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Awareness of and Education about the Biological and Toxin Weapons Convention (BTWC): Why this is Needed by All Life Scientists and How it Might be Achieved

Malcolm Dando

Introduction

The threat to global health comes from natural disease, accidental disease and the deliberate causation of disease by use of biological and chemical agents.¹ We strive to deal with natural disease by improving measures of public health and we use biosafety measures to reduce the chance of accidental disease. Deliberately caused disease, in the form of bioterrorism and State offensive biological weapons programmes² is less well known outside of security circles, but we attempt to minimize such malign misuse of the modern life sciences through an integrated web of preventive policies³ to support the international prohibition norm embodied in the Biological and Toxin Weapons Convention (BTWC) and the Chemical Weapons Convention (CWC). This is important because it is clear, particularly from the offensive biological weapons programmes of major states in the last century, that in the right conditions very-large-scale casualties and deaths could be caused to humans, animals and plants. Furthermore, ongoing advances in the life and associated sciences could make it easier for states, sub-state terrorist groups or even deranged individuals to carry out such attacks. This chapter considers the problem of deliberate disease, but it should be understood that there is an overlap in the impact of policies concerned with dealing with disease. Thus good laboratory biosecurity will also assist in

- 1 Geoffrey L. Smith and Neil Davison, 'Assessing the Spectrum of Biological Risks', *Bulletin of the Atomic Scientists*, 2010, January/February: 1–11.
- 2 Mark Wheelis, Lajos Rosza and Malcolm R. Dando, *Deadly Cultures: Biological Weapons Since 1945* (Cambridge, MA: Harvard University Press, 2006).
- 3 Board of Science and Education, *Biotechnology, Weapons and Humanity II* (London: British Medical Association, 2004).

preventing accidental disease, and good public health measures will assist in dealing with any disease outbreak – natural, accidental or deliberate.

The biological and toxin weapons convention

Article I of the BTWC states that:

Each State Party to this Convention undertakes never in any circumstances to develop, produce, stockpile or otherwise acquire or retain:

1. Microbial or other biological agents, or toxins whatever their origin or method of production, of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes . . .

So any peaceful purpose is allowed but there is a sweeping prohibition of other uses embodied in the Convention. Moreover, in order to ensure that the prohibition is effective, Article IV states:

Each State Party to this Convention shall, in accordance with its constitutional processes, take any necessary measure to *prohibit and prevent* the development, production, stockpiling, acquisition or retention of the agents, toxins . . . specified in Article I of the Convention . . . (emphasis added)

So measures such as national laws are required to prohibit what is banned by Article I, but there is an additional need to take measures to prevent malign misuse of the agents and toxins.

The Convention is assessed at a special Review Conference every five years and a consensus Final Declaration shows the agreed understandings of States Parties in regard to each Article. Thus they agreed at the Second Review Conference in 1986 under Article IV that:

The Conference notes the importance of. . .

– inclusion in textbooks and in medical, scientific and military educational programmes of information dealing with the prohibition of microbial or other biological agents or toxins and the provisions of the Geneva Protocol [of 1925, which bans use of such agents] . . .⁴

States Parties also agreed that such measures would strengthen the Convention, and they have made similar statements at subsequent Review Conferences. Thus it is clear that in-depth implementation of the Convention requires a

4 United Nations, *Final Declaration*, Second Review Conference of the Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction. (1986) BWC/CONF.II/4, 18 August, Geneva: United Nations.

high level of awareness and education of life scientists. How else could they contribute to the development and maintenance of any necessary oversight systems of potentially dangerous research that others might misuse (dual-use research) or codes of conduct, let alone know what activities might contravene the Convention?

The awareness and education of life scientists

Unfortunately, when States Parties met in the 2005 Inter-Sessional Process between the Fifth and Sixth Five Year Review Conferences, Australia reported that:

Amongst the Australian scientific community, there is a low level of awareness of the risk of the 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.

Australia is far from unique in this respect. At the same meeting I reported work with Brian Rappert in which we used his interactive seminar to assess the views of practising life scientists in the United Kingdom about the Convention. We concluded that:

There is little evidence from our seminars that participants:

- a regarded bioterrorism or bioweapons as a substantial threat;
- b considered that developments in life sciences research contributed to biothreats;
- c were aware of the current debates and concerns about dual-use research; or
- d were familiar with the BTWC.

In the following year we reported further seminars in the United Kingdom and in Finland, Germany, the Netherlands, South Africa and the United States that produced very similar results⁵ and subsequently we found much the same in Argentina, Australia, India, Israel, Japan, Kenya, Sweden, Switzerland, Uganda and the Ukraine. It is very difficult to avoid the conclusion that ignorance of the BTWC and the dangers of deliberate disease are widespread among practising life scientists around the world.

5 Malcolm R. Dando and Brian Rappert, *In-depth Implementation of the BTWC: Education and Outreach*, Review Conference Paper No. 18, November (Bradford: University of Bradford, 2006).

There could, of course, be many reasons for these findings. For example, in the fast-moving revolution in the life sciences, there is a vast amount of new information and many new technologies to be mastered by practising life scientists before they get down to the tough task of carrying out their own work. There may thus be little time to consider the potential misuse of the materials, technologies and information they are generating day by day. Yet we reasoned that if the essential material required for understanding the importance of the BTWC was incorporated into their university education at undergraduate and postgraduate levels it would be most unlikely that the widespread ignorance we encountered would have been possible.

We therefore began to examine what was being taught in university Life Sciences departments in different countries and regions of the world. The results again were very clear. In co-operation with Italian colleagues we first carried out a survey of courses in Europe. Using a sample of 142 courses from 57 universities in 29 countries, a search was made for evidence of biosecurity modules, bioethics modules and biosafety modules. These were the results:

This research suggested that only 3 out of the universities identified in the survey currently offered some form of specific biosecurity module and in all cases this was optional for students.⁶

We felt reasonably sure that this was a correct assessment of the situation because if more such modules existed they would likely have been discovered in larger numbers as the survey also found that nearly half of the degree courses surveyed had a bioethics module and a fifth had a biosafety module. Efforts to dig deeper into the material being taught by searching even for references to issues such as the BTWC brought equally bleak results. Similar findings resulted from a survey in Japan⁷ and subsequently in Israel and the Asia-Pacific region. In short, it is clear that there is a major gap in the current education of life scientists at university level around the world. It is very unlikely that they are receiving the education that States Parties to the BTWC considered important in strengthening the Convention two-and-a-half decades ago.

Correcting the education and awareness deficiency

When we followed up our surveys by asking lecturers why they did not cover the absent material, some said that they did not see the relevance of the problem.

6 Guilio Mancini and James Revill, *Fostering the Biosecurity Norm: Biosecurity Education for the Next Generation of Life Scientists* (Landau Network and University of Bradford, 2008), available at www.dual-use.bioethics.net.

7 Masamichi Minehata and Nariyoshi Shinomiya, *Biosecurity Education: Enhancing Ethics, Securing Life and Promoting Science* (Japan, National Defence Medical College, and Bradford: University of Bradford, 2009), available at www.dual-use.bioethics.net.

Others, however, did see that there was an important gap, but said that they lacked the knowledge, resources and space on the timetable to deal with it. We thus came to the conclusion that one way, among a number, in which we could help was to provide a wide-ranging internet-based ‘open-source’ Education Module Resource (EMR) that could easily be used by lecturers to add material, as they saw fit, to their ongoing courses.⁸

The question then was what material should go into our EMR? In deciding, we were guided by the States Parties to the BTWC giving more detailed consideration to the problem of education and the outcome of the BTWC Inter-Sessional Process meeting in December 2008,⁹ which concluded in part that:

State Parties noted that formal requirements for seminars, modules or courses, including possible mandatory components, in relevant scientific and engineering training programmes and continuing professional education could assist in raising awareness and in implementing the Convention.

The States Parties then went on to agree on the value of such programmes including:

- a Explaining the risks associated with the potential misuse of the biological sciences and biotechnology;
- b Covering the moral and ethical obligations incumbent on those using the biological sciences;
- c Providing guidance on the types of activities which could be contrary to the aims of the Convention and relevant national laws and regulations and international law; and
- d Being supported by accessible teaching materials, train-the-trainer programmes, seminars, workshops, publications and audio-visual materials . . .

In order to meet such objectives we decided, with our colleagues at the National Defence Medical College (NDMC) in Japan, that the EMR should have three main sections together with an introductory overview and a concluding look forward.

Thus the 21 lectures of the EMR are designed as follows:

A Introduction and Overview (Lecture 1).

B The Threat of Biological Warfare and Terrorism and the International Prohibition Regime (Lectures 2–10).

8 James Revall, *Developing Metrics and Measures for Dual-Use Education* (Bradford: University of Bradford, 2010), available at www.dual-use.bioethics.net.

9 United Nations, *Report of the Meeting of States Parties*, BWC/MSP/2008/5, 12 December, Geneva: United Nations, 2008.

- C The Dual-Use Dilemma and the Responsibilities of Scientists
(Lectures 11–18).
- D National Implementation of the BTWC (Lectures 19–20).
- E Building an Effective Web of Prevention (Lecture 21).

To assist with the use of the EMR, each of the lectures consists of 20 powerpoint slides in a standard format. Additionally, notes are provided for the lecturers and direct links on the Internet are made to the references used for the slides. There are also some background papers on issues that life scientists are less likely to know about and sets of questions for students related to each lecture.

The first major section (B) of the EMR therefore has the following series of lectures:

- 2 Biological weapons from Antiquity to World War I
- 3 Biological weapons from WWI to WWII
- 4 Biological weapons during the Cold War
- 5 The impact of biological weapons agents
- 6 Assimilation of biological weapons in State Programmes
- 7 International legal agreements
- 8 Strengthening the BTWC 1980–2008
- 9 The 2003–2005 Inter-Sessional Process
- 10 The 2007–2010 Inter-Sessional Process.

However, this unfamiliar material for life scientists was made ‘user-friendly’ by introducing modern accounts of the traditional biological agents and toxins such as anthrax, smallpox and botulinum toxin in the historical accounts of the twentieth-century offensive biological weapons programmes in major states such as the United Kingdom, United States, Union of Soviet Socialist Republics, France, Germany and so on.

Section C of the EMR then introduces the recent concerns about dual-use research and publications as follows:

- 11 Bioethics methodology
- 12 Obligations derived from the BTWC
- 13 The growth of dual-use bioethics
- 14 Dual-use: The US National Academy of Sciences Fink Report

- 15 Dual-use examples
- 16 The US National Academy of Sciences Lemon-Relman Report
- 17 Weapons targeted at the nervous system
- 18 Regulation of the life sciences.

Because life scientists have little knowledge of the BTWC, again an effort has been made to ensure that the module is user-friendly by suggesting that the problem of dual-use is best seen as an ethical problem since life scientists are often taught about ethical issues such as those, for example, surrounding GMOs and stem cell research. More specifically, we use the original outlining of the problem of dual-use in the US National Academy of Sciences Fink Committee Report and the expansion of concern across the life sciences in the Lemon-Relman Report to clearly demonstrate high-level scientific concerns about this issue.

The following section (D) sets the regulation of dual-use within the wider context of international efforts to regulate the biotechnology revolution as a whole and the national implementation of the BTWC:

- 19 International regulation of biotechnology
- 20 National implementing legislation.

Finally, the last lecture – number 21 – looks forward to examine how all elements of the overall web of preventive policies may be improved. Currently, the EMR is available in English, Japanese, French and Russian, and other translations are in progress. We have also tested out the use of parts of the module in Italy and Japan with our colleagues and reported the successful outcomes to BTWC meetings in Geneva. However, the question now is – how can this successful project, or other such projects, be used to inform the majority of practising life scientists?

Effective education?

There are obviously problems in converting small-scale projects of the kind illustrated by the development of the EMR into large-scale programmes of education. A basic difficulty is the way in which the problem of biosecurity has been formulated for scientists. Following the terrorist attacks in the United States in 2001 and the subsequent mailing of anthrax-contaminated letters, the most prominent concern has focused on terrorism and the dangers that could arise from the later misuse of dual-use experiments or publications. This approach is epitomized by the Fink Committee's designation of seven classes

of experiment of concern that require, in their opinion, a form of oversight in a pre-project review. Such reviews would weigh the benefits of the research against the potential future risks. Unfortunately, as Brian Rappert and I were often told in our seminars with life scientists, it will be very difficult to achieve a consensus that the biosecurity risks of almost any experiment will outweigh the benefits. The fact that the benefits of reconstructing the deadly Spanish influenza virus (and publication of the details) were seen to outweigh the risks is surely a good illustration, as is the vanishingly small number of publications that have been withheld on the grounds of biosecurity risk.

As Caitriona McLeish has argued, there are a number of different ways in which the concept of dual-use can be understood.¹⁰ From the perspective of the BTWC the problem is not just about individual experiments and publications but with the probability that the scope and pace of change in the biotechnology revolution could facilitate both old and new means of biowarfare and bioterrorism. Yet the last thing we want to do is to prohibit beneficial science and technology. So, properly formulated, the problem is how to prevent malign misuse without, in trying to prevent the most exceptionally dangerous research and publication, preventing beneficial work.

Put simply, it would appear that we have formulated the problem incorrectly. The problem is not (or very rarely) concerned with the benignly intended work of individual scientists but with the protection of all such work from misuse. In such circumstances it seems difficult for bioethicists to offer much help to the scientist about what to do and that may partly explain the limited forays of bioethicists to date into the field of dual-use.¹¹ My own guess is that Aquinas' Doctrine of Double Effect might help.¹² The original argument is that if I inadvertently kill an attacker in defending myself then I can hardly be called to account. However, if I am reckless in my defence, that may not hold. So if I carry on with my life science research and publication but take part in efforts to prevent misuse, I have a defensible case if my work is misused, but if I recklessly ignore the possibility of misuse, that may not hold. And maybe, also, other ethical principles can be used to help scientists decide what to do.

Even if a satisfactory bioethical approach to dual-use is developed there will clearly be a problem in transmitting it effectively to life scientists. As Jane Johnson explained:

Analysing the relatively limited literature regarding teaching philosophy to science students reveals that at the broadest level student difficulties stem from a difference in culture and norms of the humanities and sciences . . .

10 Caitriona McLeish, 'Reflecting on the Problem of Dual-Use', in Brian Rappert and Caitriona McLeish (eds), *A Web of Prevention* (London: Earthscan, 2007).

11 Michael Selgelid, 'Ethics Engagement of the Dual-Use Dilemma: Progress and Potential', in Brian Rappert (ed.), *Education and Ethics in the Life Sciences*, (Canberra: ANU E Press, 2010).

12 Stanford Encyclopedia of Philosophy, *Doctrine of Double Effect*, (2011), available at plato.stanford.edu/entries/double-effect.

She detailed the problems that arise from this difference as follows:

... science students frequently not having the requisite skills in writing, reading, and so on, to perform well in philosophy subjects generally ... in their not knowing, understanding or being comfortable with the culture and expectations of philosophy ...

Indeed:

... in their possibly having a hostile orientation towards a discipline which they may perceive as either challenging or inferior to their chosen career path in science ...¹³

There may, of course, be imaginative teachers who can overcome what I suspect are widespread characteristics among science students, but it will surely not be easy to make a lasting impact with a measurable effect.¹⁴

It is for such reasons, I suspect, that a more popular approach with scientists is to aim to develop responsible conduct of research in a much more straightforward manner with little recourse to overt philosophical (ethical) arguments. Yet for those interested in dealing with the dual-use/biosecurity problem, even this approach can present difficulties, as is easily seen by an analysis of the widely used US National Academies book, *On Being a Scientist: A Guide to Responsible Conduct of Research*.¹⁵ This book has 12 substantive chapters following the introduction which cover issues such as advising and monitoring, the treatment of data, research misconduct and so on (see Table 11.1). The issue of dual-use is covered in the final chapter (13), which is titled 'The Researcher in Society'. This chapter takes a wide-ranging view of the researcher's responsibilities, stating:

The standards of science extend beyond responsibilities that are internal to the scientific community. Researchers also have a responsibility to reflect on how their work and the knowledge they are generating might be used in the broader society.

It goes on to mention different roles that scientists might play in the wider society such as providing expert advice to government or lobbying policy-makers on topics in which they specialize but, interestingly, the 'Historic Case Study' for the chapter concerns a dual-use issue and is titled 'Ending the Use of Agent Orange'. This historic study recounts how, in the 1940s, Arthur Galston

13 Jane Johnson, 'Teaching Ethics to Science students: Challenges and a Strategy', in Rappert (ed.), *Education and Ethics in the Life Sciences*.

14 National Academies, *Ethics Education and Scientific and Engineering Research: What's Been Learned? What Should Be Done?* (Washington DC: National Academies Press, 2009).

15 Committee on Science, Engineering and Public Policy, *On Being a Scientist: A Guide to Responsible Conduct in Research* (3rd edn) (Washington DC: National Academies Press, 2009).

Table 11.1 Chapters and Case Studies*

Chapter	Case Studies	Advice	Historic Case Study	Appendix
1 **	-	-	-	-
2	y***	y	-	y
3	y	-	-	y
4	y	-	y	y
5	yy	-	y	yy
6	y	-	y	y
7	yy	-	-	yy
8****	-	-	-	-
9	y	y	y	y
10	y	-	y	y
11	y	-	-	y
12	y	y	-	y
13	-	-	y	-

*From Committee on Science, Engineering and Public Policy (2009), on Being a Scientist: A Guide to Responsible Conduct in Research, 3rd edn (Washington DC: National Academies Press).

**Introduction.

*** Symbol ‘y’ indicates presence.

****Biosafety chapter with checklist.

discovered plant bioregulators that could hasten the flowering of plants. This allowed particular plants to be grown in colder climates because it shortened the growing season required. However, in larger concentrations these synthetic chemicals could be used as herbicides to defoliate and kill the plants. When Galston discovered that the US military were using thousands of tons of the chemicals (mainly Agent Orange) as defoliants in the Vietnam War in the 1960s he actively opposed this abuse of his work. The historic case study ends by quoting Galston:

I used to think that one could avoid involvement in the anti-social consequences of science simply by not working on any project that might be turned to evil or destructive ends. I have learned that things are not that simple . . . The only recourse is for a scientist to remain involved with it to the end.

However, no further advice is offered to the scientist about how to do this. As Table 11.1 illustrates, this is in stark contrast to the other substantive chapters of the book. Some have historic case studies and a few also have advice sections, but all have one or more hypothetical case studies backed up by additional analyses and answers to some of the questions raised by these case studies in an appendix. So what this text on responsible conduct of research

lacks is precisely what the scientist needs to be responsible about biosecurity: information on dual-use and biosecurity and the BTWC.

Yet I think this approach of developing a wider sense of the responsible conduct of research can be of use in regard to dealing with the wider social responsibilities of scientists under the Convention. For example, a straightforward list of practical questions such as the following would alert the scientist to what he or she needed to find out.

A In regard to work in their scientific field:

Would you be able to spot an experiment of real dual-use concern?

B In regard to their workplace:

Is there a mechanism in place where you could raise concerns about a dual-use experiment of concern with your superiors?

C In regard to their scientific associations:

Are dual-use and biosecurity policy developments (nationally and internationally) being carefully followed and are you being kept informed so that you can contribute your expertise to finding solutions?

D In regard to national implementation of biosecurity policies:

Are you well informed about the national laws and regulations that could affect your country's obligations under the Biological Weapons Convention?

E In regard to the Biological Weapons Convention:

Are you aware of the key provisions of the Convention and of how efforts are being made to keep it up-to-date with ongoing scientific advances?

It seems possible that a new version of *On Being a Scientist* could include a case study, advice and answers to some such questions in a new section of the appendix.

Yet even if that were done and other non-governmental initiatives were undertaken it does not seem possible that a large-scale change in the culture of the life sciences towards the problem of dual-use and biosecurity could take place without government action at the national level. Some of what that might involve was set out in a US National Science Advisory Board for Biosecurity (NSABB) report on a *Strategic Plan for Outreach and Education on Dual-Use Research Issues* in 2008. According to this report:

First and foremost, the target audience must be identified and assessed as to their level of understanding of the issues since this will guide the educational strategies.

Then:

Messages should be tailored to specific target audiences. Key points must be identified and specifically crafted to effectively convey the nature and importance of the information while simultaneously addressing the unique concerns of different stakeholder groups.

And finally:

... it is important to select those methods that will most effectively reach the intended audiences.¹⁶

Even more daunting, when all of that theoretical analysis is completed for diverse stakeholder groups, an implementation plan still has to be devised, carried out and monitored to completion.

What needs to be done?

In the face of such a set of difficulties it might seem that it is an almost impossible task for the international community to deal with this gap in the web of preventive policies and to enlist the help of an aware and well-educated scientific community in the protection of their work from malign misuse. I do not agree with that assessment.¹⁷ It will be recalled that in 2008 State Parties to the BTWC agreed a set of sensible means by which the level of awareness and education of life scientists could be improved in order to strengthen the Convention.

Of course, given the different circumstances in each country there will be no 'one size fits all' solution. Each State would have to take what actions it felt would be most appropriate to achieve the desired end and then report back to the hopefully reinvigorated system of annual meetings¹⁸ in order that 'Best Practice' could more rapidly evolve. Most importantly, I think it is necessary to understand that some massive, cumbersome, top-down system is just what is *not* required. Instead, a series of low cost, imaginative, practical projects could be initiated that would help to develop and demonstrate what needs to be done. Properly reported in the scientific and educational literature, these projects would, I think, certainly then be taken up by other life scientists and the idea and implementation of the new culture could be expected to spread nationally and internationally.

For example, State-level Research Councils could deliberately advertise grants that would be available for groups to develop and implement new dual-use and biosecurity educational material and make it available 'open-source' on the internet. National and private funders could also make grants available for the

16 National Science Advisory Board for Biosecurity, *Strategic Plan for Outreach and Education on Dual-use Research Issues* (Washington DC: NSABB, 2008).

17 Simon Whitby and Malcolm R. Dando, *Effective Implementation of the BTWC: The Key Role of Awareness Raising and Education*, Review Conference Paper No. 26, November (Bradford: University of Bradford, 2010).

18 Nicholas A. Sims, *An Annual Meeting for the BTWC*, Review Conference Paper No. 22, June (Bradford: University of Bradford, 2010).

development and implementation of Train-the-Trainer programmes¹⁹ to help with the teaching of the new material or with short courses specifically designed for particular stakeholders (e.g. industry) within the country. Furthermore, grants could be made available for networks of interested lecturers to be organized, course material to be developed into textbooks and for professional associations to help develop international competency standards in biosecurity. So there are many low-cost, efficient and effective actions that could be taken by State Parties if it is decided to act upon the agreement made in 2008 (see Table 11.2).

None of that kind of funding would incur large-scale costs and could, in any event, be distributed over a number of government agencies and private sources. Moreover, it can surely be expected that as awareness and education levels improve, the scientific community will give consideration to appropriate codes of conduct and oversight systems as they appear necessary.

Conclusion

There is undoubtedly a serious gap in the overall web of preventive policies designed to minimize the possibility that the modern life sciences will be used for hostile purposes. Most practising life scientists still are unaware that there is a problem and we are certainly only in the early stages of working out how to close this dangerous gap – a gap that will certainly grow more dangerous as the biotechnology revolution continues to advance and spread.

Yet despite the difficulties in changing the culture of the life sciences – some of which, as noted here, are indeed formidable – it seems that effective action at relatively low cost could build a self-sustaining process by which the life sciences community will carry out the necessary actions itself. All that is required now is for the Seventh Review Conference of the BTWC to take the decision to act on awareness-raising and education in December 2011 and for State Parties to ensure funding for small-scale, imaginative practical projects which, when well reported, can be the model for many others to follow. In short, there is the possibility of a huge gearing up of projects by life scientists because the last thing they want to see is their benignly intended work being misused for hostile purposes.

However, the danger is that with so many possible issues to deal with and so little time at the Review Conference itself, awareness-raising and education (and, by implication, codes of conduct and oversight systems) will just get lost among what are perceived to be more important or pressing issues.²⁰ Yet a successful

19 Whitby and Dando, *Effective Implementation of the BTWC*.

20 Graham S. Pearson, *Preparing for the BTWC Seventh Review Conference in 2011*, Review Conference Paper No. 21, May (Bradford: University of Bradford, 2010).

Table 11.2 Actions that could be taken to implement the 2008 agreements on education

i. Explaining the risks associated with the potential misuse of the biological sciences and biotechnology;	
Action	The government could send a message to all Universities setting out the risks and asking that this information be circulated to all heads of departments in life and associated sciences with a view to actions being taken in regard to the education of students.
Objective	The aim would be to rapidly raise awareness of the risks among those with professional expertise and to engage them in considering what should be done about the education of their students.
ii. Covering the moral and ethical obligations incumbent on those using the biological sciences;	
Action	The government could send a letter to all Universities requesting that the information given in the letter described in section (i) above be circulated to all philosophy departments with a view to action being taken to develop an ethical approach to questions of dual-use, biosecurity and the BTWC.
Objective	To assist life and associated scientists to add this material on their moral and ethical obligations under the Convention to the material being taught on bioethics and medical ethics.
iii. Providing guidance on the types of activities which could be contrary to the aims of the Convention and relevant national laws and regulations and international law;	
Action	The government could issue a short statement setting out the national laws and international laws in brief and why they are needed to minimize the risk of bio warfare and bioterrorism.
Objective	To provide a coherent context and rationale for the development of new educational courses and materials.
iv. Being supported by accessible teaching materials, train-the-trainer programmes, seminars, workshops, publications and audio-visual materials;	
Action	Funding Agencies (government and non-governmental) could be asked to provide small grants, for example to assist in the development of new courses on dual-use bioethics and biosecurity that could then be made available 'open source' on the web or for seminar series and network building.
Objective	To develop and spread best practice effectively and efficiently.

v. Addressing leading scientists and those with responsibility for oversight of research or for evaluation of projects or publications at a senior level, as well as future generations of scientists, with the aim of building a culture of responsibility;	
Action	The government could convene a meeting of representatives of all the relevant professional associations and industry associations to consider how they could assist in the promotion of a culture of responsibility and ownership in relation to the Convention, for example through the development of appropriate elements of continuing professional development.
Objective	To engage leading scientists in the process of developing this element of the web of prevention.
vi. Being integrated into existing efforts at the international, regional and national levels;	
Action	The government could set up an interdepartmental committee to monitor and integrate these efforts at awareness raising and education and to report what is being done to the relevant meetings of the BTWC and other international meetings.
Objective	To make the overall national effort as effective as possible and to assist others in such developments.

outcome should not be seen as farfetched, indeed it may eventually be seen as mainstream when, for example, the US Presidential Commission for the Study of Bioethical Issues, in its 2010 report *New Directions: Ethics of Synthetic Biology and Emerging Technologies*, stated in its Recommendation 9:

Because synthetic biology and related research cross traditional disciplinary boundaries, ethics education similar or superior to the training required today in the medical and chemical research communities should be developed and required for all researchers and student investigators outside of the medical setting, including in engineering and material science . . .

The Recommendation continued, in part:

. . . the Executive Office of the President . . . should convene a panel to consider appropriate and meaningful training and models. This review should be completed within 18 months and the results made public.²¹

Just in case there is any misunderstanding, it should be noted that the recommendation is introduced in the Executive Summary by a paragraph that suggests that ‘*Creating a culture of responsibility in the synthetic biology community could do more to promote responsible stewardship in synthetic biology than any other single strategy*’ (emphasis added).

Encouraging signs in regard to action on education and awareness-raising also became clear at the meeting of G8 Foreign Ministers in March 2011 in the lead-up to the April meeting of the Preparatory Committee for the Seventh Review Conference. In Paragraph 9 of their concluding *Statement* the Foreign Ministers argued that:

The involvement of civil society, particularly the academic and industrial sectors, is essential to the effective implementation of the Convention. We will therefore step up such engagement to fully take account of scientific and technical developments in the biological area . . .

They continued, significantly:

. . . We will likewise work on better awareness raising among those involved in the development of life sciences in order to limit the possibilities of misuse of technical developments, including supporting dual-use education programs on bioethics.²²

This forward-looking stance was repeated by the United States Ambassador in her opening *Statement* at the Preparatory Committee. In the view of the United

21 Presidential Commission for the Study of Bioethical Issues, *New Directions: The Ethics of Synthetic Biology and Emerging Technologies* (Washington DC: Presidential Commission, 2010).

22 Meeting of G8 Foreign Ministers, *Statement on the Seventh Review Conference for the Biological and Toxin Weapons Convention*, 14–15 March 2011.

States,²³ one of the priority topics for the inter-sessional work between the Seventh and Eighth Review Conference (of 2016) should be:

Strengthening and promoting outreach, education, and awareness to and of those engaged in the life sciences to reinforce strong norms of responsible, ethical and safety- and security-conscious behaviour.

Finally, at the Preparatory Committee meeting an important Information Paper was produced by Australia, Japan and Switzerland on behalf of the JACKSNNZ group of States, and Sweden.²⁴ This Paper recounted the efforts that the countries had made to improve education and awareness-raising, supported the view that consideration should be given to awareness-raising and education at the Review Conference and made a number of suggestions as to what might be done by State Parties. Crucially, the Paper pointed out that State Parties could report on what they had done under the Annual Confidence Building Measure ‘E’ on the *Declaration of legislation, regulations and other measures* as measures that they had taken to strengthen the implementation of the Convention and then noted that:

... With the publication of this material, inter alia in CBM returns, those State Parties which are at a more advanced stage in the implementation of their dual-use awareness-raising and education activities would be able to identify, and offer appropriate cooperation to State Parties at a less advanced stage in such activities.

In short, a positive feedback system could rapidly accelerate the generation and implementation of best practice and thus lead quickly to a strengthening of the Convention and the prohibition it embodies.

23 Ambassador Laura Kennedy, *Statement of the US Special Representative for the Biological and Toxin Weapons Convention Issues at the Preparatory Committee for the BWC Review Conference*, 14 April (Geneva: United Nations, 2011).

24 Australia, Japan and Switzerland on behalf of ‘JACKSNNZ’, and Sweden, *Possible Approaches to Education and Awareness-Raising among Life Scientists BWC/CONF. VIII/PC/INF.4*, 15 April, (Geneva: United Nations, 2011).