Toward a collaborative, collective and integrative international CBRN security education

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Abstract

Despite the entry into force of the 1975 Biological and Toxic Weapons Convention (BTWC) and the 1997 Chemical Weapons Convention (CWC) many years ago, the risk of malign use of chemistry and biology has been a consistently growing threat. Various initiatives have been proposed to address CBRN security issues, particularly on the issue of Dual Use Research of Concern (DURC). In this paper, we first briefly reviewed the history and evolution of chemical and biological security education. Then we discussed the challenges faced among the initiatives developed to strengthen the BTWC and CWC. We further analysed the lessons learned for establishing global biosecurity education, and we concluded that international collaboration and coordination are keys to raising awareness of the necessity for biological security education. In the end, we detailed our new initiative entitled the International Biological Security Education Network (IBSEN) which aims to provide this needed global framework through developing resources in biosecurity education in collaboration with international and regional actors using new methodologies and a linguistic plurality. We believe that a collaborative, collective and integrative international CBRN security education is the key to ensuring a broad engagement in biosecurity education and addressing the issue of DURC.

0. Introduction

Despite the entry into force of the 1975 Biological and Toxic Weapons Convention (BTWC) and the 1997 Chemical Weapons Convention (CWC) many years ago, the risk of malign use of chemistry and biology has been a consistently growing threat. The term ‘dual use dilemma’ was introduced in the publication *Biotechnology Research in an Age of Terrorism* in 2004 by the National Research Council (NRC).[1] The term evolved over the following decade to ‘dual use research of concern’ (DURC). The National Science Advisory Board for Biosecurity (NSABB) formed by the U.S. Government in 2005 defined DURC as ‘life sciences research that, based on current understanding, can be reasonably anticipated to provide knowledge, information, products, or technologies that could be directly misapplied to pose a significant threat with broad potential consequences to public health and safety, agricultural crops and other plants, animals, the environment, maternal or national security’.[2] There is a general agreement among international organizations and academic institutions that DURC refers to the use of beneficial research misapplied to cause harm.

Amongst the first notable cases that caused discussion of dual-use was the introduction of interleukin 4 (IL-4) gene in ectromelia virus by an Australian laboratory in 2001.[1] The introduction of the gene was proposed to improve production of a contraceptive vaccine to control the wild mouse population. However, the modified virus was more virulent than the wild type in naïve animals and even virulent in immune mice. Another significant discussion

arose in 2002 in regard to the poliovirus genome assembled from oligonucleotides thus raising concerns about the potential for the pathogen to be constructed from the sequence information.[3]

Despite the ever-growing risks of DURC and the threat of bioterrorism, there has been a lack of internationally coordinated efforts to implement effective biosecurity education for life scientists. In this paper, we described the historical evolution of chemical and biological security education, placing emphasis on methodologies and implementation strategies and also focusing on key challenges faced, and then proposed to form an International Biological Security Education Network through a collaborative, collective and integrative way.

1. History and evolution of chemical and biological security education

The growing risks of DURC and threats of bioterrorism over the preceding decade have led to much discussion on prevention tactics and thus resulted in the emergence of multiple educational activities to help improve chemical and biological security. Chemical and biological security issues are often viewed and discussed individually. However, there are many overlapping areas of concern and as such it is beneficial to take them together as a whole when discussing security. The rapid progression of science and technology further highlights the growing risk and the need for an effective CBRN security education.

The early 2000s saw relevant codes of conduct developed by numerous entities such as The Royal Netherlands Academy of Arts and Science, the Organisation for Economic Cooperation and Development, and the DIYBio Community.[4–6] The mid-2000s saw an influx of Biosecurity educational and training initiatives pioneered by a series of 90 biosecurity seminars, across 13 countries developed by Brian Rappert and colleagues in 2005.[7] The University of Bradford then developed the first online Biosecurity Education Module Resource in 2006.[8] The University of Bradford proceeded with this initiative with the development of 'Train the Trainer' courses in 2011 followed by short biosecurity educational courses which were implemented in former Soviet States and the Middle East. Two notable resources were published in 2015 and 2016: *Preventing Biological Threats, What Can You Do: A Guide to Biosecurity Issues and How to address them and* the *Biosecurity Education Handbook: The Power of Team-Based Learning.*[9,10] Each resource provided an in-depth analysis of current biosecurity risks and emphasized the requirement for education and awareness raising. A broad range of biosecurity initiatives and competitions were introduced in the 2010s. These included the 'Emerging Leaders in Biosecurity Fellowship' by the Johns Hopkins Centre for Health and Security, the 'Fellowship for Ending Bioweapons' by the Council on Strategic Risks, the 'Youth for Biosecurity Initiative' by the BTWC Implementation Support Unit, and the 'Next Generation Initiative for Biosecurity Initiative' by the Nuclear Threat Initiative (NTI).[7] The emergence of these initiatives fostered and encouraged a security awareness-raising international environment within professions and academia.

There are many other initiatives have been continuously proposed in recent years. Later in 2018, the University of Bath and Biosecure Ltd. published the first Massive Open Online Course (MOOC) on biosecurity and dual-use issues entitled *Next Generation Biosecurity: Responding to 21st Century Biorisks.*[11] The MOOCs are continuously updated with new modules, case studies, and educational materials to meet with new science and technological advancements.

The US Department of Health and Human Services and Agriculture working group focused on strengthening biosecurity, biosafety and responsible conduct culture provides an annual *Guide to Training and Information Resources on the Culture of Biosafety, Biosecurity, and Responsible Conduct in the Life Sciences*. The guide provides 22 listed courses, training and educational resources offered/produced by professional associations, governments, and non-governmental organisations.[7]

The International Federation of Biosafety Associations (IFBA) has developed seven individual international professional certifications in biorisk management. The professional certifications encapsulate biosecurity and cybersecurity, and its target audience is young professionals. Most recently, IFBA partnered with Masinde Muliro University of Science and Technology (Kenya) to pilot an undergraduate-level degree. The degree was officially launched as a Bachelor of Science in Biosafety and Biosecurity in May 2024. The IFBA has also launched the game-based learning tool, 'Biorisk Adventure' - An Online Risk Assessment Game. The tool uses real-life scenarios in a range of geographical locations to enable players to use their judgment in risk mitigation measures.[12]

Furthermore, the United Nations Institute for Disarmament Research (UNDIR) has recently developed the first Biological Weapons Convention National Implementation (NIM) Database. The BWC NIM database, funded by the United States, is designed to strengthen the implementation of the BWC, allowing States and other stakeholders to better understand different approaches to national implementation from around the world. The database serves as a confidence-building tool which seeks to promote trust, transparency, and cooperation concerning the BWC. The database is an ongoing project, and as of March 2024, 35% of State Parties profiles were completed, to finalize the database by the end of 2024. UNIDIR promotes seven general approaches to biosecurity education: modules, specialized Workshops, translations, certification programmes, dedicated centres, networks, and online platforms.[13]

Since 2016, the Advisory Board on Education and Outreach (ABEO) of the Organisation for the Prohibition of Chemical Weapons (OPCW) of the Chemical Weapons Convention (CWC) has provided guidance on education.[14] A Temporary Working Group (TWG) recommended a centralised digital strategy and to nurture partnerships with academic institutions. The ABEO has provided advice regarding the translation and dissemination of education resources, working to foster a culture of peaceful uses of chemistry. The ABEO is currently preparing an inventory of academic institutions worldwide with courses on the CWC and/or OPCW. The ABEO has a large range of target audiences such as National Authorities, policymakers, the chemical industry, and academia among other stakeholders. The Strategic Plan of the ABEO reflects priorities in education, such as the ChemTech's Centre's 'bluebook' to promote the Centre and delves into the best strategies to reach out to diverse audiences. The ABEO Strategic Plan is currently being updated by the Board to adapt and reflect the new context following the destruction of all declared chemical weapons as of July 2023. The ABEO focus is on raising awareness of the CWC amongst civil society, academia, and young professionals.

Regionally, academics in Latin America for example have echoed the need to consider cultural, economic and geopolitical differences in CBRN security education. Academics and the research community in Argentina have expressed great interest in biosecurity, Biorisk management, and dual-use research of concern. Professors in Argentina have already begun introducing biosecurity concepts to students; however, this was not a formal part of the syllabus

but used additional sections. Courses focused on the CWC have also been established in Cordoba and at the Technical University in Bueno Aires. CWC courses in Cordoba are available online and target young professionals, however, they are only taught in Spanish.[15]

2. Challenges

Although the aforementioned chemical and biological security education initiatives were developed independently, the challenges they faced are common. These challenges included assessing the needs for security education, developing adapted resources at the regional and local levels and promoting them to different stakeholders.

2.1 The difficulty of implementing global initiatives at the regional level

Implementing chemical and biological security education developed at the international level can sometimes present challenges at the national and regional levels. Both legal and cultural norms must be considered, as well as the practicality of activities. Pakistan and Latin America are two good examples. Academics in Pakistan pointed out that the unstable political climate heightens Pakistan's vulnerability to biosecurity threats.[16] The mass disinformation campaigns seen during the COVID-19 pandemic in addition to the resurgence, normalization and ever-increasing danger of the anti-vaccine movement pose a major threat to sustainably establishing biosecurity education to the general public. Major activities in Pakistan to strengthen education include international liaison, policy suggestions to the government and the development of measures to counter infodemics. Dr Maria Espona emphasises that despite its perception as a homogenous region, Latin American countries have significant differences regarding cultural heritage, governments, languages, national criminality, threat perception and regional and international integration.[17] Therefore, to effectively establish biosecurity education in Latin America, individual countries and regional situations must be taken into account.

A linguistic plurality is also needed to consider when developing educational resources adapted to regional needs. This is increasingly recognised by international organisations and civil society. The London Metropolitan University's Biological Security Research Centre conducted the 'cartoon project'.[18] This series of cartoons explained the issue of dual-use and the role of the BTWC and CWC and were translated into fourteen different languages. Translating education resources and developing new materials in collaboration with local actors and institutions are the first steps to reaching global and regional audiences. This effort has received very good feedback and has been uanimously used by other actors in the field.

2.2 Fostering public and stakeholders' engagement

Public engagement is essential to raise awareness of the need for chemical and biological security education and the latest developments in the field. However, scientists have limited interactions with the public.[19] Issues of disinformation and misinformation were also highlighted during the COVID-19 pandemic.[20] International organisations are therefore relying on new methods to share their resources. For example, the Temporary Working Group of the ABEO recommended setting up a centralised digital strategy and developing partnerships with academic institutions.[21] Similarly, the UNIDIR's BWC NIM Database was designed to

strengthen the implementation of the BTWC.[13] Furthermore, the ABEO Strategic Plan is being updated to adapt it to the new context following the destruction of all declared chemical weapons in July 2023. The role of the ABEO in raising awareness of the CWC among civil society, academia, and young professionals is key to fostering engagement with non-proliferation and disarmament architecture. This emphasises the adaptability of the international organisations in chemical and biological security.

However, as organisations and institutions are leading different projects on chemical and biological security education, the priority should be the creation of a 'mapping' among already-existing projects. This survey of projects would enable the design of a clear roadmap for future initiatives. Going beyond the creation of educational material, institutions and international organisations should also learn from each other regarding how to engage with the targeted audiences. This 'mapping' of projects would also allow for a review of the methodologies used in chemical and biological security education. Surveying existing methodologies is essential to understand if new methodologies are used differently to raise awareness among younger generations. These new methodologies could include Team-Base Learning or video games and Artificial Intelligence. This bottom-up approach is key to fostering public engagement.

Furthermore, a significant challenge faced by actors in chemical and biological security education is the engagement with the relevant stakeholders. The top-down approach is often difficult as it is challenging to reach and convince ministries of education and other policymakers. The lack of formal governmental policy reinforces these difficulties and weakens the initiatives, particularly in biosecurity education due to its complex nature. Developing educational resources therefore relies mainly on individual commitments and initiatives from the civil society and international organisations. Therefore, an ideal solution would be to design an effective national authority which would enable stakeholders to hold regular meetings at the national level. However, there is a lot to be done regarding the structure of this national authority and how to adapt it to different national contexts.

2.3 A necessary multidisciplinary approach to chemical and biological security education

One of the issues faced by chemical and biological security education is that biological and chemical issues have been often overlooked. This can be illustrated in the difficulty of raising the profile of CBW (Chemical and Biological Weapons) disarmament above the 'loud noise' of the nuclear debate. During the Cold War, the anti-CBW campaign was overshadowed by the non-proliferation of nuclear weapons campaign. Although it may not be productive to approach each element of security education separately, attention must be given to a multidisciplinary and collaborative approach.

Chemical and biological security education is highly multidisciplinary and must also include social sciences and humanities in addition to sciences. Integrating history in chemical and biological security education is essential in contextualising the development of biological, chemical and other weapons. Society is slower in adapting to changes, whether they are advancements in technology and weaponry or policy and law. Therefore, it is crucial to learn from history and ensure that law evolves at the same pace as scientific advancements. Similarly, social sciences are key in developing governance on chemical and biological security. For

example, International Relations provide theoretical and conceptual frameworks to understand the attraction of Weapons of Mass Destruction (WMD) and how they can be misused by state (such as rogue States) and non-state actors (such as bioterrorists).[22] This multidisciplinary approach including life sciences and social sciences is necessary to develop efficient biosecurity education.

Chemical and biological security education are complicated and need to adopt a collective, integrative approach. Multidisciplinary educational resources, trainers' backgrounds and professional applications are essential for an efficient and exhaustive chemical and biological security education.

2.4 Lack of sustainable funding prevents long-term initiatives

The issue of lack of sustainable funding is common to civil society and other international organisations in CBRN security education. For example, the Implementation Support Unit (ISU) of the BTWC faces issues in satisfying the demands of State Parties regarding biosecurity education due to the absence of funding.[23] Therefore, international coordination and civil society input are needed to overcome this lack of sustainable funding. For example, a recent grant from the Joseph Rowntree Charitable Trust (JRCT) enabled the Biological Security Research Centre at the London Metropolitan University to start the long-term project of the International Biological Security Education Network (IBSEN).[24]

3. Enhancing biosecurity education: a global network for international collaboration and regional applications

The development of global biosecurity education is an interdisciplinary and cross-sectoral effort. Ongoing initiatives in the field are often limited to specific regions and audiences and therefore hard to encompass multiple elements of chemical and biological security education. A new initiative answering these challenges is therefore necessary to strengthen global biosecurity.

A new initiative developed by the London Metropolitan University (LMU) Biological Security Research Centre (BSRC) aims to raise awareness of the urgent need for biosecurity education. Founded in February 2024, the International Biological Security Education Network (IBSEN) addresses these challenges by designing educational materials and curricula in collaboration with members from across the world. IBSEN is formed of a core team at the LMU and of a global network of scientists, policymakers, high school lab technicians and teachers and govermnent officials from all continents. This new initiative aims to change the widespread lack of awareness of dual use in the life sciences.[25] IBSEN's strategy focuses on learning from previous initiatives in CBRN security education and implementing the 'lesson learned' from these initiatives. This iterative process is one of the key strengths of the project as it enables the development of effective tools in collaboration with relevant actors. The work of IBSEN is therefore built around four key pillars: learning from previous initiatives, raising awareness, development of education resources and evaluation of impact.

Firstly, IBSEN will develop resources in biosecurity education for life scientists across the world. As its first step, the newly published book *Essentials of Biological Security: A Global Perspective* is a one-stop-shop resource to help people teach biological security in support of the Tianjin Guidelines.[7] This is the first of a series of books on biosecurity. With its effort and commitment to developing global biosecurity education, IBSEN has started a translation project, including at first a version in Chinese, Portuguese and Spanish. This book is complementary to other resources developed through the IBSEN project and by the staff at the BSRC such as academic articles on the BTWC and DURC issues.[25,26] IBSEN also recently published its *First and Second Quarterly Newsletter* which discussed the lessons learned from the experience of both the International Nuclear Security Education Network (INSEN) and the ABEO. The Newsletters were published in three languages (English, French and Spanish). The analysis on the readers of the first newslwtter showed that 77% of the readers accessed it in English, 13% in French and 10% in Spanish. Internationality is therefore a key strength of IBSEN as its structure allows to raise awareness globally and to provide useful materials for regional initiatives development through tailored resources in different languages.

The engagement of broad members to IBSEN is also necessary to develop the network globally and regionally. IBSEN is advised by an International Oversight Board including eight members for all the continents. Our International Oversight Board members will be working as local 'champions' to help the network grow. We grouped our INSEN members into four categories, i.e. secondary education, academic institutions, professional organisations, international organisations and governments. This responds to the need for collaboration and involvement of different sectors, particularly civil society and governments.[26] This plurality of backgrounds is essential to develop courses and educational materials for different stakeholders to meet their individual needs.

Finally, IBSEN will incorporate the literature on best educational practices and new methodologies to design biosecurity resources. Recent research has emphasised a shift from the instruction paradigm to the learning paradigm.[27] Moving from a teacher-centred approach, the learning paradigm aims to create an environment where students and professors create knowledge together. Team-Based Learning (TBL) is an efficient tool for biosecurity education as it 'empowers educators, students and practitioners' and was initially used by the University of Bradford is one example of good practice in developing methodological tools for biosecurity education.[28] TBL focuses on the application of concepts by the students through a motivational framework including individual and group work and immediate feedback.[28] IBSEN also plans to develop a variety of methodological approaches adapted to different audiences. For example, game-based learning tools could be developed in collaboration with high school lab technicians and teachers. Here again, IBSEN will learn from good practice such as the IFBA and its game-based learning tool 'Biorisk Adventure'.[12]

Learning from lessons from existing international initiatives in chemical and biological security education, the IBSEN has objectives at both the global and regional levels. It aims to raise awareness globally of the risks of DURC and meet the need for biosecurity education. IBSEN will also develop resources in biosecurity education in collaboration with international and regional actors through new methodologies and a linguistic plurality. This is key to ensuring a broad engagement within and beyond the network.

4. Conclusion

International organisations such as the CWC ABEO, the INSEN or ISU BWC focus on either chemistry, biological or nuclear security, they face similar challenges in CBRN security education, especially in promoting the educational materials developed globally to meet national and regional needs. International collaboration and coordination are therefore keys in raising awareness of the necessity for chemical and biological security education and their implementations. IBSEN is a good example of using an international and interdisciplinary approach to biosecurity education. The structure of the network and its approaches reflect this effort by ensuring engagement at the regional, national and international levels.

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