Advances in Science and Technology and the Chemical Weapons Convention

- Arms Control Today

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- How States Might Skirt the Chemical Weapons Ban

With the second review conference of the Chemical Weapons Convention (CWC) approaching in April, a raft of studies have appeared making clear that fundamental changes in science and technology are affecting the implementation of the treaty and that it must be adapted to take account of them.[1]

The most significant development is the revolution in the life sciences and related technologies, including a growing overlap between chemistry and biology. There is a vastly increased understanding of the functioning of biological systems as a result of the mapping of the human and other genomes as well as of advances in structural biology and the study of proteins (proteomics). Information technology and engineering principles are increasingly integrated into biology. The intersection between chemistry and biology has further expanded thanks in part to the automation of synthesis and screening of chemical compounds enabling laboratories to assess vast numbers of new chemical structures and a much-enhanced understanding of how certain “chemicals of biological origin” act. Technological advances supplement these trends, for example, providing for more efficient means of delivering biologically active chemicals to target populations or targeting organs and receptors within an organism.

These developments are expected to bring many benefits, including new medical treatments and methods of pest control. At the same time, the capacity to discover or design new chemical structures that may have utility as chemical warfare agents has also increased significantly. Novel agents can be created far more quickly than ever before. In addition, advances in manufacturing technology have shortened other time requirements, enabling shortcuts in the progression from research and development to full-scale manufacturing. Changes in the chemical industry have dispersed technology and facilities, complicating verification and traditional nonproliferation strategies.

As a result, the time and effort needed to field a new chemical weapon has shrunk, particularly in the early stages, while the capability to detect such actions has not grown significantly. These trends and a recently increased interest in the use of incapacitants for law enforcement purposes raise at least the threat that states could skirt or quickly break out of the CWC prohibitions on developing and acquiring chemical weapons. It has also enlarged the overlap between the two otherwise quite separate treaties governing chemical and biological weapons, the CWC and the Biological Weapons Convention (BWC). States-parties need to adapt the implementation of the CWC to account for these changes or risk diminishing confidence in its effectiveness and endangering its viability.

Advances in Technology and Industry

To be sure, many traditional obstacles remain to the development of chemical weapons in a state-level program. Most importantly, any potential agents must meet tough requirements before they can be fielded. These include the possibility of industrial-scale production, tactical mixtures that can be effectively disseminated and are sufficiently stable for long-term storage, effective dissemination

equipment/devices, and adequate means of ensuring that one's own forces are protected.

These constraints do not apply to the threats of terrorist chemical weapons use. The threat that terrorists may use toxic chemicals, however, correlates more closely with the accessibility of toxic materials than with the evolving scientific capability to develop novel agents in the laboratory. That is not to dismiss the concern, but the problem is less one of enforcing an international norm such as the CWC than of how states, companies, and research institutions can control access to chemical facilities and materials.

Technological change can also bring significant benefits to the fight against chemical weapons. For example, advances in nanotechnology are expected to help in developing more effective protections against agents, such as new detection devices (faster, cheaper, more sensitive, and more selective sensors), and improved filtration materials, means of decontamination, and medical countermeasures.

Still, these scientific and technological gains undoubtedly come with new concerns. Nanotechnology offers the possibility to engineer "smart" materials that respond to specific stimuli. It also promises a more efficient and targeted drug delivery via the respiratory system and other pathways. For example, it could facilitate the entry of toxic chemicals into the body or specific organs, in particular the brain, for selective reaction with specific gene patterns or proteins or for overcoming the immune reaction of the target organism. These developments may have significant applications as new medicines and treatments. They could, however, also be exploited for the development of new chemical warfare agents or the fine-tuning of existing ones. Any offensive chemical weapons program begun today would surely take advantage of these new methods and concepts.

Technological advances continue to change the manufacturing processes in the chemical industry. New processes are being introduced to increase efficiency and yield, including a range of new catalytic processes. The use of multipurpose equipment and the adoption of on-demand principles has become a common feature. Manufacturers adjust to changing market demands and increasingly use technologies and equipment that allow them to switch production output on short notice. Although allowing chemical plants to be converted to the production of new products, this also means that there is a risk of standby capabilities appearing that could easily and quickly be switched to supplying an offensive chemical weapons program.

A more recent development is the use of microreactors, which have begun moving from the laboratory to (limited) industrial production. One of the driving factors is safety: chemicals that are otherwise hazardous to manufacture, handle, or store can be produced safely on-site when needed. In addition, capital costs for such facilities are low, and many chemical reactions show improved reactivity, product yield, and selectivity when performed in microreactors. Microreactors allow companies to scale up a chemical process from laboratory to industrial scale more quickly and easily. Production output can be increased by combining multiple reactors in batteries, a process also known as "numbering-up."

Of course, these advantages could also apply to new chemical warfare agents. The use of microreactors can significantly shorten the time required to synthesize new toxic chemicals for testing and development purposes. Microreactors can apply combinatorial principles to synthesize a series of related compounds for test purposes, or they can be used to make small quantities of toxic chemicals easily and quickly during the development of a new agent for weaponization. Worryingly, if states were to produce chemical weapons in such reactors, there would be fewer clues that might indicate to outsiders that such production was taking place. Traditional industrial-scale chemical weapons production facilities require heavy-duty ventilation systems, scrubbers, and high stacks. Because processing highly toxic or corrosive materials in microreactors produces fewer waste streams and reaction yields are much higher, there is less need for telltale pollution abatement systems.

In addition, structural change in the chemical industry could also pose risks to CWC implementation. Driven by market forces, the industry is moving from its traditional production locations (Japan, the United States, and western Europe) to new places in Asia, eastern Europe, Latin America, and the Middle East. Some of the countries involved in setting up new chemical operations have limited

experience in regulating chemicals or weak implementation systems for the CWC. At the same time, international trade in chemicals is on the increase. These are challenges to the CWC's verification system as well as to traditional nonproliferation measures in the chemical field.

Recommendations to the Review Conference

What, then, are the issues that the upcoming review conference ought to consider when it assesses the impact of advances in science and technology on the operation of the CWC?

A first is whether the CWC's schedules, which attempt to characterize agents and precursors by their risk based on past weaponization and other factors, need to be amended. Currently, the Organization for the Prohibition of Chemical Weapons (OPCW), the international body charged with implementing and verifying the CWC, and states-parties tightly control high-risk chemicals (Schedule 1). This is feasible because these agents and key precursors, as a rule, have very few legitimate uses. States and the OPCW less stringently control Schedule 2 and 3 chemicals, which have legitimate uses ranging from smaller-scale specialty chemicals to mass-produced chemicals and thus have much higher thresholds before such production triggers declarations and inspections. Should the growing overlap between chemistry and biology and the emergence of new biologically active compounds necessitate the inclusion of new chemicals into the schedules or are the schedules unfit to deal with these emerging risks? Including new chemicals with potential chemical weapons utility in Schedule 1 would severely hamper their legitimate uses. Listing them in Schedules 2 and 3 might be meaningless given the relatively high thresholds for declaration and inspection; many would simply fall through the net.

If the schedules were to remain as they are, there is a risk that the CWC verification system may get stuck in the past. One way to avoid this fate would be to step up the frequency and effectiveness of verification at other chemical production facilities (OCPFs) producing unscheduled discrete organic chemicals.[2] This relates to a number of issues: the overall number of OCPF inspections that is desirable, the amount of information available on these facilities to the OPCW Technical Secretariat, an improved site selection mechanism for inspections, the level of expertise at the OPCW to ensure that inspectors can adequately assess facility capabilities during an inspection, and the ability to use inspection methods such as sampling and on-site analysis. There is, however, a degree of reluctance to respond to the trends in chemicals manufacturing with a shift in verification focus. Some developing countries see suggestions to shift emphasis from verifying scheduled chemicals to OCPFs as an attempt to exercise control over the use of chemical technology and to shift the burden of verification to the developing world. They are therefore reluctant to accept that the OCPF verification regime needs to be further enhanced in response to trends in the chemical industry.

In a broader context, to adapt the CWC to the new challenges emanating from advances in the life sciences will require consideration of how best to reinforce the "general purpose criterion."[3] This includes national implementation (legislation, regulations, and enforcement); the recognition that the schedules must not limit the scope of the CWC; and the need to ensure effective (self-)governance of the life sciences as well as industry. One example of this is the Responsible Care program, a global voluntary chemical industry initiative to improve health, safety, and environmental performance; communicate with stakeholders; and apply self-regulatory measures to ensure compliance with regulations, including the CWC.

A second issue relates to how verification can make use of new opportunities created by science and technology, such as new or improved verification equipment and methods. The OPCW has identified gaps in its tool box, for example, with regard to analyzing biomedical samples. This capability gap affects the OPCW's ability to investigate allegations of chemical weapons use and should be closed swiftly. There are also efforts under way to improve further the OPCW's capability to conduct environmental sampling and analysis on-site and to use other inspection methods. The review conference should encourage the OPCW Technical Secretariat to make best use of technological advances so as to maintain a high standard with regard to its verification methods and equipment.

A third issue is whether technological and scientific advances might aid the destruction of chemical weapons, particularly old and abandoned chemical weapons and those dumped in the sea.[4] This is an area where the review conference could encourage further cooperation between states-parties

and the sharing of assessments, experience, and technological know-how.

A fourth issue is how advances in science and technology will help improve protection against chemical weapons. Many of these advances can help upgrade the protection against chemical agents, enhance decontamination capabilities, or lead to new medical countermeasures. This is important as states harden their structures against the menace of chemical terrorism. It will also have a deterrent effect against the use of chemical weapons by states that still remain outside the regime. The review conference should recognize the need to improve the protection against chemical weapons further, encourage cooperation and exchanges between the states-parties in this field, and call on the Technical Secretariat to help states-parties develop and improve their protective capabilities. For example, this could include exercises to simulate national and international response mechanisms to chemical incidents.

A fifth issue relates to the CWC objective to enhance international cooperation in the peaceful uses of chemistry. Recent scientific and technological advances will create many opportunities in this respect, but they must be pursued in recognition of the fact that international cooperation must be fully consistent with the CWC's disarmament and nonproliferation obligations. There is therefore good reason to maintain a strong link between international cooperation programs and OPCW efforts to promote national implementation and ensure effective verification. The review conference should recognize that the OPCW is not a development agency but that its efforts with regard to industry verification as well as helping states-parties adopt national regulations and controls in the chemical field will facilitate trade and investment into the emerging chemical sectors of developing countries.

Finally, the arms control community has over the past four decades kept a clear demarcation between chemical and biological weapons. The CWC and the BWC have taken different directions with regard to a number of implementation issues, most prominently verification. In the real world of research and, increasingly, industry, the borders between the two fields are getting blurred. What the implications will be for the two regimes has yet to be fully understood. At the national level, there are signs of what one might call "regime conversion," with some countries combining their national implementing agencies and mechanisms for the two conventions. There also is an overlap of efforts within the scientific and industrial communities to adopt governance mechanisms and ethical codes to prevent the misuse of chemical and biological sciences for hostile purposes.

The situation at the international level, however, is more complicated, particularly with regard to verification. It is difficult to understand how the CWC can successfully address the verification dimension of the increasing convergence between chemistry and biology without running into some of the same difficulties that prevented the adoption of a BWC verification protocol in 2001-2002.[5] There is thus a risk that the CWC review conference might set itself up for failure if it aimed too high. At the same time, it cannot ignore the advances in the life sciences and their effect on the CWC. The challenge will be to find the right balance in further developing the treaty's verification system while enhancing national implementation, developing self-governance mechanisms, and involving all stakeholders in the implementation process.

How States Might Skirt the Chemical Weapons Ban

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It might be possible for states to carry out programs that could take advantage of new discoveries in science and technology to develop a novel agent while asserting that they are technically complying with Chemical Weapons Convention (CWC) obligations.

The CWC allows for the use of toxic chemicals for "law enforcement purposes including domestic riot control." The traditional interpretation of this clause has been that states-parties are clearly allowed to use riot control agents (RCAs) for domestic riot-control purposes subject to certain conditions in the CWC. Some have claimed that the provision has broader implications, for example, permitting occupying forces, such as those of the United States in Iraq, to use RCAs abroad.[1] Similarly, some states-parties have said that toxic chemicals other than RCAs could be used for law enforcement purposes. In

particular, they have insisted that they consider the use of lethal chemicals for capital punishment consistent with the provisions of the CWC.

Internationally, the changing nature of armed conflict, with an increased focus on counterinsurgency and counterterrorism methods, has stimulated a renewed interest in so-called nonlethal weapons, including incapacitants. Advances in the life sciences could lead to the development of drugs that may match to an extent the pharmaceutical profile required of such weapons, and the very fact that progress in life science research may be seen to offer such opportunities could fuel further developments.

The implications are both legal and practical. On the legal side, the prohibition not to develop, produce, and stockpile (new generations of) chemical weapons could be seriously undermined. After all, there is no such thing as a nonlethal toxic chemical—lethality depends on such factors as the dosage, the vulnerabilities of the target population, and the methods and location of agent dispersal.[2] Moreover, in a military context, there is an additional factor: the agents would be used on a battlefield where other weapons are present (guns, artillery, aircraft, etc.), and incapacitants could increase the lethality of these conventional weapons if used in combined operations.

On the practical side, the remaining comfort that one could derive from the fact that it still may take considerable time to go from discovering a new agent to actually fielding an effective weapon would be gone. Inspectors might find chemical weapons at the stages of development, production, or stockpiling, and a state-party could claim that these arms were entirely legitimate as part of a program for law enforcement purposes.

To ensure transparency and promote confidence, some have proposed to make toxic chemicals intended for law enforcement purposes subject to declaration to the Organization for the Prohibition of Chemical Weapons. This step may be premature, but it will be important that states-parties recognize this issue and start discussing the implications of these developments so as to prevent the emergence of a new generation of chemical weapons. The review conference would be the appropriate forum to initiate such a discussion.

ENDNOTES

1. See, for example, Kyle M. Ballard, “Convention in Peril? Riot Control Agents and the Chemical Weapons Ban,” Arms Control Today, September 2007, pp. 12-16.

2. British Medical Association, “The Use of Drugs as Weapons,” May 2007, located at www.bma.org.uk/ap.nsf/Content/drugsasweapons.

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ENDNOTES

1. The International Union of Pure and Applied Chemistry (IUPAC) conducted an international workshop on the matter in April 2007 in Zagreb, Croatia, and submitted a report to the Organization

for the Prohibition of Chemical Weapons (OPCW). The OPCW's Scientific Advisory Board prepared an interim report to the OPCW Working Group for the Preparation of the Second Review Conference. With the support of the Netherlands and the European Union, the OPCW held an Academic Forum and an Industry and Protection Forum, which looked at the strategic challenges for the CWC. Also, a number of national studies of these issues have been commissioned.

2. The CWC schedules focus on dual-use materials, the toxic chemicals and precursors that could be used for chemical weapons purposes. The OCPF regime attempts to capture chemical plants that may have an "intrinsic" technological capability to produce chemical warfare agents. This category encompasses a large part of the organic chemical industry with a wide array of chemical plants that pose varying degrees of risk to the CWC, ranging from highly-relevant multipurpose plants capable of switching production to a variety of chemicals on short notice to rather less-relevant, dedicated plants producing basic organic intermediates, fertilizers, and other mass products. For more detail, see Jonathan Tucker "Verifying the Chemical Weapons Ban: Missing Elements," Arms Control Today, January/February 2007, pp. 6-13.

3. This is shorthand for a concept built into the definition of chemical weapons as well as the requirements for national implementation of the CWC. Rather than relying on a list of prohibited chemicals, the CWC considers any toxic chemical or precursor a chemical weapon unless it was intended for purposes not prohibited, such as for peaceful uses or for chemical defense, and only as long as their types and quantities can be justified by such legitimate purposes. The schedules must therefore not be confused with a list of prohibited chemicals or a definition of chemical weapons. Their sole purpose is to guide routine verification measures.

4. Given that Russia and the United States, for example, have agreed to destroy their stockpiles by 2012, new technologies are unlikely to make a major contribution to destruction efforts related to stockpiled chemical weapons. The IUPAC report noted that "[t]echnologies for the destruction of stockpile[d] chemical weapons have matured to a point, and timelines for the completion of [chemical weapons] destruction operations are such, that there is little point in reviewing emerging technology options for these destruction operations. Although there remain [chemical weapons] destruction facilities that have yet to be commissioned, the technology choices are well-known and assessed. Issues that may influence outstanding decisions on technology choices are largely in the legal, policy, regulatory, public awareness/education, and economic domains." Mahdi Balali-Mood et al., "Impact of Scientific Developments on the Chemical Weapons Convention (IUPAC Technical Report)," Pure and Applied Chemistry, Vol. 80, No. 1 (2008), p. 189.

5. For a discussion of the reasons that led to the U.S. administration's refusal to complete negotiations of the BWC verification protocol and of the measures subsequently adopted by the BWC review conference instead of such a protocol, see, for example, "The BWC After the Protocol: Previewing the Review Conference," Arms Control Today, December 2001, pp. 13-18; Kerry Boyd, "BWC Review Conference Meets, Avoids Verification Issues," Arms Control Today, December 2002, p. 21.

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