

The Chemical Weapons Convention and convergent trends in science and technology

Summary

On 18 February 2013, the Royal Society held a seminar at the headquarters of the Organisation for the Prohibition of Chemical Weapons (OPCW) to inform preparations for the third Review Conference of the Chemical Weapons Convention (CWC) taking place in April 2013. The seminar discussed the implications for the CWC of convergent trends in science and technology (S&T) as identified in Royal Society's 2012 report, *Brain Waves 3: Neuroscience, conflict and security*. Three case studies were profiled: incapacitating chemical agents, synthetic biology, and nanotechnology (see Appendix 1). The seminar brought together leading scientists, policy experts, diplomats and senior officials, including the OPCW Director-General (see Appendix 2). This report summarises the presentations and discussions at the seminar. It does not necessarily represent the views of the Royal Society.

Key findings

- States Parties (those countries that have ratified or otherwise acceded to the CWC) should address the provisions of the CWC on the definition and status of incapacitating chemical agents (ICAs) at the forthcoming Review Conference. The UK Government should clarify its position on ICAs by publishing a statement on the reasons for its apparent recent shift in position on the interpretation of the CWC's law enforcement provision.
- States Parties should reaffirm the comprehensive scope of the CWC at the forthcoming Review Conference. The OPCW's verification system should be revisited; in particular, the quantitative thresholds that trigger the Other Chemical Production Facilities regime.
- There needs to be better co-ordination and information sharing between the implementing bodies of the CWC and Biological Weapons Convention (BWC) on convergent trends in science and technology (S&T). Convergence should feature in the S&T review processes of the five yearly review conferences of the CWC and BWC. The OPCW Technical Secretariat could increase its, and the OPCW Scientific Advisory Board's, interaction with experts associated with the BWC.
- A fresh effort is needed to inculcate the awareness of dual-use challenges amongst scientists at an early stage of their training. States Parties should be encouraged to include information on the CWC in educational materials and programmes for scientists. The OPCW should design and implement an effective, systematic and well-funded education programme to raise awareness.
- More effective engagement between the CWC and the wider scientific community is needed to alert and inform intergovernmental decision making about the major benefits and risks posed by convergent trends in S&T. More effective engagement with the wider scientific community would also build capacity among national delegations.

1 Incapacitating chemical agents

1.1 *The biochemical threat spectrum*

Some characteristics of biological weapons, such as incubation period and contagiousness, clearly distinguish them from chemical weapons. However, the increasing convergence of chemistry and biology makes such sharp distinctions problematic when considering agents such as toxins (toxic chemicals derived from living organisms) and peptide-based bioregulators (chemicals that control many physiological functions in the human body). Chemical and biological weapons are therefore often understood as lying on a biochemical threat spectrum, ranging from classical chemical agents, such as nerve, blood and blister agents, to biological agents, such as bacteria and viruses (Royal Society 2012).

Incapacitating chemical agents (ICAs) are sometimes referred to as incapacitating biochemical agents to reflect these convergent trends. Conceivable ICAs would typically fall within a category of mid-spectrum agents. ICAs are intended to cause prolonged but transient disability through centrally acting effects, such as loss of consciousness, sedation, hallucination, incoherence, paralysis and disorientation. However, the safety margin (the difference between desirable and undesirable effects) may often be very small for a candidate agent, so the effects of ICAs are in fact variable and can include death (Royal Society 2012).

1.2 The definition and status of ICAs under the CWC

The CWC prohibits the development, production, stockpiling and use of chemical weapons, including those that cause temporary incapacitation. However, the CWC includes an exemption that permits the production and use of toxic chemicals for 'law enforcement including domestic riot control purposes' (Article II.9(d)), as long as the 'types and quantities' are consistent with such permitted purposes. The interpretation of the law enforcement exemption with regards to the definition and status of ICAs has yet to be clarified by States Parties (those countries that have ratified or otherwise acceded to the CWC). The first and second CWC Review Conference in 2003 and 2008 failed to do so. In the run-up to the third Review Conference, the International Committee for the Red Cross and the Swiss delegation to the OPCW have both highlighted the need to address the use of ICAs for law enforcement. The OPCW's Scientific Advisory Board (SAB) has concluded that 'the technical discussion on the potential use of toxic chemicals for law enforcement purposes has been exhaustive' (OPCW 2012). At the forthcoming third Review Conference, States Parties should address the provisions of the CWC on the definition and status of ICAs (Royal Society 2012).

1.3 Clarifying the UK's position on ICAs

The UK Government's position on ICAs remains unclear. A statement given to Parliament by the Foreign and Commonwealth Office in 1992 indicated that the UK considered riot control agents to be the only toxic chemicals permissible for law enforcement purpose under the CWC. A more recent statement in 2009 indicates a less restrictive interpretation, suggesting that the use of ICAs for law enforcement purposes would be in compliance with the CWC as long as they were in types and quantities consistent with that permitted purpose. The UK Government should clarify its position on ICAs by publishing a statement on the reasons for its apparent recent shift in position on the interpretation of the CWC's law enforcement provision (Royal Society 2012).

2 Implications of convergent trends for the Chemical Weapons Convention

The convergence of chemistry and biology has caught the attention of governments as a core issue in the benefits provided, and risks posed, by developments in neuroscience (FCO 2012). The SAB has set up a Temporary Working Group on the Convergence of Chemistry and Biology. The Working Group first met in November 2011 and its work will be reviewed in 2013 by the SAB and the Director-General.

2.1 *The development of new chemical weapons*

Convergence could possibly lead to the development of new chemical weapons. Nanotechnology can provide major pharmaceutical benefits through improved aerosol-based drug delivery using hollow nanoparticles. Nanoparticles could also be used to deliver chemical weapons by concealing weaponised molecular structures with a benign and target-friendly exterior.

Synthetic biology involves designing and making biologically compatible parts and systems that do not exist naturally, or redesigning existing biological systems. Drawing on engineering, chemical and biological principles, synthetic biology facilitates the designing of cells to produce chemicals that are identical to chemicals synthesised from other means, as well as novel chemicals and materials with a vast range of useful applications. Synthetic biology offers major benefits, including easing the production and magnifying the immune responses of vaccines and antibiotics (Mukunda *et al* 2009). In the short term, synthetic biology is unlikely to have significant implications for developing new chemical weapons, although barriers to producing certain toxic chemicals could be lowered. In the longer term, synthetic biology could enable the biological production of known and novel harmful chemicals that are the concern of the CWC, perhaps even including chemicals that could target specific ethnic groups by interacting with particular foods or genetic markers (Mukunda *et al* 2009).

2.2 *The development of new countermeasures*

Convergence would benefit the development of new defensive countermeasures against chemical weapons. Nanotechnology can support improved detection, diagnostic and decontamination systems, as well as protective clothing and respiratory protection. Nanotechnology can also support miniaturised, easily deployable sensors that could allow real-time awareness of how a chemical attack was dispersing and unfolding.

2.3 *Guarding against technological surprise*

2.3.1 Reaffirming the CWC's comprehensive scope

Reaffirming the CWC's comprehensive scope at the forthcoming Review Conference would provide a safeguard to the possible development of new chemical weapons. The CWC applies not only to those chemicals specified in its schedules but many other toxic chemicals, including those that are not yet known. Such comprehensiveness, however, raises problems about implementation. As Article VI of the CWC states, it is the responsibility of individual States Parties to ensure the implementation and broad compliance with production bans and restrictions. National capacity may need to be strengthened to fulfil this responsibility.

2.3.2 Revisiting the OPCW's verification system

The CWC establishes an international system to verify declarations through a variety of verification measures and inspections to resolve concerns about compliance with the CWC. The Technical Secretariat of the Organisation for the Prohibition of Chemical Weapons (OPCW) implements these verification measures and other functions. Convergence may stimulate demand that certain biochemical agents, such as toxins or peptide bioregulators, are brought within the OPCW's verification system. The SAB has been asked to establish a new Temporary Working Group on Verification. The Director-General has recommended to the third Review Conference that the Secretariat could start to prepare verification activities for ICAs (OPCW 2013).

One mechanism involves the Other Chemical Production Facilities (OCPF) regime. However, the OCPF has been interpreted by some States to exclude biotechnological processes since the provision of the CWC that establishes the OCPF regime seems to limit it to chemicals 'produced by synthesis'. A clearer understanding of 'produced by synthesis' is still needed, and the SAB Working Group on Convergence has been tasked to consider this further. Even if clarity were achieved, multi-kilogram quantities of convergent products would fall below the quantitative thresholds triggering the OCPF regime. The existing declaration and inspection thresholds are set at multi-tonne levels reflecting 1940s technology. The Review Conference should consider revisiting the OCPF thresholds.

3 The CWC's relationship with the Biological Weapons Convention

Convergence suggests the CWC and BWC need to provide overlapping governance of mid-spectrum agents to avoid gaps developing in the legal coverage or measures to implement the treaties. Co-ordination between the implementing bodies of the CWC and BWC should therefore be improved (Royal Society 2012). The OPCW has more resources to draw upon and could offer support to the BWC's Implementation Support Unit (consisting of only three people).

Improved co-ordination should be complemented by closer cooperation between BWC and CWC experts and meetings. Convergence should feature in the science and technology (S&T) review processes of the five yearly review conferences of the CWC and BWC. The OPCW Technical Secretariat could increase its, and the SAB's, interaction with experts associated with the BWC (OPCW 2013).

The BWC does not establish an international verification system. The BWC lacks any institutional structure comparable to the OPCW (compliance concerns are resolved through other mechanisms of the United Nations and Security Council). If convergent products were ever added to the CWC's schedules, this could provide some form of verification applying to areas also covered by the BWC (FCO 2012).

4 Effective engagement with the scientific community

4.1 Raising awareness of dual-use

There is a pervasive lack of awareness among scientists about their obligations under the CWC. This is partly due to a lack of space in existing curricula; time and resources to develop new curricula; and expertise and available literature on security education. A fresh effort is needed by appropriate professional bodies to inculcate the awareness of dual-use challenges amongst scientists at an early stage of their training (Royal Society 2012). The SAB has formed a Temporary Working Group on Education and Outreach in Science and Technology Relevant to the Chemical Weapons Convention. The Working Group first met in 2012 and its work will be reviewed in 2015 by the SAB and Director-General.

States Parties should be encouraged to include information on the CWC in educational materials and programmes for scientists. Educational resources could be developed, drawing on the experience of the BWC (Royal Society 2008). The Disarmament Research Centre at Bradford University along with the National Defence Medical College in Japan and the Landau Network Centro Volta in Italy have developed free open source shareware education modules to raise the awareness of students and life scientists about biosecurity threats; responsibilities of life sciences; national implementation of the BWC. The content of these resources can be tailored by users for specific academic and industrial contexts. This resource is

available in many languages, including English, French, Georgian, Japanese, Polish, Russian, Spanish and Urdu.¹

Such initiatives should be complemented by a systematic and well-funded education programme designed and implemented by the OPCW. This could be modelled on the International Atomic Energy Agency's International Nuclear Security Education Network that develops peer-reviewed educational materials and facilitates student exchange (Novossiolova and Pearson 2012).

4.2 *Staying apace of developments in science and technology*

Convergence raises questions about how the CWC can keep up with the rapid pace of scientific advances and the unpredictable direction and timing of technological discoveries. Formal reviews may be necessary (as part of the preparation and conduct of Review Conferences) but no longer sufficient. More effective engagement between the CWC and the wider scientific community is needed to alert and inform intergovernmental decision making about the major benefits and risks posed by these advances and discoveries. This engagement could take the form of various complementary activities. Diplomats and scientific experts could meet more regularly. States Parties could work with relevant professional and scientific bodies in their own countries (FCO 2012). National academies of science have a role to play, perhaps through the Biosecurity Working Group of the Inter Academy Panel.²

More effective engagement with the scientific community would also build capacity among national delegations. The OPCW is based in The Hague in the Netherlands. The Hague is primarily a bilateral posting for diplomats. In many cases, duties relating to the OPCW may be additional to broader engagement with the Netherlands. Diplomats' direct experience of the CWC and relevant S&T areas may be limited.

References

FCO (2012) *The convergence of chemistry and biology: implications of developments in neurosciences* Foreign and Commonwealth Office: London
<http://daccess-dds-ny.un.org/doc/UNDOC/GEN/G12/615/23/PDF/G1261523.pdf?OpenElement>

Mukunda et al. (2009) 'What rough beast? Synthetic biology and the future of biosecurity'. *Politics and the Life Sciences* 28.2 (2009):2-26
<http://www.ncbi.nlm.nih.gov/pubmed/20205520>

Novossiolova and Pearson (2012) *Biosecurity education for the life sciences: nuclear security education experience as a model* Bradford Briefing Paper No 5 (Third Series). University of Bradford: Bradford
http://www.brad.ac.uk/acad/sbtwc/briefing/3_BP_5.pdf

OPCW (2013) *Response by the Director-General to the report of the Scientific Advisory Board on developments in science and technology for the third special session of the conference of the States Parties to review the operation of the Chemical Weapons Convention* Organisation for the Prohibition of Chemical Weapons: The Hague
http://www.opcw.org/index.php?eID=dam_frontend_push&docID=16090

¹ <http://www.brad.ac.uk/bioethics/educationalmoduleresource/>

² <http://www.interacademies.net/Activities/Projects/17806.aspx>

OPCW (2012) *Report of the Nineteenth Session of the Scientific Advisory Board* Organisation for the Prohibition of Chemical Weapons: The Hague

http://www.opcw.org/index.php?eID=dam_frontend_push&docID=15843

Royal Society (2012) *Brain Waves 3: Neuroscience, conflict and security* Royal Society: London

<http://royalsociety.org/policy/projects/brain-waves/conflict-security/>

Royal Society (2008) *Royal Society activities on reducing the risk of the misuse of scientific research* Royal Society: London

<http://royalsociety.org/policy/publications/2008/misuse-scientific-research/>

Acknowledgements

The Royal Society would like to thank the following individuals for their comments on this report:

- Professor Malcolm Dando, Professor of International Security, Department of Peace Studies, University of Bradford; Member, Royal Society Working Group on neuroscience, conflict and security
- Professor Rod Flower FRS, professor of Biochemical Pharmacology, William Harvey Research Institute, Queen Mary, University of London; Chair, Royal Society Working Group on neuroscience, conflict and security
- Professor Alastair Hay, Professor of Environmental Toxicology, Leeds Institute of Genetics, Health and Therapeutics, University of Leeds; Member, Royal Society Working Group on neuroscience, conflict and security
- Professor Irene Tracey, Nuffield Professor of Anaesthetic Science & Director, Oxford Centre for Functional MRI of the Brain, University of Oxford; Member, Royal Society Working Group on neuroscience, conflict and security
- Professor Peter Leadley FRS, Herchel Smith Professor of Biochemistry, Department of Biochemistry, University of Cambridge
- Dr Piers Millett, Deputy Head, Biological Weapons Convention Implementation Support Unit
- Mr Stefan Mogl, Chairperson, Scientific Advisory Board, Organisation for the Prohibition of Chemical Weapons
- Professor Julian Perry Robinson, Emeritus Professor, Science and Technology Policy Research, Harvard Sussex Program, University of Sussex; Member, Royal Society Working Group on neuroscience, conflict and security
- Dame Jean Thomas FRS, Biological Secretary and Vice President, The Royal Society
- Sir Mark Welland FRS FREng, Professor of Nanotechnology, Nanoscience Centre, University of Cambridge

The Royal Society would also like to thank the following members of staff for organising the seminar and drafting this report:

- Ben Koppelman, Senior Policy Adviser, The Royal Society
- Elinor Buxton, Policy Adviser, The Royal Society

Contact

Ben Koppelman

Tel: +44 (020) 7451 2532

Email: ben.koppelman@royalsociety.org

Appendix 1 Agenda

09:00	Refreshments
09:30-09:45	Introduction
	<p><i>Brain Waves 3: Neuroscience, conflict and security</i> Professor Irene Tracey, Nuffield Professor of Anaesthetic Science & Director, Oxford Centre for Functional MRI of the Brain, University of Oxford; Member, Royal Society Working Group on neuroscience, conflict and security</p>
09:45-11:00	Examples of convergent science and technology
	<p><i>Incapacitating chemical agents</i> Professor Alastair Hay, Professor of Environmental Toxicology, Leeds Institute of Genetics, Health and Therapeutics, University of Leeds; Member, Royal Society Working Group on neuroscience, conflict and security</p> <p><i>Synthetic biology</i> Professor Peter Leadlay FRS, Herchel Smith Professor of Biochemistry, Department of Biochemistry, University of Cambridge</p> <p><i>Nanotechnology</i> Sir Mark Welland FRS FEng, Professor of Nanotechnology, Nanoscience Centre, University of Cambridge</p>
11:00 - 11:15	<i>Coffee</i>
11:15 – 12:15	Institutional perspectives on convergent science and technology
	<p><i>Personal perspectives from the BWC on convergent science and technology</i> Dr Piers Millett, Deputy Head, Biological Weapons Convention (BWC) Implementation Support Unit</p> <p><i>Perspectives from the CWC on convergent science and technology</i> Stefan Mogl, Chairperson, Scientific Advisory Board, Organisation for the Prohibition of Chemical Weapons</p>
12:15-13:00	Next steps for the CWC Review Conference on convergent science and technology
	<p><i>Education and raising awareness amongst chemists on dual-use</i> Professor Malcolm Dando, Professor of International Security, Department of Peace Studies, University of Bradford; Member, Royal Society Working Group on neuroscience, conflict and security</p> <p><i>Implications of convergent science and technology for the CWC</i> Professor Julian Perry Robinson, Emeritus Professor, Science and Technology Policy Research, Harvard Sussex Program, University of Sussex; Member, Royal Society Working Group on neuroscience, conflict and security</p>
13:00-14:00	<i>Lunch</i>

Appendix 2 Attendees

1.	H.E. Dr Sa'ad Al-Ali, Permanent Representative (Iraq)
2.	H.E. Paul Arkwright, Permanent Representative (UK)
3.	H.E. Nassima Baghli, Permanent Representative (Algeria)
4.	Szymon Bochenski, Counsellor (Poland)
5.	Emanuel Boscardin, Delegate (Switzerland)
6.	Philippe Brandt, Minister-Counsellor (Switzerland)
7.	Sarah Broughton, Deputy Permanent Representative (UK)
8.	Doug Brown, Director, Treaty Compliance, Department of Commerce (USA)
9.	Elinor Buxton, Policy Adviser, Royal Society
10.	H.E. Zelmys Cortina, Permanent Representative (Cuba)
11.	Anne Craig, Deputy Permanent Representative (Australia)
12.	Professor Malcolm Dando, Professor of International Security, University of Bradford
13.	Jonathan Dent, Second Secretary (Ireland)
14.	Mahmoud Esfahaninejad, Deputy Permanent Representative (Iran)
15.	Daniel Feakes, Senior Policy Officer, Organisation for the Prohibition of Chemical Weapons
16.	Georges Flanagan Whalen, Deputy Permanent Representative (Canada)
17.	H.E. Peter Goosen, Permanent Representative (South Africa)
18.	Professor Alastair Hay, Professor of Environmental Toxicology, University of Leeds
19.	Yukinari Hirose, Deputy Director-General, Foreign Policy Bureau and Disarmament, Non-Proliferation and Science Department, MOFA (Japan)
20.	Stian Holen, Head of Policy, Organisation for the Prohibition of Chemical Weapons
21.	Yutaka Kikuta, Minister (Japan)
22.	Ben Koppelman, Senior Policy Adviser, Royal Society
23.	Vladimir Ladanov, First Secretary (Russia)
24.	Professor Peter Leadley FRS, Herchel Smith Professor of Biochemistry, University of Cambridge
25.	Jim McGilly, Defence Science and Technology Laboratory
26.	H.E. Robert Mikulak, Permanent Representative (USA)
27.	Piers Millett, Deputy Head, Biological Weapons Convention Implementation Support Unit
28.	Stefan Mogl, Chairperson, OPCW Scientific Advisory Board
29.	Tsuyoshi Okuyama, Director, Chemical Weapons Control Policy Office, Japan
30.	Bill Parker, US Department of State
31.	Professor Julian Perry Robinson, Science and Technology Policy Research, University of Sussex
32.	Gonke Roscher, Deputy Permanent Representative (Germany)
33.	Aamir Shouket, Deputy Permanent Representative (Pakistan)
34.	H.E. Dr Fauziah binti Mohd Taib, Permanent Representative (Malaysia)
35.	Professor Irene Tracey, Director, Oxford Centre for Functional MRI of the Brain, Oxford University
36.	H.E. Ahmet Uzumcu, Director-General, Organisation for the Prohibition of Chemical Weapons
37.	Dr Koos van der Bruggen, Koninklijke Nederlandse Akademie van Wetenschappen
38.	H.E. Jan-Lucas van Hoorn, Permanent Representative (The Netherlands)
39.	Sir Mark Welland FRS FEng, Nanoscience Centre, University of Cambridge
40.	H.E. Mary Whelan, Permanent Representative (Ireland)