Informal Note by the Technical Secretariat

The multiple uses of chemicals: innovation, science and security

An Informal thematic discussion on science and technology during the 3rd Special Session of the Conference to Review the Operation of the Chemical Weapons Convention

Overview

1. As part of the Third Special Session of the Conference to Review the Operation of the Chemical Weapons Convention an informal thematic discussion on science and technology, "The multiple uses of chemicals: innovation, science and security", was held on 12 April 2013 from 15:00-18:00 at OPCW headquarters. The event was moderated by Dr. Patricia Lewis (Director of International Security, Chatham House).

2. A video recording of the event is available at http://www.opcw.org/rc3/webcasts/

3. The programme is attached in Annex 1. Panel members are listed in Annex 2.

Opening Remarks and Introduction

4. The OPCW Director-General opened the discussion. He noted the importance and influence of developments in science and technology on implementation of the Chemical Weapons Convention and that both benefit and threats could arise. The remarks described the important relationship between science and the Convention by highlighting the Articles that are affected by technological advancements. The importance of ensuring that the Convention remains relevant with time and that policy making must be forward thinking in regards to a changing technological landscape were key points in his statement.

5. Dr Patricia Lewis framed the purpose of the discussion by noting that chemistry has many benefits and highlighted its contribution to the wide range of technologies and consumer products that exist today. At the same time, she noted that chemistry has been used for harm and this is why Convention must keep pace with scientific and technological developments, and preferably stays ahead of the curve. Dr Lewis emphasised the rapid pace of change in science – in particularly with regard to the convergence of chemistry, biology, and informatics. Furthermore, she spoke of engaging with the scientific communities and civil society, especially the younger generation who will be the scientists and policy makers of the future. She suggested using the tools of scientists, taking a problem-solving approach and asking questions, as a way to effectively bring stakeholders into the discussion. She concluded her introduction by asking the following questions:

    a) What do the advances in science (in particular regarding the convergence of chemistry, biology, and informatics) mean for the international system?

    b) Can we ever keep up with developments in science and technology?

The Multiple Uses of Chemicals

6. Professor Pawan Dhar presented an overview of the emergence of synthetic biology research in India and how it is now making its way into chemical production. Key points included:

   a) Biofuel and biobased chemical synthesis are currently the predominant research activities in synthetic biology in India.

   b) The Indian Government's Department of Biotechnology (DBT) has promoted these activities by creating special centres for the advancement of bioenergy research in the country.

   c) In general, the innovation capital of the biotech industry seems to have declined in recent years, leading to increased polarization of the invested capital.

   d) Though the current Indian patent act effectively addresses most of the issues concerning live organisms, there is room for improvement for example including newer methods and convergent technologies.

   e) Professor Dhar's recent Delphi study (to be published) of the synthetic biology research in India highlighted that the "regulation issue" is a major concern of the stakeholders.

7. Dr Robert Mathews presented developments that are possible from the scientific developments coming out of the convergence of the sciences and nanotechnology and that show promise for improved protection and countermeasures against chemical weapons and toxic chemicals. His presentation included a brief introduction to the development of protective gear and compared the current situation to the First World War where development was necessitated by the large scale use of chemicals in war. Dr Mathews noted that while research is very promising with potential for advanced materials offering advanced protection and reduced physiological burden, taking a scientific development from the laboratory to a robust piece of equipment is a difficult and lengthy process that requires development of prototypes, testing and optimizing usage protocols, and field testing under appropriate conditions. It can take many years before such developments are available and deployable.

8. Highlights from the discussion following these two presentations included:

   a) By the year 2020 it is estimated that biomediated chemical production processes will account for 10-20% of worldwide chemical production. These processes will be developed using genetically modified microorganisms, wherein lies security concerns about the ease with which such genetically modified microorganisms could be used to produce toxic chemicals.

   b) Research in synthetic biology that has taught how to manipulate genomes and convert microorganisms into chemical producers is not a simple process and requires time and resources in order to develop viable large-scale chemical production. This has a practical effect on reducing the attractiveness of using synthetic biology to produce weapons (an unlikely scenario), but the potential

threat is a concern to many outside the synthetic biology community – especially as developments in the field reduce the barrier to entry.

c) The synthetic biology community is currently discussing and implementing (on an ad-hoc basis) self-governing policies to prevent misuse. These include screening synthetic DNA orders for gene sequences in known toxic and/or toxin producing organisms. However it was noted that there are no binding State-level measures covering this topic (it was noted that only one UN member state was known to be addressing the issue).

d) It was considered important to encourage and protect "good" science, so that society can reap the benefits of synthetic biology and scientific convergence in general. In parallel, the discussion and implementation of measures on preventing misuse must be continued. It was noted that scientists discuss this amongst themselves, but bringing the discussions outside the scientific community can be difficult.

Education for Prevention

9. Professor Alejandra Graciela Suarez described educational approaches being used in Argentina. She emphasized the key role that the CWC National Authority has for education and outreach activities in each country and described how the National Authority in Argentina is approaching the academic and scientific community and the activities being developed for the implementation of the CWC and preventing the re-emergence of chemical weapons. She described a workshop on "Education in chemistry for peace: ethics and responsibility for present and future generations of chemists", will be held in Rosario, Argentina on 27-28 June 2013. The workshop will focus on the importance of addressing the ethical and practical aspects preventing the misuse of chemistry and how CWC issues can be reflected in education programmes for careers related to chemistry. The National Authority in Argentina is developing an initiative to foster a culture of dual-use science. Professor Suarez concluded by asking: what is the best strategy to use in such endeavours?

10. Dr. Temechegn Engida spoke on the importance of education and outreach and the issues that need to be addressed for effectiveness of such efforts. He raised three questions:

a) Do chemists and chemistry educators agree that education and outreach in relation to the CWC is a necessary part of their professional obligations?

b) If the answer to the previous question is yes, chemists and chemistry educators would need to devise strategies that accomplish these obligations. Could professional societies like national chemical societies, continental federations, and international unions be in a position to take the on the burden of education and outreach activities?

c) What are the most effective ways of reaching such large segments of the African population while using the education and outreach materials in relation to the CWC for purposes not prohibited under the Convention?

11. Dr Engida noted three themes that are relevant to education and outreach activities related to the CWC: ethics in chemistry education; multiple uses of chemicals; and laboratory safety and security. Dr. Engida informed the audience of the "First African Conference on Research in Chemistry Education" (ACRICE-1), to be held on 5-7 December 2013 in Addis Ababa, Ethiopia. The overall purpose of the Conference would be to explore "chemical education for human development in Africa", and all three of the themes mentioned above were included in the programme.

12. Highlights from the discussion following these two presentations included:

    a) Questions were raised on how the openness of science and scientific discussion be balanced with security concerns and codes of conduct for scientists. It was noted that the answers to these questions are not simple and agreement on openness and information sharing as well as what is appropriate conduct was difficult to achieve.

    b) Scientists are very sensitive to interference of regulations on scientific progress.

    c) Introducing ethical issues and teaching responsible science has often taken an ad-hoc approach. It would, however, be better to introduce these topics systematically over the course of the entire educational period, starting with younger students and continuing to address the topics in subsequent grade levels, thus better embedding the principles and concepts into behaviour.

    d) Ethics courses and education for scientists were discussed. It was noted that ethics is very broad and goes beyond misuse of science and good conduct. There is a risk that a check-box requirement to graduate from a programme and might thus not be effective in influencing future scientific practices.

    e) The issues raised by the speakers affect every country (science is global), yet each country has its own context regarding how chemistry is used and how science is practiced. Therefore, the most effective strategies would be placed in the national context and each State Party might need to consider different approaches.

    f) It was noted that no country has been able to develop without a strong science and technology programmes. States Parties might thus wish to consider the benefits from engaging, within their countries, not only scientists but also politicians, civil society, and others.

    g) One of the key challenges will be how to sustain interest. Suggestions included:

        i. Games, apps, and other interactive electronic tools were suggested as useful in educational activities. This ties back to the engagement of scientists through asking questions.

        ii. For students, simulation exercises to keep them actively thinking through the issues were suggested. Such exercises that spanned the

duration of an academic term had been observed to keep students highly engaged.

iii. Competitions, debates, and other activities that encourage active participation were discussed. Winners could, for example, be invited to present their findings or ideas in a forum of international experts (this had been done by the Implementation Support Unit of the Biological Weapons Convention in the past).

iv. It was suggested to gear activities toward "young minds".

OPCW Analytical Capabilities

13. Dr. Hugh Gregg gave a presentation on chemical analysis in the verification of the Chemical Weapons Convention. He briefly described how chemical sampling and on-site analysis is performed during OPCW inspections, and how information not related to the mandate of the inspection is not revealed. He noted that if on-site analysis was not possible or was inconclusive, samples could be shipped to several of the 22 laboratories in the network of OPCW Designated Laboratories. He concluded his presentation with a brief description of a series of confidence building exercises on biomedical sample analysis. The goal of these exercises was to broaden the capability of the Designated Laboratories.

14. Highlights from the discussion following this presentation included:

a) The audience posed a number of questions related to the types of samples and the integrity of samples collected under specific circumstances that would be amenable to analysis using the current methodologies. Dr. Gregg pointed out that a simple yes/no answer is not always possible due to unique aspects of samples (e.g. concentration levels being looked for, age/degradation of samples, sample matrix or form, sample preparation, etc).

b) Chemical forensics was briefly discussed and it was noted that this requires a database of characteristics and/or reference materials to which a sample can be compared.

Concluding Remarks

15. Mr. Stefan Mogl summarized that Education and Outreach, following Advances in Science and Technology and Preparedness are three important points to prevent the re-emergence of chemical weapons:

a) Education and outreach are important activities for the future of the Chemical Weapons Convention. The experiences shared by Professor Suarez and Dr Engida about the experiences from Argentina and African countries are valuable and can teach us how to initiate successful programs in other countries. The workshop in Argentina and the conference in Ethiopia that are taking place later this year are great examples for advancing education and outreach.

b) Developments in science and technology may lead to benefits as well as risks. Some benefits may facilitate a better implementation of the Convention, others may improve countermeasures against chemical weapons. Advances in production technology may create potential new risks in the chemical industry or may lead to new methods for the formation of toxic chemicals. It is important to follow advances in science and technology and assess their relevance for the implementation of the Convention regularly.

c) In order to be prepared to detect re-emergence of chemical weapons, the Organisation must be in a position to detect any attempts to develop chemical weapons, and this requires, for example, adequate sampling and analysis methods and knowledge of new toxic chemicals.

16. Highlights from the overall discussion included:

a) There is a high level of enthusiasm amongst scientific professionals and educators for pursuing activities in education and outreach. These efforts should be supported and strengthened.

b) Discussion of science can be highly engaging and can be a way to get people excited about interesting developments and thinking about how the world works. It was suggested that arranging for students to meet policy makers at future discussions on science and technology in relation to the CWC could help bridge the gap between science and policy and allow students to interact with both scientists and policy-makers.

c) Greater appreciation is needed about the way new scientific developments change chemical production and how these developments arise from communities that are not always aware of the security dimensions.

d) This meeting reinforced the need for horizon scanning and assessment of scientific and technological developments.

Annex 1

Programme

1. Opening Remarks by the OPCW Director-General, Mr. Ahmet Üzümcü.

2. Introduction: The science-and-Security Context

   a) "Science and Security: Why Should We Care?" by Patricia Lewis, Director of International Security, Chatham House

3. The Multiple Uses of Chemicals

   a) "Emerging Synthetic Biology Trends in India" presented by Professor Pawan Dhar (Director, Centre for Systems and Synthetic Biology, University of Kerala, India).

   b) "Protection and Countermeasures" presented by Dr. Robert Mathews, (Defence Science and Technology Organization, Australia).

   c) National delegations and experts discussion with the panel.

4. Education for Prevention

   a) "Project in Education and Outreach Relevant to the CWC in Argentina" presented by Professor Alejandra Graciela Suarez, (National University of Rosario and National Research Council of Argentina)

   b) "Education and Outreach About the CWC in Africa" presented by Dr. Temechegn Engida (President of the Federation of African Societies of Chemistry, and Editor-in-Chief of The African Journal of Chemical Education).

   c) National delegations and experts discussion with the panel.

5. OPCW Analytical Capabilities

   a) "Chemical Analysis in the Verification of the Chemical Weapons Convention" presented by Dr. Hugh Gregg (Head of the OPCW Laboratory).

   b) National delegations and experts discussion with the panel.

6. Overview and Conclusions

   a) Remarks by Stefan Mogl (Spiez Laboratory).

   b) National delegations and experts discussion with the panel.

   c) Closing remarks by Patricia Lewis.

Annex 2

Biographical Information on Speakers

Dr. Patricia Lewis is the Research Director for International Security at Chatham House. Dr. Lewis has served on the Advisory Panel on Future OPCW Priorities, she is a nuclear physicist, and has headed some of the world's most prestigious think-tanks and institutions dealing with arms-control, disarmament and international verification. From 1997-2008, Dr. Lewis was Director of the UN Institute for Disarmament Research (UNIDIR) in Geneva. Earlier in her career, she was Executive Director at the Verification Research, Training and Information Centre (VERTIC) in London. Before taking up her current post at Chatham House, Dr. Lewis spent more than three years as Deputy-Director and Scientist-in-Residence of the James Martin Center for Nonproliferation Studies in Monterey, California.

Professor Pawan Dhar is the Founder Director of the Centre of Systems and Synthetic Biology, University of Kerala. Prior to this he held senior scientific positions at RIKEN, Japan and Bioinformatics Institute, Singapore. His work on making genes from junk DNA has received significant global attention. Dr. Dhar is the Founding Editor-in-Chief of the Springer's System and Synthetic Biology journal.

Dr Robert Mathews is a member of the Temporary Working Group on Education and Outreach and the Temporary Working Group on Convergence of Biology & Chemistry He is also a former member of the OPCW Scientific Advisory Board (SAB). He is currently Head, NBC Arms Control Unit, DSTO, Melbourne, Australia and Manager of the NBC counter-proliferation arms control programme. He is also an Associate Professor at the Asia Pacific Centre for military law. His areas of expertise are: analytical chemistry, chemical and biological defence and arms control, the Chemical Weapons Convention, and industry consultations.

Professor Alejandra Suárez is the Vice-Chair of the SAB and a member of the Temporary Working Group on Education & Outreach. She is a professor at the Facultad de Ciencias Bioquímicas y Farmacéuticas, Universidad Nacional de Rosario, Argentina. Professor Suárez is a Researcher of the Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET). Her areas of expertise are: organic and organo-metallic chemistry, and green chemistry.

Dr Temechegn Engida is a member of the Temporary Working Group on Education and Outreach. He has been a Programme Officer for ICT Use in Education at the UNESCO-International Institute for Capacity Building in Africa (IICBA), based in Addis Ababa/Ethiopia, since October 2003. Prior to this, Dr. Engida spent about 15 years in the Addis Ababa University, Faculty of Education, teaching both undergraduate and post graduate (MA and PhD) courses as well as researching and advising research works through face-to-face and distance modes. Currently, he is the President of the Federation of African Societies of Chemistry, Editor-in-Chief of the African Journal of Chemical Education, and PhD research advisor for science and technology education students at the University of South Africa (UNISA) and the Addis Ababa University, in addition to his duties at IICBA.

Dr Hugh Gregg obtained his Ph.D. in Analytical Chemistry in 1985 at Michigan State University in the United States. He worked at the Lawrence Livermore National Laboratory

in California for 25 years, first as a bench chemist, then in various management roles. In 2000, he co-led the effort to establish LLNL as an OPCW Designated Laboratory. In 2010, after 25 years at LLNL, Hugh left California for the Netherlands, where he is the Head of the OPCW Laboratory.

Mr Stefan Mogl is the Chairperson of the SAB and a member of the Temporary Working Groups on the Convergence of Biology and Chemistry; Verification; and Education and Outreach. Mr Mogl is the Head of Chemistry of Spiez Laboratory, The Swiss NBC Institute in the Federal Office for Civil Protection. His areas of expertise are: analytical chemistry, chemical disarmament, and chemical incident response.