 OPCW (2014) *Report of the Nineteenth Session of the Conference of the States Parties*, C-19/5, 1-5. Organisation for the Prohibition of Chemical Weapons, The Hague. 5 December 2014

34 See: Report of First Workshop:

https://www.opcw.org/fileadmin/OPCW/SAB/en/March_2015_Ethical_Codes_Workshop-Report.pdf;Report of Second Workshop:

https://www.opcw.org/fileadmin/OPCW/SAB/en/Hague_Ethical_Guidelines_2nd_Workshop_Report.pdf

35 OPCW, *The Hague Ethical Guidelines: Applying the norms of the practice of chemistry to support the Chemical Weapons Convention*, Brochure, 18 November 2015.

36 OPCW, *Compilation of Codes of Ethics and Conduct: A Collection of Codes of Ethics and Conduct (and Related Guidelines) Compiled for the Workshops on Ethical Guidelines for the Practice of Chemistry under the Norms of the Chemical Weapons Convention*, September 2015.

37 https://www.opcw.org/sites/default/files/documents/Science_Technology/Hague_Ethical_Guidelines_Brochure.pdf

[38] For further information on the *Hague Ethical Guidelines*, associated materials, endorsement and promotion, see: OPCW website, https://www.opcw.org/hague-ethical-guidelines.

[39] For further information and copies of the Global Chemists' stakeholders *Code of Ethics*, see: American Chemistry Society website,

https://www.acs.org/content/acs/en/global/international/science-and-human-rights.html.

[40] https://www.opcw.org/hague-ethical-guidelines

[41] Novossiolova, T. *et al*. (2019) 'Altering an Appreciative System: Lessons from Incorporating Dual-Use Concerns into the Responsible Science Education of Biotechnologists, *Futures,* 108, 53-60.

[42] See, for example, Tang, C. and Foreman, J.E. (2018) *Development of the Hague Ethical Guidelines, OPCW Presentation at the MX2 Experts Meeting*, 9th August. United Nations, Geneva; Tang, C. (2019) *Update on The Hague Ethical Guidelines, Presentation by the Chair of the OPCW Scientific Advisory Board to the MX2 Experts Meeting*, August. United Nations, Geneva.

[43] Lighthouse (2013) *Developing a Code of Conduct: A Step-By-Step Guide*. Available from https://www.lighthouse-services.com/documents/Developing%20a%20Code%20of%20Conduct%20[A%20Step-by-Step%20Guide].pdf.

[44] Lighthouse (2013) *Developing a Code of Conduct: A Step-By-Step Guide*. Available from https://www.lighthouse-services.com/documents/Developing%20a%20Code%20of%20Conduct%20[A%20Step-by-Step%20Guide].pdf

[45] Martens, L. T. (2005) Writing an Effective Global Code of Conduct. *International Business Ethics Review*, 8(1). 1 and 9-14.

[46] Martens, L. T. (2005) Writing an Effective Global Code of Conduct. *International Business Ethics Review*, 8(1). 1 and 9-14.

[47] OPCW (2015), Hague Ethical Guidelines, https://www.opcw.org/hague-ethical-guidelines.

[48] Royal Netherlands Academy of Arts and Sciences (2008), *A Code of Conduct for Biosecurity,* https://www.knaw.nl/en/news/publications/a-code-of-conduct-for-biosecurity

[49] See for example the codes put forward by Russia in 2005 (BWC/MSP/2005/WP.2) and by Chile and eight other States in 2014 (BWC/MSP/204/WP.6).

[50] Novossiolova, T. and Martellini, M. (2019) Promoting Responsible Science and CBRN Security through Codes of Conduct and Education, *Biosafety and Health,* 1(2), 59-64.

Unprecedented Environmental Impacts of Chemical and Biological Warfare: A Critical Appraisal

Dr. Dhanasree Jayaram &

Ms Yashaswini Patel

Summary

Despite the existence of several mechanisms and frameworks that regulate the use and production of CBWs, they continue to exist, and pose risk to environmental and human health. Their use in wars and conflicts in the past have inflicted severe damages on ecosystems, as evidenced by the cases of different wars. Yet these issues are seldom brought up in the narratives on chemical and biological warfare, except from a moral point of view. The long-term effects of these agents are still ambiguous, but as the world faces a major crisis in the form of the coronavirus pandemic, one needs to reflect upon various aspects of environmental destruction, and its interrelationship with the changing nature of warfare in the 21st Century. In this context, the article attempts to analyse the environmental implications of chemical and biological warfare, by delving into historical examples, and providing an overview of futuristic implications from an environmental point of view.

Introduction

The destructive effects of chemical and biological weapons (CBWs) on ecosystems and human lives have been recorded since time immemorial, yet they have been deployed by both state and non-state actors to debilitate enemies (by inflicting infectious diseases, such as plague and smallpox), and win battles/wars. Any evidence of their use (and related environmental disruptions) dates back to ancient history in many countries, particularly that of Europe, Asia, and North America, where measures such as the use of toxic chemicals (pollutants), and contamination of water bodies were practiced by the armies.[1] For instance, Peloponnesians used a sulfur-based irritant against the town of Plataea (in the 5th century BC)[2], and the Byzantines used 'Greek Fire', which is a napalm-like liquid substance, to attack their enemies.[3] The lethality of these, and other similar agents was such that these would not only incapacitate humans, but also render lands uninhabitable temporarily, or even permanently.

In the 21st century, despite the existence of chemical and biological weapons conventions, as seen in the case of the Syrian conflict, in which chemical agents (for example, sarin and chlorine) were allegedly deployed by both state and non-state actors such as the Daesh or Islamic State of Iraq and Syria, leading to disastrous environmental and public health impacts[4], CBWs may continue to be used in the future by some groups to gain leverage over their adversaries. Hence, there is a need to address the environmental impacts of CBWs, not only of those that were deployed in the past (whose effects are still indeterminable), but also of their plausible use in the future, by both states and violent non-state actors. At a time when the coronavirus pandemic has unleashed catastrophe across the world, there is a need to relook at the changing nature of warfare, and how such outbreaks can also be exploited by terrorist organisations to their advantage.

Use of CBW's during the World Wars: Long-lasting and Uncertain Environmental Effects

The World Wars led to the emergence of new forms of warfare, guided by the use of CBWs. The birth of modern CBRN (Chemical, Biological, Radiological and Nuclear) warfare is commonly traced to the use of chlorine gas by Germans in the First World War. Not only Germany, but other countries also overtly or covertly engaged in this type of warfare. War-time use and testing of CBWs are known to cause unprecedented damage to the environment. Their impacts in terms of biodiversity loss, and even species extinction have been recorded.

Mustard gas was used widely to disable enemy combatants, and contaminate lands and groundwater during the First World War, indirectly affecting the civilians also. As scientific studies reveal, the environmental effects of its use are long-term in nature, and are yet to be discerned completely.[5] The large-scale use of CBWs during the war led to the signing of the 1925 Geneva Protocol (Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or other Gases, and of Bacteriological Methods of Warfare), by which the use of CBWs was prohibited in wars.[6] Due to the lack of trust, countries such as France, Italy, Germany, Japan, and Great Britain continued to research on CBWs. Japan, which had initiated its research on biological weapons in the 1920s, carried out a massive biological attack on various Chinese cities during the Second World War, by dispersing plague-infected substances, *B. anthracis*, cholera bacteria, etc. — affecting food and water supplies, and killing thousands of people. During the same time, Germany developed a poisonous gas, called sarin nerve gas, which attacks the nervous system, causing suffocation and death. Sarin is a potent water and food contaminant, and it is known to have hazardous effects on marine and freshwater ecosystems, due to neurotoxicity.[7]

In the early 1940s, British scientists working at Porton Down facility (officially known as Ministry of Defence's Defence Science and Technology Laboratory or DSTL), undertook bomb experiments at Gruinard Island using *Bacillus Anthracis* (*B. anthracis*), which had long-lasting implications.[8] These bombs typically contained "106 special bomblets filled with anthrax spores"[9], and killed several sheep (introduced to the island to check their lethality and feasibility) within days of exposure. Through these explosions, they found that anthrax could be used as a bioweapon. In fact, the British planned to use it in Germany, but ended up not doing so. In any case, the experiments are known to have gone out of control, as an anthrax outbreak occurred on the island in 1943, and the tests had to be eventually terminated, and the island, sealed.[10] It remained in this state until the 1980s, when the British Government decontaminated the island by removing the worst-infected topsoil, and soaking subsoil in formaldehyde, diluted in seawater.[11] However, for years, the fear of transmission of contaminated soils to the Scottish mainland remained.

After the Second World War, numerous chemical agents were dumped in the oceans by countries, such as the United States (US), Soviet Union, and others, including in the Baltic Sea. These include arsenic-containing substances, sulfur mustard, hydrogen cyanide, etc. As some of these agents degrade over a period of time, the resultant products could be toxic, and could even affect marine ecosystems (albeit the environmental risk assessment is extremely difficult due to the lack of knowledge about their nature and toxicity). However, scientists warn that there is a need to constantly monitor the developments in the disposal sites as their effects are still uncertain and unpredictable, even as fishing activities increase in the affected areas.[12]

The Use of CBWs during the Vietnam War and Consequent Environmental Effects

Despite regulations/protocols, CBWs continued to be utilised by countries. Perhaps, one of the watershed moments with respect to the use of chemical and biological agents in wars, was their extensive, and deplorable application during the Vietnam War by the US military. Apart from using Napalm (a highly gelatinous and flammable liquid), the US military carried out 'Operation Ranch Hand', under which it sprayed an estimated 19 million gallons of defoliants and herbicide (Agent Orange and others) over nearly 6 million acres of land.[13] These were deployed to destroy forests, and to deprive the Viet Cong guerrillas of vegetation cover. By the end of the war, about 3.8 million acres of land were destroyed, and approximately 13,000 livestock died. These agents gave rise to public health-related problems in Vietnam as defoliated areas became more susceptible to diseases, such as plague, cholera, malaria, etc.[14]

Environmentally, it wreaked havoc by contaminating agricultural (paddy) fields, water bodies (rivers, lakes, etc.) soils, and other ecosystems, as well as by infiltrating the food chain (with consequences for human health for many years). At the same time, a large proportion of the forest ecosystems are known to have irreversibly harmed, thereby also disrupting the habitats of several wildlife species. According to reports, the Vietnamese authorities took years to ecologically restore the affected areas, particularly natural defences, mangroves.[15] The Vietnam War, therefore, was a classic example of environmental warfare, carried out by the US, which eventually led to the establishment of the Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques of 1977 (ENMOD).[16]

Environmental Implications of CBWs: A Futuristic Perspective

Due to their extreme lethality, CBWs are regulated by the international community through conventions such as the Biological Weapons Convention (BWC) and Chemical Weapons Convention (CWC). Yet, state and violent non-state actors are engaged in stockpiling chemical and biological agents. Even dismantling of chemical weapons poses adverse environmental risks. The sealing of stockpile storage facilities, excavation of the old/abandoned stockpiles, transportation, and the entire dismantling process needs to be handled through sophisticated, and environmentally safe methods. Although the CWC refers to environmental safeguards that require to be adopted while eliminating chemical weapons (and production facilities), it does not provide standards, which complicates compliance.[17] In the US, due to concerns regarding environmental and human health, the initial proposal to construct three "centralized incinerator facilities" to destroy them had to be shelved in favour of similar facilities in all the nine sites possessing chemical weapons (as declared by them), so that the stockpiles do not have to be transported (that might prove to be risky).[18]

As the world is grappling with the COVID-19 crisis, one needs to remember that the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), whose origin still remains unclear, but it has certainly put a spotlight on the need to prepare more effectively for epidemics and pandemics. More importantly, this crisis points towards the adverse implications of environmental destruction (primarily habitat fragmentation and biodiversity loss), which is considered to be responsible for the outbreak of several epidemics and pandemics in the past few decades, such as Nipah virus infection, Severe Acute Respiratory Syndrome (SARS), and Ebola virus disease, among others.[19] Hence, a holistic, integrated planetary approach is required to deal with the complex challenges of the 21st century, wherein making any actors accountable for wilful destruction of the environment, leading to intended or unintended consequences in the form of a disease outbreak, would be next to impossible. Some of these activities can be clandestinely carried out, and would then go unnoticed. At the same time, certain actors, particularly terrorist organisations and rogue armed groups may even try to capitalise on such disease outbreaks to achieve their political goals.

Disclaimer: The views expressed in the article are personal.

Dr. Dhanasree Jayaram (dhanasree.j@manipal.edu) is an Assistant Professor, Department of Geopolitics & International Relations, and Co-coordinator, Centre for Climate Studies, Manipal Academy of Higher Education (MAHE), Karnataka.

Ms. Yashaswini Patel (yashaswinipatel1999@gmail.com) is a postgraduate research scholar, Department of Geopolitics & International Relations, MAHE, Karnataka.

Endnotes:

1 Eric Croddy, Clarisa Perez-Armendariz and John Hart, *Chemical and Biological Warfare: A Comprehensive Survey for the Concerned Citizen*, New York: Springer, 2002.

2 Kim Coleman, *A History of Chemical Warfare*, London: Palgrave Macmillan, 2005, p. 6.

3 Alex Roland, 'Secrecy, Technology, and War: Greek Fire and the Defense of Byzantium, 678-1204', *Technology and Culture, Vol. 33, No. 4, 1992, pp.* 655-679.

4 Ralf Trapp, 'The Use of Chemical Weapons in Syria: Implications and Consequences', in Bretislav Friedrich, Dieter Hoffmann, Jürgen Renn, Florian Schmaltz and Martin Wolf (eds), *One Hundred Years of Chemical Warfare: Research, Deployment, Consequences*, Cham: Springer, 2017, pp. 363-375.

5 Katarzyna Chmieliñska, Daniel Hubé, Tobias Bausinger, Markus Simon, Gilles Rivière, Patrik Fauser and Hans Sanderson, 'Environmental contamination with persistent cyclic mustard gas impurities and transformation products', *Global Security: Health, Science and Policy*, Vol. 4, No. 1, 2019, pp. 14-23.

6 '1925 Geneva Protocol', *United Nations Office for Disarmament*, https://www.un.org/disarmament/wmd/bio/1925-geneva-protocol/, accessed on 8 April 2021.

7 Andrew Reginald Charkrabarty and Abhay J. Simha, 'Chemical Warfare: An Unprecedented Environmental Threat', *International Proceedings of Chemical, Biological and Environmental Engineering*, Vol. 70, pp. 49-52.

8 Corey J. Hilmas and Jaime Anderson, 'Anthrax', in Ramesh C. Gupta (ed.), *Handbook of Toxicology of Chemical Warfare Agents*, Amsterdam: Elsevier, 2015, p. 388.

9 Stefan Riedel, 'Anthrax: a continuing concern in the era of bioterrorism', *Proceedings (Baylor University. Medical Center)*, Vol. 18, No. 3, 2005, p. 236.

10 Gary Thatcher, '`Anthrax' Island: where life imitates fiction', *The Christian Science Monitor*, 15 December 1988, available at https://www.csmonitor.com/1988/1215/z3chem4.html, accessed on 8 April 2021.

11 Robert Harris and Jeremy Paxman, *A Higher Form of Killing: The Secret History of Chemical and Biological Warfare*, New York: Random House Trade Paperbacks, 2002.

12 Andrew Curry, 'Chemical Weapons Dumped in the Ocean after World War II Could Threaten Waters Worldwide', *Smithsonian Magazine*, 11 November 2016, available at https://www.smithsonianmag.com/science-nature/decaying-weapons-world-war-II-threaten-waters-worldwide-180961046/, accessed on 8 April 2021.

13 James G. Lewis, 'James G. Lewis on Smokey Bear in Vietnam', *Environmental History, Vol. 11, No. 3, 2006, p. 601.*

14 J. B Neilands, 'Vietnam: Progress of the Chemical War'*, Asian Survey*, Vol. 10, No. 3, 1970, pp. 2019-229.

15 Jason Von Meding And Hang Thai T.m., 'How U.S. chemical warfare in Vietnam unleashed an enduring disaster', *Phys.org*, 4 October 2017, available at https://phys.org/news/2017-10-chemical-warfare-vietnam-unleashed-disaster.html, accessed on 8 April 2021.

16 'Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (ENMOD)', *United Nations Office for Disarmament Affairs*, https://www.un.org/disarmament/enmod/, accessed on 8 April 2021.

17 Ayce-Martina Böhringer and Thilo Marauhn, 'Environmental Implications of Disarmament: The CWC Case', in Carsten Stahn, Jens Iverson and Jennifer S. Easterday (eds), *Environmental Protection and Transitions from Conflict to Peace: Clarifying Norms, Principles, and Practices*, Oxford: Oxford University Press, pp. 192-202.

18 Paul F. Walker, 'A Century of Chemical Warfare: Building a World Free of Chemical Weapons', in Bretislav Friedrich, Dieter Hoffmann, Jürgen Renn, Florian Schmaltz and Martin Wolf, *One Hundred Years of Chemical Warfare: Research, Deployment, Consequences*, Cham: Springer, p. 387.

19 Cristina O'Callaghan-Gordo and Josep M. Antób, 'COVID-19: The disease of the anthropocene', *Environmental Research*, Vol. 187, 2020, pp. 109-683.

Role of Internet of Things in Biological Warfare

Utkarsha Mahajan

PhD Candidate at the Department of Geopolitics and International Relations, Manipal Academy of Higher Education (MAHE), Manipal, India

Summary

The weaponisation of Information and Communication Technology (ICT) has been a new element in twenty-first century warfare where 'biowarfare' is no exception. Active research has been taking place on the Internet of Things (IoT) domain which finds a wide range of applications in biology. Digitalisation and artificial intelligence have a significant impact on the functioning of microbiology laboratories. The underlying concept of biosecurity, bound by agreements and treaties, fails to incorporate technology as a formal field of study. IoT, a subdomain of ICT, is no exception to be explored as a tool for biowarfare. The impact of the use of biowarfare agents is not visible immediately and can be seen only after an incubation period. Hence, the rapid detection and identification of these agents have become a necessity. Several competitive methods are available to identify the biological warfare agents, where IoT provides an effective solution.

Introduction

With the COVID-19 pandemic, the discussions regarding the changing nature of biological warfare[1] have resurfaced. Biological warfare or biowarfare refers to the intentional use of micro-organisms and toxins to harm humans, livestock, and crops. It has the potential to not only inflict considerable mortality and morbidity but also create a high level of panic, environmental contamination, and extreme pressures on emergency healthcare services. Though the nature of biowarfare has kept changing over the centuries, bioweapons can be identified as systems consisting of two factors i.e., weaponised biowarfare agent and the delivery mechanism.

The history of the use of bioweapons provides evidence of the use of missiles, humans, or air as the mediums for the delivery of the agents. Whereas, over time, more sophisticated and subtle ways of proliferation and dissemination have come into being. Biosensors, for biological warfare agents, serve as simple but reliable analytical tools for the field as well as laboratory assay.[2] Such analytical tools, beneficial for recognising the biological warfare agent and the presence or diagnosis of diseases caused by the agents, are required for adopting adequate countermeasures and to select an effective therapy for the exposed masses. With the growing dependence of individuals' daily lives on the modern interactive digital systems, the vulnerability of the masses to the cyber-attacks has increased multi-fold.

As the Internet of things[3] (IoT) has been revolutionising the modes of interactions between humans and machines, a variety of applications can be seen in several domains including medical R&D, adding to the new ways of creation, delivery and dissemination of biowarfare agents. The highly networked IoT infrastructure contains a range of integrated circuits, biosensors and bio-identification data. The data collection and its complexity further amplify the need to use advanced technologies to achieve a detailed and structured description of the microbiological data, e.g., the Microbiology Investigation Criteria for Reporting Objectively (MICRO) criteria.[4]

Epidemiological databases can also benefit from structured data. Such databases are highly vulnerable to unauthorised access by adversaries, criminals and terrorist organisations. Most of the medical research facilities and hospitals use state-of-the-art technology for preserving micro-organisms and disease-related information, where IoT applications provide peculiar and effective solutions. Powered by IoT-generated data, Machine learning (ML) has radically changed the mode of handling healthcare-related data that includes information related to clinical microbiological and infectious diseases. The data acquired from IoT devices is processed using ML algorithms at each step of the microbiological diagnostic process i.e., from pre-to post-analytics that helps to deal with the increasing quantities and complexity of data.[5]

With the increasing number of IoT applications in the biological sciences, a large number of subdomains have emerged under IoT such as the Internet of Nano-Things (IoNT), Industrial Internet of Things (IIoT) and Internet of Medical Things (IoMT).[6] The exchange of medical or healthcare-related data between people and medical professionals and medical devices (sensors, monitors, implants etc.) using wireless communication,[7] creates more opportunities for causing biological damage through cyberspace. IoNT can enhance the effectiveness of the provision of combatant defensive kits, which includes smart armour and stealthily active camouflage and medicinal sensors to protect them from chemical and biological agents to serve as the self-healing material.[8]

IoT the Biowarfare: Weaponisation and Agent Detection

The weaponisation of Information and Communication Technology (ICT) has been a new element in the twenty-first century warfare where 'biowarfare' is no exception. The underlying concept of biosecurity which is bound by agreements and treaties, fails to incorporate technology as a formal field of study. IoT, a subdomain of ICT, has not been exempted from being explored as a tool for biowarfare. One of the main challenges that the infectious pathogens and toxins, also referred to as the biological warfare agents, is their dual-use nature. Despite the Biological Weapons Convention (1972) prohibiting the production and stockpiling of the biowarfare agents[9], they can still be legally produced and manipulated for medical or research purposes where therapies, new drugs, vaccines are invented. Though states have signed the convention, the development of pathogens as weapons became the province of clandestine nation-state programs and non-state actor terrorism.[10] The impact of the use of these agents is not visible immediately and can be seen only after an incubation period. Hence, the rapid detection and identification of the biowarfare agents is a need of the hour. A number of competitive methods are available for the identification of these agents. The methods like mass spectrometry along with Chromatography and Polymerase chain reactions[11] (PCR) are some of the widely used techniques for the detection of the agents.

Synthetic biology expands on the possibility of creating new types of bioweapons. DNA synthesis and gene editing can increase the number and severity of the bioterrorists' threat as mentioned by a U.S. Department of Defense report.[12] The report also identifies three concerns of high priority, including recreating pathogenic viruses like Ebola, SARS or smallpox. The ongoing Covid-19 pandemic has been caused by the agent belonging to the SARS group of viruses.[13] A variant of PCR, called real-time reverse transcription PCR (real-time RT-PCR) is the widely used method for detecting the virus. The reverse transcription process refers to converting RNA to DNA followed by amplification of the DNA for confirming the presence of the virus.[14] As the virologists are desperately seeking solutions for an early vaccine, a cross-disciplinary approach has been actively sought in order to develop adequate monitoring, contact tracing and diagnosing or detecting the virus. Several efforts are being put in developing portable, user-friendly, and cost-effective systems for point-of-care (POC) diagnostics, which could also create an Internet of Things (IoT) for healthcare via a global network.[15]

The 2016 Zika virus outbreak led to the development of a sensitive CRISPR[16]-based biosensor, used to detect a different strain of this virus at low concentration. The application of IoT, big biomedical data, cloud computing, artificial intelligence and signal data obtained from CRISPR-based biosensors or nano-biosensors provide clinical data in the cloud computing system. CRISPR, a powerful technology for gene-editing, has been revolutionising the life sciences and medical research. With the decreasing cost of the technology, CRISPR kits are widely available. A well-connected grid of biosensors integrated with the futuristic CRISPR/Cas's systems to monitor DNA or RNA, connected through GPS, Wi-Fi and Bluetooth using a cloud-based database, will soon be generating a massive amount of data with a range of applications in the telemedicine or e-healthcare systems. Although the data will have restricted access to authorised personnel and institutions. However, these systems are highly vulnerable to attacks by the adversaries, for the misuse of the genetic information. Based on the individual's genotypes and by identifying the weaknesses of the immune system[17], creating more deadly synthetic pathogens make the future biological wars even more destructive.

Another means of IoT weaponisation, in the biowarfare, includes the delivery and dissemination of the biowarfare agents. A variety of spraying devices, weak explosives, pressure vessels can act as parts for the delivery of these biological warfare agents controlled using networked autonomous systems. The remote access to these mechanisms can enable the terrorists to carry out the bio-attack without physically entering the territory or infrastructure.

Internet of Bodies (IoB)[18], an extension of IoT, refers to accessing and controlling the human body via the internet, where autonomous health sensing and actuating systems *aka* closed-loop systems that sense and act towards a biological condition, are used.[19] The IoB systems not only collect a vast amount of biometric data but also can alter the human body's function. The IoB based emerging concepts beyond formal healthcare systems which include Transhumanism, Body hacking and Biohacking are likely to become common practices with their access through smart wearables and smartphones will be available. These activities will not only contribute to the vulnerability to sensitive personal data but also a massive attack that can infringe the body autonomy of the target population.[20]

Mitigating the Biowarfare using IoT

To mitigate the challenge of biowarfare, a well-networked IoT infrastructure is required for monitoring the development and misuse of these biohazardous substances. The preparedness for biowarfare is essential as the origin and identification of Biological weapons are more difficult to recognise than other weapons of mass destruction. Delegated by the Office of Naval Research, a programme was undertaken by the Quantum Leap Innovations, Inc. (QLI) to develop, evaluate, and demonstrate novel technology support to the early detection and rapid response for biological or chemical threats.[21] Other than this, a number of specific technological solutions in Situational Awareness, Course of Action Planning, Command & Control, and Data & Process Integration find applications in the emergency management and force transformation during the biowarfare.

IoT, through an integrated biological warfare framework, can provide an integrated decision support mechanism to address the following challenges of biowarfare:

- Monitoring a biological outbreak
- Identifying the cause of outbreak and source
- Predicting potential exposure
- Planning an effective response and risk reduction strategy
- Notifying the related authorities (such as hospitals, local governments, law enforcement, military, pharmaceutical industries, etc)

The existing state-of-the-art IoT platforms such as the Generative Adversarial Network (GAN)[22], based semi-supervised learning approach for clinical decision support in the health-IoT platform, focus on other health conditions other than pandemic diseases. It improves the classification process and facilitates learning about the illness, and suggests a suitable treatment course. An interoperable Internet of Medical Things (IoMT) platform based on Semantic Web Concepts[23] and the M2M architecture, having doctors as users, have been sought for achieving standardisation.

The Way Ahead

Biomedical data acquired through IoT infrastructure is prone to misuse by adversaries and terrorists for amplifying the infectivity, virulence, and resilience towards vaccines, leading to the severity of the biowarfare leading to a more uncontainable epidemic or pandemic. Biological dual-use specialty represents the character of being used either for peaceful purposes, such as medicine, prevention, protection, or non-peaceful purposes, such as developing and producing biological weapons. Coupling synthetic biology with IoT acquired data can lead to the creation of more lethal biological warfare agents. The development of newer strains of pathogens can develop antibiotic-resistant microorganisms with greater invasiveness and pathogenicity of commensals.[24]

The cross-domain awareness regarding the use of IoT in identifying pathogens and toxins and their delivery and dissemination through networked devices can help the medical research facilities and healthcare systems enhance the security of their control facilities and data storages.

The global health actors such as the World Health Organization, Wellcome Trust, World Bank and the Bill & Melinda Gates Foundation have already developed action plans, protocols, policy documents and research programs.[25] That addresses some of the current needs and tentatively covers emerging and future priorities, including the biowarfare threats emanating from synthetic biology and the use of cyber means for the launch of attacks. Fine-grained spatial and temporal mapping of physical and biological parameters coupled with the reduced lag between data acquisition and analytics ensures the progress toward real-time analysis for the identification of potential bioweapons. There is an increasing need for statecraft and defence research facilities to prioritise the networked real-time data acquisition and analytics schemes for disaster risk reduction and response for effective preparedness.

The laws regarding genetic and biomedical data sharing via the cloud and access to the IoT and IoB devices need to be more stringent. International debates and deliberations on the biowarfare and prohibition of biological weapons must recognise the dual-use nature of networked systems and hence work towards a cooperative mechanism for the peaceful and constructive use of synthetic biology to prevent the eruption of another more threatening pandemic.

Endnotes:

1 David P. Clark, Nanette J. Pazdernik, ‘Biological Warfare: Infectious Disease and Bioterrorism’, *Science Direct*, *Biotechnology (Second Edition)*, pp. 687-719, 2016, available at https://doi.org/10.1016/B978-0-12-385015-7.00022-3, accessed on 5 May 2016.

2 Miroslav Pohanka, ‘Current Trends in the Biosensors for Biological Warfare Agents Assay’, *Materials (Basel),* Vol. 12, No. 14, 230318, July 2019, doi:10.3390/ma12142303, available at https://pubmed.ncbi.nlm.nih.gov/31323857/ (doi:10.3390/ma12142303), accessed on 30 May 2021.

3 Carrie Clickard, *The Internet of Things*. Chicago, IL: Norwood House Press, 2019.

4 A. Egli, J. Schrenzel, G. Grueb, “Digital microbiology”, Clinical Microbiology and Infection, 27 June 2020, available at https://www.clinicalmicrobiologyandinfection.com/article/S1198-743X(20)30367-0/pdf accessed on 2 May 2021

5 Luz CF, ‘Machine learning in infection management using routine electronic health records: tools, techniques, and reporting of future technologies’, *Clin Microbiol Infect* 2020, vol. 26, no. 1291e9, available at https://doi.org/10.1016/ j.cmi.2020.02.003.

6 Abdullahi Umar Ibrahim, Fadi Al-Turjman , Zubaida Sa’id, Mehmet Ozsoz, ‘Futuristic CRISPR-based biosensing in the cloud and internet of things era: An Overview’, *Springer Nature*, 2020, available at https://doi.org/10.1007/s11042-020-09010-5, accessed on 29 April 2021

7 Ibid.

8 Rohan Malhotra, Nano Tech: An Emerging Field In Indian Army’s Strategic Defence’, Society for the Study of Peace and Conflict, *SSPC Monograph Series No. 1*, July 2019, available at https://sspconline.org/sites/default/files/2019-07/SSPC-Monograph-1-NanoTech-%20RMalhotra_1.pdf accessed on 4 May 2021.

9 Miroslav Pohanka, ‘Current Trends in the Biosensors for Biological Warfare Agents Assay’, *Materials (Basel),* Vol. 12, No. 14 230318 July 2019, doi:10.3390/ma12142303, available at https://pubmed.ncbi.nlm.nih.gov/31323857/, accessed on 30 May 2021.

10 Consensus Study Report,‘National Academies of Sciences, Engineering, and Medicine 2018’. *Biodefense in the Age of Synthetic Biology*. Washington, DC, The National Academies Press, 2018, available at https://doi.org/10.17226/24890, accessed on 30 April 2021.

11 James J Walters, Karen F Fox, A Fox, ‘Mass spectrometry and tandem mass spectrometry, alone or after liquid chromatography, for analysis of polymerase chain reaction products in the detection of genomic variation’, *Journal of Chromatography* B, Vol. 782, Vol. 1, No.2, 2002, pp. 57-66, ISSN 1570-0232, available at https://doi.org/10.1016/S1570-0232(02)00563-9. (https://www.sciencedirect.com/science/article/pii/S1570023202005639), accessed on 3 May 2021

[12] The National Academies Press, 'Biodefense in the Age of Synthetic Biology', *The National Academies of Sciences, Engineering, Medicine*, 2018, available at https://www.nap.edu/download/24890 accessed on 3 May 2021.

[13] 'Severe Acute Respiratory Syndrome (SARS)', *World Health Organization*, available at https://www.who.int/health-topics/severe-acute-respiratory-syndrome#tab=tab_1, accessed on 29 April 2021.

[14] Nicole Jawerth, 'How is the COVID-19 virus detected using real time RT-PCR?', *IAEA Bulletin*, June 2020, available at https://www.iaea.org/bulletin/infectious-diseases/how-is-the-covid-19-virus-detected-using-real-time-rt-pcr, accessed on 2 May 2021.

[15] Hanliang Zhu, Pavel Podesva, Xiaocheng Liu, Haoqing Zhang, Tomas Teply, Ying Xu, Honglong Chang, Airong Qian, Yingfeng Lei, Yu Li, Andreea Niculescu, Ciprian Iliescu, and Pavel Neuzi, 'IoT PCR for pandemic disease detection and its spread monitoring', *US National Library of Medicine National Institutes of Health*, 11 September 2019, available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7125887/ accessed on 3 May 2021

[16] 'CRISPR: A game-changing genetic engineering technique', *Harvard University*, 31 July 2014, available at https://sitn.hms.harvard.edu/flash/2014/crispr-a-game-changing-genetic-engineering-technique/, accessed on 4 May 2021

[17] Stew Magnuson, 'National Security Implications of Gene Editing', *National Defence, NDIA's Business and Technology Magazine,* 26 March 2019, available at https://www.nationaldefensemagazine.org/articles/2019/3/26/editors-notes-national-security-implications-of-gene-editing accessed on 30 April 2021.

[18] Asamanya Mohanty, 'Internet of Bodies (IoB) extends Internet of Things (IoT)- Redefines Future of Bionics and Embedded Systems', Scrabbl, available at https://www.scrabbl.com/internet-of-bodies-iob-extends-internet-of-things-iot—redefines-future-of-bionics-and-embedded-systems, accessed on 3 May 2021

[19] Bhokisham, VanArsdale, Stephens, 'A redox-based electrogenetic CRISPR system to connect with and control biological information networks', *Nature Communication*, Vol. 11, No. 2427, 2020, https://doi.org/10.1038/s41467-020-16249-x, available at https://bioengineeringcommunity.nature.com/posts/internet-of-bodies-iob-using-crispr-to-electrically-connect-with-and-control-the-genome accessed on 30 April 2021.

[20] Mary Lee, Benjamin Boudreaux, Ritika Chaturvedi, Sasha Romanosky, Bryce Downing, *The Internet of Bodies: Opportunities, Risk and Governance*, 2020, ISBN: 978-1-9774-0522-7, available at https://www.rand.org/content/dam/rand/pubs/research_reports/RR3200/RR3226/RAND_RR3226.pdf, accessed on 1 May 2021

[21] F. Abbott, A. Johnson, S. Prior and Donald Steiner, 'Integrated Biological Warfare Technology Platform (IBWTP). Intelligent Software Supporting Situation Awareness, Response, and Operations', *Semantic Scholar*, 2007, available at https://www.semanticscholar.org/paper/Integrated-Biological-Warfare-Technology-Platform-Abbott-Johnson/6e48c45c09ca657d9213ac241ad4d74c352fabec, accessed on 29 April 2021

[22] Bernard Marr, 'Artificial Intelligence Explained: What Are Generative Adversarial Networks (GANs)?', *Forbes*, 12 June 2019, available at https://www.forbes.com/sites/bernardmarr/2019/06/12/artificial-intelligence-explained-what-are-generative-adversarial-networks-gans/?sh=3b886f917e00 , accessed on 4 May 2021.

[23] Karin Koogan, Breitman Marco, Antonio Casanova, Walter Truszkowski, *Semantic Web: Concepts, Technologies and Applications*, Part of the NASA Monographs in Systems and Software Engineering book series (NASA), 2007, ISBN: 978-1-84628-581-3, available at https://doi.org/10.1007/978-1-84628-710-7

[24] Ramesh C, Gupta D, Thavaselvam, Swaran S. Flora, 'Chapter 30 - Chemical and biological warfare agents', Biomarkers in Toxicology, Academic Press, 2014, pp. 521-538, ISBN 9780124046306, available at https://doi.org/10.1016/B978-0-12-404630-6.00030-0 accessed on 3 May 2021

[25] David Thaler, Michael Head, Andrew Horsley, 'Precision public health to inhibit the contagion of disease and move toward a future in which microbes spread health', *BMC Infectious Diseases*, 06 February 2019, available at https://doi.org/10.1186/s12879-019-3715-y accessed on 2 May 2021

Pervasive Geopolitics, Elusive Science: The Quest for the Origins of SARS CoV-2

Anand V.

Assistant Professor at the Department of Geopolitics, and the Coordinator of the China Study Centre of the Manipal Academy of Higher Education, Manipal, India

Summary

The COVID-19 crisis has emerged at a time when the world has been witnessing a renewed geopolitical rivalry, and the pandemic has accentuated it. As a result, the quest for the origins of the SARS CoV-2 has remained elusive, even after a long-awaited investigation done by the WHO. Geopolitics seems to have been the final arbiter of the probe, rather than science. The blame of "creating" the virus aimed at China has been deflected by the country using its clout over the investigation, to cast doubts outside its borders. As a result of the current geopolitical environment, the probability of zeroing in on the source of the virus appears bleak.

Introduction: The Need to Trace the Origins of COVID-19

The COVID-19 pandemic has been ravaging nations across the world for more than a year. The pandemic has lashed the global population in multiple waves and the SARS CoV-2 virus which is responsible for it has taken the form of numerous mutant variants. As a result, around one percent of the world's population has got infected, and close to two percent of them have deceased. The global economy has taken a big setback due to the disruption created by the pandemic, and the multiple waves in different parts of the world has hindered any effort of an overall recovery. Globalization in the physical realm is under the constant threat of being "quarantined" on a frequent basis, with restrictions in international travel and the hardening of borders.

In such a time, it becomes essential for the global community to search for the origins of this existential threat that has eclipsed the world. Such a quest could lead to the possible invention of cures as well as the development of more effective vaccines. Moreover, it could help identify and prevent future pandemics. However, what should have ideally been a unified quest by nations across the world has turned out to be a partisan affair of a blame game. The pandemic has come at a time when the great power rivalry has made a comeback in global geopolitics. COVID-19 has accentuated differences between rivals, overturning cooperative endeavours, heating up the competition, and widening the potential for conflicts. The era of a Cold War 2.0 may have already dawned, [1] and this has made the pursuit for the source of this current scourge on humanity difficult, if not impossible.

The WHO-China Joint Study: Key Findings

To understand the source of the virus, the international community has been demanding investigations at the global level. The World Health Organization (WHO), after repeated attempts, finally got the green light from China to conduct a field study in the country from where the pandemic started. Subsequently, a year after COVID-19 went global, seventeen members of the WHO team landed in Wuhan, the epicenter of the outbreak which started the pandemic. The objective of the mission was to conduct a joint study with seventeen Chinese experts on the possible origins of the virus. The probe lasted for four weeks in 2021, from 14 January to 10 February. The investigation included visits of the WHO team to the Wuhan Institute of Virology (WIV) of the Chinese Academy of Sciences, alleged to be a possible site of origin of the virus, as well as the Huanan Seafood Wholesale Market, supposedly the "ground zero" of the pandemic.

At the end of the study, the WHO team came up with a joint report with their Chinese counterparts about the findings of the probe.[2] In a nutshell, they evaluated the likelihood of four scenarios of the origin of the virus – direct zoonotic transmission, introduction through intermediate host followed by zoonotic transmission, introduction through the cold/food chain, and introduction through a laboratory incident. Out of these four, the "lab leak" hypothesis was found to be extremely unlikely, and the possibility of an intermediate host was inferred to be the most likely scenario. Though a direct zoonotic spillover was gauged as likely, the "cold/food chain" hypothesis was evaluated to be possible. Clearly, the study did not prove to be a decisive one that could provide a solid answer to the international community. Moreover, the study created controversy by stirring up a flurry of criticisms, based on the numerous loopholes apparent since the very beginning of the mission.

The Lab Leak Hypothesis: Questions Remain

Ever since the beginning of the pandemic crisis, China has been under the shadow of suspicion with regard to the origins of the virus. Several theories have come up regarding the origins of the virus, and among them, the "lab leak" hypothesis turned out to be detrimental to the image of China and its ruling Communist Party of China (CPC).[3] Though there has been only marginal support for this possibility from the side of scientists, the theory has attained much popularity outside the mainstream.[4] However, the Donald Trump administration, apparently based on intelligence assessments, have been very vocal about this possibility.[5] The WHO has been criticized for being soft on China since the start of the crisis. Tedros Adhanom Gabhreyesus, the Director of the WHO, has been known for his close relationship with China. His stance on China, which often gave an impression of defending the country's initial response towards the pandemic, was not viewed favourably by certain sections of the international community, most notably the previous US administration.[6] The US even withdrew from the WHO on account of the growing asymmetric influence of China in the organization.[7] The move, rather than nudging the WHO to a more neutral ground, may have produced a converse effect.

It is in this context that the joint study has taken place. After the findings were publicized by the end of March 2021, the Joe Biden administration of the US criticized the opaqueness of the investigation, though adopting a much diluted stance than the previous Trump administration.[8] The US, together with 13 other countries came up with a joint statement, questioning the credibility of the study.[9] In addition to this, a group of scientists from 24 countries came together to draft an open letter, accusing that the investigation was politically manipulated by China.[10] The crux of the accusations was that the Chinese government dragged its feet on allowing the investigation, then set the terms for the investigation, and further did not provide access to certain critical raw data, as well as insisted on vetting the findings. The WHO was also put at fault by highlighting that the team took the Chinese arguments uncritically, and did not exercise objectivity in the selection of team members. The presence of at least one of the team members with a clear conflict of interest was certainly glossed over.[11] The team allegedly also diminished the possibility of the "lab leak" hypothesis, justifying it with lack of evidence. The same logic could also have been used to discard the "cold/food chain" hypothesis, which they did not.

The accusations got more teeth with Tedros himself accepting the lack of access to raw data of early cases.[12] These accusations were rebuffed by China's Ministry of Foreign Affairs, China's nationalist media, as well as Liang Wannian, who led the Chinese counterpart of the WHO team. [13] They put forward defensive counter-arguments that the WHO agreed to the terms of the probe, and that certain data could not be provided due to domestic legal restrictions. They denied any manipulative role of China and emphasized that the country was transparent to the WHO field study. They also accused the West and the US of pressurizing the WHO to malign China's image. Moreover, China went on a counter-offensive that similar studies should be conducted in other countries like Italy, France, and Brazil, where there have been certain sketchy pieces of evidence of COVID-19 emerging even before the outbreak in Wuhan. They also challenged the US specifically to accept investigations into its critical biological lab facilities like Fort Detrick, which has been cited by certain sources in China as a source of the virus. China also buttressed the "cold/food chain" hypothesis by alleging that the virus could have entered China through cold chains. The food which was transported to the foreign athletes of the Seventh World Military Games held in Wuhan in October 2020, just months before the first case was reported, was especially suspected in this context.[14] However, these arguments largely remain as allegations and lacking any evidence, as compared to the "lab leak", where there is at least a smoking gun.

Conclusion: Way Ahead to Ground Zero

It looks fairly clear that the WHO investigation into the origins of the virus ended up with findings that China has no complaints about, but others do. Though the WHO team has given an interim verdict favourable for China geopolitically, the hard work of the team has nevertheless been acknowledged by countries like the US. There seems to be an understanding that with the WHO's imperative to get more data from China, certain compromise of sorts could have been arrived at during the investigation. At the same time, the organization has to face the wrath of countries that feel China needs to be taken to task, based on intelligence assessments about a probable "lab leak". The WHO investigation, which was supposed to be given the "lab leak" hypothesis a burial, seems to have actually created counter-productive results. The "lab leak" argument seems to have been resurrected, and China has therefore been consistently pushing the possibility of a "ground zero" outside its borders. As the geopolitics fuelled blame game seems to further continue, the scientific truth about the virus origins seems to have become the casualty. As time goes on, the possibility to find the virus origins could only reduce, as possible pieces of evidence keep disappearing from view. The way ahead to the "ground zero" may eventually end up with several "ground zeros", as parallel narratives spin divergent pathways to the past, while the virus surges forward into the future.

Disclaimer: The views expressed in the article are personal.

Endnotes:

1 M. D. Nalapat, "Cold War 2.0: US and India Work on a Winning Strategy", The Sunday Guardian, 24 October 2020, available at https://www.sundayguardianlive.com/news/cold-war-2-0-us-india-work-winning-strategy, accessed on 27 April 2021

2 "WHO-convened Global Study of Origins of SARS-CoV-2: China Part", *WHO-China Joint Study Report*, 30 March 2021, available at https://www.who.int/publications/i/item/who-convened-global-study-of-origins-of-sars-cov-2-china-part, accessed on 27 April 2021.

3 Maanvi Singh, Helen Davidson and Julian Borger, "Trump claims to have evidence coronavirus started in Chinese lab but offers no details", *The Guardian*, 1 May 2020, available at https://www.theguardian.com/us-news/2020/apr/30/donald-trump-coronavirus-chinese-lab-claim, accessed on 27 April 2021.

4 "Coronavirus Bioweapon – How China Stole Coronavirus from Canada And Weaponized It", *Great Game India*, 26 January 2020, see website https://greatgameindia.com/coronavirus-bioweapon/, accessed on 27 April 2021.

5 "Fact Sheet: Activity at the Wuhan Institute of Virology, US Department of State", US Department of State, 15 January 2021, available at https://2017-2021.state.gov/fact-sheet-activity-at-the-wuhan-institute-of-virology/index.html, accessed on 27 April 2021.

6 "Full Text of Trump's Scathing Letter to WHO Chief Dr Tedros Ghebreyesus", *Free Press Journal*, 19 May 2020, available at https://www.freepressjournal.in/world/full-text-of-trumps-scathing-letter-to-who-chief-dr-tedros-ghebreyesus, accessed on 27 April 2021.

7 "White House officially withdraws US from WHO: Report", Economic Times, 8 July 2020, available at https://health.economictimes.indiatimes.com/news/industry/white-house-officially-withdraws-us-from-who-report/76850341, accessed on 28 April 2021.

8 Chris Cameron, "U.S. secretary of state calls for more thorough investigation of Covid origins in China", *New York Times*, 11 April 2021, available at https://www.nytimes.com/2021/04/11/world/blinken-covid-investigation-china-origins.html, accessed on 28 April 2021.

9 "Joint Statement on the WHO-Convened COVID-19 Origins Study", US Department of State, 30 March 2021, available at https://www.state.gov/joint-statement-on-the-who-convened-covid-19-origins-study/, accessed on 28 April 2021.

10 "Open Letter: Call for a Full and Unrestricted International Forensic Investigation into the Origins of COVID-19", 4 March 2021, available at https://s.wsj.net/public/resources/documents/COVID%20OPEN%20LETTER%20FINAL%20030421%20(1).pdf, accessed on 28 April 2021.

11 "How the WHO's Hunt for Covid's Origins Stumbled in China", *Wall Street Journal*, 17 March 2021, available at https://www.wsj.com/articles/who-china-hunt-covid-origins-11616004512, accessed on 28 April 2021.

12 Stephanie Nebehay and John Miller, "Data withheld from WHO team probing COVID-19 origins in China: Tedros", *Reuters*, 30 March 2021, available at https://www.reuters.com/article/us-health-coronavirus-who-china-report-idUSKBN2BM26S, accessed on 28 April 2021.

13 Zhao Yusha, Chen Qingqing, Cao Siqi and Li Sikun, "Western countries' attack on WHO report 'politically driven', next stage investigation should be conducted globally:

Chinese experts", Global Times, 31 March 2021, available at https://www.globaltimes.cn/page/202103/1219945.shtml, accessed on 28 April 2021.

[14] Zhang Hui and Xu Keyue, "GT investigates: Getting closer to early Covid 19 cases", Global Times, 15 April 2021, available at https://www.globaltimes.cn/page/202104/1221102.shtml, accessed on 28 April 2021.

Chemical and Biological News

NATIONAL AND INTERNATIONAL DEVELOPMENTS

23% of COVID-19 Casualties in Bhopal are Bhopal Gas Tragedy Survivors

Vivek Trivedi | 2 June 2021

Dr Ravi Shankar Verma, the Chief Medical Officer of Gas Relief recently told the media that out of 933 Covid-19 related deaths, 218 were 1984 victims which account for 23% of the Covid-19 deaths.

The survivors' organisations are flagging the issue for a long and also wrote to various authorities for urgent measures since last year. Besides the deplorable conditions of the assigned medical facilities and equipment, these organisations are also accusing the administration of under-reporting the figures among the 1984 victims.

OPCW Releases Second Report by Investigation and Identification Team

OPCW | THE HAGUE, Netherlands–5 February 2021

The IIT is responsible for identifying the perpetrators of the use of chemical weapons in the Syrian Arab Republic where the OPCW Fact-Finding Mission (FFM) has determined that chemical weapons have been used or likely used in Syria. The IIT released its first report on 8 April 2020.

The IIT's second report reiterates its mandate, the legal and practical challenges of its work, and the findings of the investigation focusing on the incident in Saraqib, Syrian Arab Republic, on 4 February 2018. The IIT's investigation and analysis included a comprehensive review of all the information obtained including: interviews with persons who were present in the relevant places at the time of the incidents, analysis of samples and remnants collected at the sites of the incidents, review of the symptomatology reported by casualties and medical staff, examination of imagery, including satellite images, and extensive consultation of experts. The IIT also obtained topographic analysis of the area in question and gas dispersion modelling to corroborate accounts from witnesses and victims. The investigation relied on relevant FFM report as well as on samples and other material obtained by the Technical Secretariat.

The report reached the conclusion that there are reasonable grounds to believe that, at approximately 21:22 on 4 February 2018, a military helicopter of the Syrian Arab Air Force under the control of the Tiger Forces hit eastern Saraqib by dropping at least one cylinder. The cylinder ruptured and released chlorine over a large area, affecting 12 named individuals.

Scientists adapt solar energy technology to detect chemical warfare agents & pesticides

ARC Centre of Excellence in Exciton Science | 3 March 2021

In a colourful solution to a dangerous problem, Australian scientists are adapting a component from cutting-edge solar cells to design a rapid, light-based detection system for deadly toxins.

While use of chemical warfare agents like sulfur mustard (aka mustard gas) - is banned internationally, we do rely on other strictly-controlled chemicals for agriculture, industry and throughout our daily lives, including fumigants like methyl iodide, which is used to control insects and fungi. The wrong amounts or incorrect use of these fumigants can be harmful to people and degrade the ozone layer.

Because it's invisible and doesn't smell, it's hard to tell whether there are dangerous amounts of methyl iodide present, and until now the best way to test for it was in a laboratory using expensive, complicated equipment, which isn't practical in many real-world settings. Some cheaper, lightweight detection methods have been tried, but they didn't have enough sensitivity and took too long to deliver results.

Now, research led by the ARC Centre of Excellence in Exciton Science has found a way to detect methyl iodide through changes in colour, with - for the first time - the accuracy, flexibility and speed necessary for practical use. Importantly, this new sensing mechanism is versatile enough for use in detecting a wide range of fumigants and chemical warfare agents.

Working with Australia's national science agency CSIRO and the Department of Defence, the researchers borrowed some new technology that's being used to improve solar power - synthetic nanocrystals based on a perovskite structure - and turned it into a detection method.

Their approach relies on the fact that these highly fluorescent nanocrystals react with the fumigant causing a change in the colour of the light they emit. The presence of methyl iodide causes the nanocrystal emission to shift from green to yellow, and then on to orange, red, and finally deep red, depending on the amount of fumigant present.

The new mechanism has the widest range, highest sensitivity and quickest response ever achieved for a technique that doesn't rely on expensive laboratory instrumentation, producing its results in around five seconds at room temperature.

The researchers now hope their findings will provide a platform for building a test device that can be used in real-world applications.

Enemies 'could create new Covid as weapon': Former colonel issues bleak warning over threat of biological warfare

Mark Nicol | 15 March 2021

Action must be taken now to protect against a Covid-type virus being used as a weapon to cause another deadly pandemic, a leading expert warned last night.

Colonel Hamish de Bretton-Gordon urged the Government to prioritise biosecurity in its Integrated Review of defence and foreign policy, which will be published tomorrow.

The former commander of the military's Chemical, Biological, Radiological and Nuclear (CBRN) Regiment said he was 'concerned' the threat of a man-made pandemic deliberately being imported into the UK, either by an enemy state or a terrorist organisation, would be overlooked.

While COVID-19 may not have been conceived as a weapon, the spread of this deadly virus has provided a template for terrorists, as well as Russia and China, for how effective a biological weapon could be.

Chemical warfare detection tech used in device to make bakeries safer

George Nott | 30 March 2021

Technology developed for the military to detect chemical attacks is being pitched at the bakery industry to avoid diseases like white lung, caused by breathing in flour dust.

Suffolk firm Arosa Instruments has developed wearable monitors for use by bakery workers, which use air sampling tech developed by the Defence Science and Technology Laboratory and the University of Hertfordshire.

White lung, known as baker's asthma, is a serious health and safety risk facing the sector. Latest data from the Health and Safety Executive estimates 17,000 new cases of self-reported "breathing or lung problems" caused or made worse by work each year.

INTERNATIONAL COOPERATION

First Responders from Latin America and the Caribbean Develop Use of Chemical Emergency Management Tools

OPCW | THE HAGUE, Netherlands–5 February 2021

Emergency first responders from Latin America and the Caribbean (GRULAC) participated in a workshop to learn the full potential of two important tools for managing chemical emergencies – the Wireless Information System for Emergency Responders (WISER) and the Emergency Response Guidebook (ERG). The Organisation for the Prohibition of Chemical Weapons (OPCW) conducted the online training from 1 to 5 February with the support of instructors from Peru and Spain.

For handling emergencies involving hazardous chemicals, the participants explored the assistance the WISER and ERG systems offer such as substance identification, use of human health information, and containment and suppression methods. The online workshop also covered: personal protection against chemical warfare agents and toxic industrial chemicals, contaminant dispersion in the environment, as well as the set up and delimitation of safety and security zones.

The 46 participants came from a variety of civilian and military response backgrounds, including civil defence, hazmat equipped firefighters, and CBRN military units. They represented the following 15 OPCW Member States: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominica, the Dominican Republic, Ecuador, Guatemala, Nicaragua, Panama, Paraguay, Peru, and Uruguay.

DISARMAMENT

'Limited' progress in closing Syria chemical weapons file, UN Disarmament Chief tells Security Council

UN | 4 March 2021

Seven years after the Security Council mandated the destruction of Syria's chemical weapons programme, there have been only "limited developments" in the implementation of resolution 2118, passed unanimously in 2013 to bring the country into compliance with its global obligations.

Analysis of all the information and other materials gathered by the Declaration Assessment Team since 2014 indicates that production and/or weaponization of chemical warfare nerve agents did, in fact, take place at this facility.

Syria has yet to respond to OPCW's request that it declare the exact types and quantities of chemical agents produced and/or weaponized at this site.

The country also needs to provide sufficient technical information or explanations that would enable the OPCW Technical Secretariat to close the issue related to the finding of a Schedule 2 chemical detected at the Research Centre's Barzah facilities during the third round of inspections in 2018.

The OPCW Fact-Finding Mission, meanwhile, is studying all available information related to the alleged use of chemical weapons in Syria, engaging with Syrian authorities and other States Parties to the Chemical Weapons Convention on a "variety of incidents"

The Investigation and Identification Team likewise continues its research into incidents in which the Fact-Finding Mission has determined that chemical weapons were used or likely used and issue reports in due course.

CBW Magazine

Journal on Chemical and Biological Weapons

Summer / January-June 2021

MANOHAR PARRIKAR

idsa

MANOHAR PARRIKAR INSTITUTE FOR
DEFENCE STUDIES AND ANALYSES

मनोहर पर्रिकर रक्षा अध्ययन एवं विश्लेषण संस्थान

Manohar Parrikar Institute for Defence Studies and Analyses

No. 1, Development Enclave, Rao Tula Ram Marg
Delhi Cantt., New Delhi-110 010
http://www.idsa.in