Scientific and technological change and the future of the CWC: the problem of non-lethal weapons

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Article VIII, paragraph 22 of the Chemical Weapons Convention (CWC) requires that when the first Review Conference takes place in April-May 2003, it, amongst other things, takes '... into account any relevant scientific and technological developments'. Given the political difficulties that the convention has recently encountered, and the failure of the negotiations to strengthen the Biological and Toxin Weapons Convention (BTWC), it is possible that relevant scientific and technological developments may receive relatively little attention at the Review Conference. Yet the relevant science and technology are in a period of extremely rapid development that could have a severe impact on the future scope of the prohibition embodied in the convention.[1] For that reason, scientific and technological developments should be subject to very careful analysis at the Review Conference. This paper is intended to illustrate that point by particular reference to recent changes in the capabilities for developing non-lethal incapacitant chemicals that affect the central nervous system, and to what those changes might portend.

Reasons for concern

In the current post-Cold War period, it has become obvious that the military forces of technologically advanced countries are likely to be increasingly involved in complex operations other than war in the developing world and often in difficult urban areas. The equipment and basic training of such military forces are manifestly not necessarily well suited to dealing with such situations, and this has led to a renewed interest in many forms of non-lethal weapons.[2]

Discussions of non-lethal weaponry are made more difficult by the enormous range of different technologies that are under consideration. Furthermore, some advocates of non-lethal weapons clearly envisage their use at the strategic level rather than just at the tactical level, for example for crowd control.[3] So, within this one concept, there might be discussion of improved bean-bag rounds to replace plastic bullets and the strategic paralysis of a country by fouling of its electrical supply system with carbon fibres dropped from the air (thus shorting out the power lines). Nevertheless, most current developments remain at the tactical level, but even here weapon systems based on acoustics, biological or chemical agents, electromagnetics, and kinetic energy have all been under various forms of development. Non-lethal chemicals, for example, could include adhesives, corrosives, embrittlement

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agents, foams, slippery lubricants and engine modifiers. Similarly, electromagnetic-based non-lethal weapons could include not only carbon fibre conductive material but also lasers, optical munitions, microwaves and electrical stun systems.

What is undoubtedly true is that non-lethal chemical incapacitants figure large in many discussions of this new form of warfare. As the report of a recent series of British-American meetings noted: 'During the wargame scenarios, numerous participants expressed the desire to have a NLW [non-lethal weapon] that could quickly incapacitate individuals ... '.[4] The capability was particularly desired for 'a variety of scenarios ranging from crowd control to incapacitation of enemy combatants' and generally '*a chemical based calmative agent was viewed as the technology that could provide this capability*' [emphasis added].

At first sight it might appear that the CWC absolutely prohibits any such use of chemical agents. Article I of the convention reads:

> 1. Each State Party to this Convention undertakes never under any circumstances:
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> (a) To develop, produce, otherwise acquire, stockpile or retain chemical weapons, or transfer, directly or indirectly, chemical weapons to anyone;
>
> (b) To use chemical weapons;
>
> (c) To engage in any military preparations to use chemical weapons ... .

The convention then states that chemical weapons are 'Toxic chemicals and their precursors, *except where intended for purposes not prohibited under this Convention, as long as the types and quantities are consistent with such purposes* ... ' [emphasis added] and a toxic chemical is defined as 'Any chemical which through its chemical action on life processes can cause death, temporary incapacitation or permanent harm to humans or animals ... '.

The problem arises, in large part, because one of the purposes not prohibited under the convention is 'law enforcement including domestic riot control purposes'. Whilst Article I (5) of the convention also states that 'Each State Party undertakes not to use riot control agents as a method of warfare' there is clearly a grey area where different interpretations of what is permitted are possible—when, in short, does law enforcement end and a method of warfare begin?

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Writing in the *Naval Law Review*, and drawing on many original sources, Major Ernest Harper of the United States Marine Corps has recently tried to elucidate in detail how this ambiguity arose in the negotiations of the CWC.[5] In his view, Article I (5), whilst seemingly simple and straightforward, is in fact an 'intentionally undefined and ambiguous text that represents a compromise designed to find middle ground between polarized parties'. The parties in the polarized dispute did not want to change their positions, but they wanted to complete the agreement, so 'Everyone remained silent as to the meaning of the language, so as to avoid upsetting the delicate balance that had been created'.

Harper explains that when the United States entered the CWC negotiations in 1984, its official view was that riot control agents 'did not constitute chemical weapons, due to their nonlethal nature'. Indeed, when the United States moved to ratify the 1925 Geneva Protocol in 1975, President Ford had, in Executive Order 11850, allowed for some specific exemptions that permitted the use of riot control agents—for example for the control of rioting prisoners of war and for the rescue of downed aircrew. The United States wished to preserve such options and therefore wanted to define chemical weapons in a way that did not include riot control agents. Other countries, including many American allies, wanted riot control agents included in the definition of chemical weapons so as to exclude their use in warfare. As Harper notes:

> They believed that any use of a RCA [riot control agent] could all too easily escalate to the use of lethal chemical weapons, and viewed RCAs as a large loophole in the effort to eradicate chemical warfare, a loophole they were determined to close.

In the end, opponents of the American position had to accept a compromise, as did the United States. When the United States ratified the convention, President Clinton accepted that all the options embodied in Executive Order 11850 were still allowed for American forces. Harper, however, correctly views this as a unilateral American interpretation and is concerned that American forces might, if they actually employed such options, be viewed by others as violating an international agreement. His paper is an attempt to clarify the meaning of 'method of warfare' in such a way that the United States could legitimately use the options it wishes to retain.

What is of interest here is that the major states which wanted the toughest possible barrier to the future use of chemical weapons were forced to accept a vague compromise, the United States still believes it has the option to use riot control agents under certain non-domestic circumstances and, of course, other states may later choose to take the same position. In short, the option to try to develop new forms of non-lethal chemical incapacitants that we know were attractive to the superpower militaries during the Cold War remains open.[6] Before considering the reasons why scientific and technological advances make the successful development of such incapacitants much more likely today, it is essential to note the extreme seriousness *for international law* of the potential development of non-lethal weapons.

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As David Fidler has argued, the moral principles underlying the rules of war have been remarkably consistent over the centuries, and international lawyers are resistant to the idea that non-lethal weapons require some form of special treatment: ' … under current international law, there is no good reason to think in terms of lethal versus "non-lethal" weapons because international legal principles must be applied to all weapons … '.[7]

Fidler contrasts this 'compliance perspective' with the 'selective change perspective' put forward by non-lethal weapons advocates like John Alexander.[8] In the selective change perspective, the chance to do less harm by using non-lethal rather than lethal weapons in very difficult operational circumstances should not be given up; if international law has to be modified ('modernized') that is a price well worth paying. So in this perspective, it would clearly be sensible to modify the CWC so that riot control agents were understood to be permitted, for example to protect civilians who were being used to mask or screen an attack.

What is interesting about Fidler's analysis is that he raises the prospect of a third perspective: 'radical change'. In Fidler's view:

> The selective change perspective uses changes in military operations and technologies as a basis for advocating selective, case-by-case reforms in international law to allow more NLW development and use but it does not embrace the more radical implications of 'future war'. Giving these implications more weight produces the radical change perspective.

He argues, for example, that non-lethal weapons may expand rather than limit the acceptable 'just causes' for using force:

> Anticipatory self-defence might be viewed more favourably if undertaken with NLWs rather than merely with lethal force. Attacks on terrorist groups harboured inside states might be less controversial if the attacks were conducted with NLWs … .

More particularly, he notes the importance, in the arguments of proponents of non-lethal weapons, of a dynamic rather than static view of military technology:

> Arguments in favour of developing and deploying NLWs often rely on the new capabilities such weapons give military forces and *suggest that such capabilities affect how we evaluate the ethics of weapons' use …* [emphasis added].

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What is at stake here, therefore, is no small issue. The discussion involves all the ideas about ethics and war that international society has developed; non-targeting of civilians, proportionality, unnecessary suffering and superfluous injury are all concepts that may have to be overthrown in this perspective as operational needs and military technology evolve. These look like dark and dangerous waters that should not be entered lightly, yet the scope and pace of change in science and technology are such that these issues cannot be avoided for long.

Chemistry, biology and future war

There is an obvious linkage between growth of the sciences of chemistry and biology and the development of chemical and biological weaponry. Only with the systematization of chemistry and the growth of the chemical industry at the end of the nineteenth century was the production of chemical agents on a large scale possible during the First World War. Growing understanding of the role of the neurotransmitter acetylcholine underpinned elaboration of the new nerve agents around the time of the Second World War, and then, during the early stages of the Cold War, a fortuitous discovery of drugs which helped those suffering from mental illness led to renewed interest in chemical incapacitants and weaponization, for example of BZ by the United States.[9] Similarly, the revolution in bacteriology at the end of the nineteenth century, with the clarification of the nature of many infectious bacterial diseases, facilitated the anti-animal biological warfare of the First World War. Increased knowledge of aerobiology and of industrial-scale production lay behind the Second World War programmes of, for example, the United Kingdom and the United States, which produced the range of 'classical' agents such as anthrax and botulinal toxins. Elucidation of the nature of viruses in the 1950s, and then the capabilities for genetic engineering, were undoubtedly deployed in the late Cold War Soviet offensive biological weapons programme, and today we face the possible applications of genomics, if only to modify classical agents.

As the Final Declaration of the fourth Review Conference of the BTWC stated in 1996, there were:

> … apprehensions arising from relevant scientific and technological developments, *inter alia*, in the fields of microbiology, biotechnology, molecular biology, genetic engineering and any application resulting from genome studies.

Although the 2001 fifth Review Conference of the BTWC did not produce a Final Declaration,[10] it is possible to understand the growing concerns of states parties by analysing the background papers on relevant scientific and technological developments that some of them produced.[11] These papers reveal an awareness and concern over the huge revolution underway today in the life sciences. It is quite clear that developments in structural and functional genomics, proteomics, bioinformatics and combinatorial chemistry, together with advances in specific areas such as neuroscience, are having a massive impact on our capabilities for benign and malign applications. One particular point is that the divide between chemistry and biology becomes increasingly difficult to maintain as we understand and grapple with events at the molecular level in living organisms.

It is therefore appropriate and necessary that there is an overlap between the scope of the CWC and the BTWC in relation to mid-spectrum agents such as chemical incapacitants. In short, we have to deal with the control of a biochemical threat spectrum ranging from classical lethal chemical agents, industrial chemicals, bioregulators and toxins (covered by the CWC) through bioregulators, toxins, classical biological agents and genetically modified biological agents (covered by the BTWC).

It is necessary to grasp the enormity of the issue we face. A long-term student of chemical and biological weapons arms control, Professor Matthew Meselson of Harvard University, has rightly argued that every major technology in the past has been intensively exploited for military purposes. He asks whether we are going to allow this to happen with modern biology. In his opinion:

> During the century ahead, as our ability to modify fundamental life processes continues its rapid advance, we will be able not only to devise additional ways to destroy life but will also become able to manipulate it—including the processes of cognition, development, reproduction, and inheritance … .[12]

He continues his argument:

> A world in which these capabilities are widely employed for hostile purposes would be a world in which the very nature of conflict had radically changed. Therein could lie unprecedented opportunities for violence, coercion, repression, or subjugation … .

So what we are now proceeding to discuss is indeed no small issue. As with David Fidler's concerns about the possible eventual overthrow of all current standards of international law by the development of new non-lethal weaponry, our discussion of potential new chemical incapacitants has to be seen as but a particular early example of scientific and technological developments that could completely alter the nature of human conflict. The stakes here should definitely not be underestimated.

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Neuroscience

In 1990 the United States Congress designated the coming decade as the 'Decade of the Brain'. The achievements of that decade were marked by a special meeting at the National Academy of Sciences in Washington in 1999.[13] The Society for Neuroscience, which organized the meeting, noted that 'The past decade has delivered more advances than all previous years of neuroscience research combined.'

That gives some idea of the scale of this successful research into the mechanisms underlying human behaviour. We are familiar, of course, with the accomplishments of neuroimaging from media stories, for example of scientists discovering anomalies in the way people with dyslexia process information. Such elucidation of neuronal circuits is of critical importance but less well known, and of equal importance for future progress, are the spectacular advances of the 1990s in psychopharmacology. Advances in this area are of particular importance for the development of new non-lethal incapacitants affecting the central nervous system.

It became clear only at the end of the nineteenth century—through the use by Ramón y Cajal of Golgi's staining techniques—that the nervous system is made up of individual cellular units, the so-called neurons. These are of three main types: sensory neurons that detect changes in the environment; effector neurons that, for example, cause muscles to move; and interneurons that, through simple or complex chains, link the other two types together. Neurons have diverse structures but all possess a cell body containing the nucleus (and thus the DNA of the cell), dendrites which receive input information to the cell, and an axon which conveys output information from the cell. Information is known to be conveyed *within* the neuron by electrical means. After the discovery, in the early decades of the twentieth century, of acetylcholine's effect on heart muscle, it gradually became clear that transmission of information *between* neurons is overwhelmingly by chemical means—by so-called *neurotransmitters*. Acetylcholine was the first neurotransmitter to be discovered. Other well-known examples such as noradrenalin, serotonin and glutamate then gradually followed.

The transfer of information between neurons, and between neurons and effector systems like muscles, occurs at places of close contact called synapses. An electrical event in the axonal ending of the pre-synaptic cell leads to the release of the neurotransmitter(s) which moves across the gap (or synaptic cleft) between the cells, links up with receptors in the membrane of the post-synaptic cell, and causes changes in that cell. This is clearly a complex system which requires storage of the neurotransmitter in the pre-synaptic cell, mechanisms for its release and then for its destruction or removal from the synaptic cleft when it has done its job, and a receptor by which it is recognized and responded to appropriately by the post-synaptic cell.

The incredible complexity of the human nervous system makes it difficult to analyse, but many of the basic features of nervous systems can be fruitfully studied in simpler organisms and deductions can be made about how the more complex systems function. Nevertheless, our understanding of the human nervous system has also developed by quite serendipitous means. In particular, in the middle years of the twentieth century, a series of drugs was discovered—basically by accident—that greatly helped in the first successful treatment of major mental illnesses. Furthermore, research demonstrated that these new drugs had functions related, albeit in complex ways, to the operations of known neurotransmitters. Against that background, major efforts were inevitably made to gain a better understanding of the events occurring at synapses and to develop further drugs with increased effectiveness and greater specificity.

The initial research obviously concentrated on drug chemistry. Following the discovery of a substance with an effect of interest, medicinal chemists would elucidate its molecular structure and then begin systematically to create variations in the hope of enhancing that specific effect. However, despite the high capability of the chemists, this task was very difficult. The human nervous system has many sub-systems and it is not easy to affect just one and leave the rest untouched. Furthermore, the nervous system is intimately linked to the endocrine (hormone) system and, as is now becoming clear, to the immune system. All these systems, and many others in the body, communicate by chemical means and the same—or very similar—chemicals have, in the course of evolution, come to serve different purposes in the different systems. Finding new chemical drugs for benign purposes, or new incapacitants for the military, was therefore not easy in the decades following the initial breakthrough in the mid-twentieth century.

It was clear also that the nature of the transmitter was not the only factor of importance at a particular type of synapse. Nicotine, for example, was found to mimic the effect of acetylcholine at synapses on skeletal muscle but to have no effect on heart muscle. On the other hand, muscarine, a hallucinogenic component of some mushroom species, has no effect on skeletal muscles, but mimics the effect of acetylcholine at (acetylcholine) synapses on heart muscle. There clearly had to be differences in the receptor systems in these two cases, but it was not possible to discover how complex receptor systems really were until the advent of molecular biology in the latter part of the twentieth century.

Some of the body's signalling chemicals operate by entering the cell body and directly affecting metabolic activities therein, but those of interest to this article are among the ones which operate by affecting receptors on the *surface* of the cell. As it became possible to identify different genes and their products, and because these receptors fall into a relatively small number of general categories, a vast cornucopia of knowledge has accumulated during the 1990s. This has led, and will increasingly lead, to the development of more specific and useful drugs—and perhaps also to new incapacitants.

It is essential to recognize how quickly knowledge of all these receptor systems developed during the 1990s. In 1990, one standard listing was some thirty pages long and contained structural information on only a quarter of the receptors listed. By contrast, in 1999 the editors commented: ' ... In this tenth edition, 106 pages are required to accommodate current information on approximately 50 receptor and ion channel classes, for which structural information is presented for over 99% ... '.[14]

The difficulties of designing a drug or incapacitant with a specific effect before this level of complexity was understood is quite obvious. What has now changed is that the receptors and the chemical neurotransmitters (ligands) operating in particular circuits are being increasingly clarified. This opens up the possibility of specific interference with the central nervous system and with particular behaviours that could well be of military interest.

Bioregulators and the military

Neurotransmitters are best regarded as a sub-set of bioregulatory chemicals. In his detailed review 'Bioregulators as instruments of terror', Elliott Kagan defined these substances as ' ... naturally occurring organic compounds that regulate diverse cellular processes in multiple organ systems ... '.[15] He added that, as such, they are produced in very small quantities and are essential for normal body functioning. Bioregulators are structurally diverse and, as has been shown in many background scientific and technological papers for BTWC Review Conferences since 1991, used in abnormal amounts or modified (synthetic) forms they can do untold damage to living organisms.

Kagan discussed cytokines such as endogenous pyrogens that deregulate temperature, eicosanoids that cause spasms and mucus production in the lungs, hormones such as insulin that can cause coma, and plasma proteases that can produce hypotension or blood coagulation. His paper is of interest because it discussed the potential advantages to terrorists of use of such substances—for example, that they are not usually on anyone's threat list, are difficult to diagnose, cannot be vaccinated against, and can cause massive effects over large areas via unusual routes of dispersion. As the United Kingdom Foreign Secretary's 2002 Green Paper noted:[16]

> ... advances in biotechnology thus create the potential for the misuse of peptide [chemicals made up of short strings of amino-acids] bioregulators in offensive BW programmes. Advances in the use of viral and bacterial vectors enhance the possibility for direct delivery of a toxin or bioregulator to the human target or they could be used to transfer the toxin or bioregulator genes to the target.

So it is possible to envisage the use of bioregulators to cause disease or to use our increasing understanding of the immune system to destroy the body's natural defences. However, if we look down the road ahead, why should anyone wish to take such action if they could simply control the victim's (target's) behaviour? The real question here is how far along that road are we? Is it possible to see evidence in the open literature of an ability to use a specific chemical to affect a specific receptor or even a sub-type of receptor in a specific circuit to bring about a (beneficial or dysfunctional) behavioural change?

Targeting the central nervous system

The first thing to understand is the considerable military interest in this issue. The Soviet offensive biological weapons programme is known to have included the substantial 'Ovchinnikov' bioregulator component.[17] In the United States the Joint Non-Lethal Weapons Directorate[18] has as an objective 'to identify possible non-lethal chemical materials for further testing which have minimal side effects for immobilizing adversaries in military and law enforcement scenarios'. The Applied Research Laboratory at Pennsylvania State University, which works closely with the Joint Non-Lethal Weapons Directorate, produced a major report on calmatives (pharmacological compounds or agents that cause a calm or tranquil behavioural state) in 2000.[19] Among the objectives of this report were to provide ' ... an in-depth review of selective calmatives identified by the literature search with a high potential for further consideration as a non-lethal technique ... ' and ' ... to identify and provide recommendations on new areas in pharmaceutical drug development that may uniquely meet the requirements of calmatives as non-lethal[s] ... '. It should be noted that the report pointed out other classes of pharmaceutical agents that were also worthy of detailed review in regard to such objectives.

The report reviews a very wide range of calmatives with effects on the central nervous system such as benzodiazepines, dopamine agonists, serotonin transporters and so on, which clearly shows how modern benign civil research is being studied for means to produce other, less benign effects. Not surprisingly, given previous work by the American military,[20] the report states that in regard to adrenenergic receptors: ' ... The researchers identified several drug classes (e.g. ... alpha 2-adrenoreceptor agonists) and individual drugs (... dexmedetomidine) found appropriate for immediate consideration as non-lethal[s] ... '. It is not difficult to understand the attractions of the alpha 2-adrenoreceptor system for advocates of non-lethal chemicals. Most of the noradrenaline-containing nerve cells in the brain are located in an area called the locus coeruleus. The axons from this small group of cells branch widely through the brain and the output of noradrenaline from their axon endings plays a major role in determining the state of alertness and attention. Alpha 2-adrenoreceptors limit the production of noradrenaline by inhibitory feedback. Hence introduction of a specific *agonist* (a chemical with the same effect as the alpha 2-adrenoreceptors), such as dexmedetomidine, will reduce alertness and attention—in fact, it will put the target person to sleep. Furthermore, elucidation of the precise roles of the various receptor sub-types, thus facilitating even more discriminating interventions, is proceeding apace.[21]

A similar problem can be seen in regard to the muscarinic M2 acetylcholine receptor. It is clear that the cognitive deficiencies manifested in Alzheimer's disease are related to a deficiency in acetylcholine function in the higher nervous system. Muscarinic M2 receptors are again inhibitory autoreceptors on acetylcholine-producing cells that limit the neurotransmitter's production through negative feedback. In relation to the treatment of Alzheimer's disease, much effort has therefore gone into discovering specific *ant*agonists that block the receptor and thus maintain higher production of acetylcholine. At least in mice this approach does seem to have positive effects on cognition.[22] A highly specific *agonist* might be expected to have the opposite effect. There was considerable work in the 1960s and 1970s on potential military agents to target this system.[23] With the increased knowledge today of receptor sub-types, such investigation might now lead to much more successful results.

So there is little room for doubt that in regard to two of the original, and important, small molecule neurotransmitters—noradrenaline and acetylcholine—it is possible to target specific receptor sub-types with specific chemicals in specific circuits, and that the behavioural functions affected could be of interest to the military seeking new non-lethal weapons. The situation regarding peptide neurotransmitters is perhaps even more worrying because the vast amount of data on new neuroreceptors has shown quite clearly that there are many more natural ligands—probably with important behavioural functions—to be discovered. The race is on amongst pharmaceutical companies to find these new ligands because they will almost certainly be important in the development of beneficial new drugs.

Two examples of peptide neurotransmitter research can give an indication of the kinds of function that could soon come under attack. Substance P is a tachykinin. It has been known for some time that substance P and two related peptides operate through three different receptor sub-types, for example in the perception of pain. Recently, it has also been discovered that substance P probably plays a role in depression. Appropriate receptors are found in plausible parts of the brain and specific substance P *ant*agonists alleviated depression and anxiety in human clinical trials.[24] Clearly, if substance P is involved in this way, effective delivery of a synthetic *agonist* via one of the many new means of drug delivery under development might well have the opposite effect of *inducing* anxiety or depression.

A specific example of such an impact is known in the case of the cholecystokinin B (CCKB) receptor. Administration of CCKB receptor agonists to animals causes indications of increased anxiety, and administration of the natural ligand CCK4 causes panic attacks in humans with a history of such attacks as well as in healthy volunteers.[25] There is even some evidence of natural variations in this receptor being linked to susceptibility to panic attacks.[26]

The ugly possibility therefore arises that rather than, as Meselson argued, the human race being at a crossroads and having to decide whether to accept or prevent the major military application of modern biology, we may already have taken the wrong path. At the very least, in regard to the above examples, there are clear warning signs of the necessity to act.[27]

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What should be done?

There are many ways in which action can be taken to help prevent the misuse of the modern life sciences: students can be taught the history of the misuse of their subject so that they are properly alerted to the potential dangers; professional associations can develop codes of ethics that reinforce the norm of only peaceful uses of modern chemistry and biology; national governments can introduce laws that increase the protection of dangerous materials and knowledge. Yet the foundation for all this evolving ‘web of deterrence’ must be the international resolve to safeguard the prohibitions embodied in the 1925 Geneva Protocol, the 1975 BTWC and the 1995 CWC. Without international resolve, national and sub-national efforts are inevitably fragmentary and likely to be transient.

Yet how can international treaties be protected in a time of such fundamental—seismic—change in our scientific and technological capabilities? Fortunately, both the BTWC and CWC have their prohibition enacted in a general purpose criterion which specifies that only peaceful purposes are allowed. This provides robust, if not complete, protection of the norm.[28] Moreover, in regard to the BTWC, the succession of review conferences has provided a means by which the states parties can elaborate their shared understandings of the scope of the convention. Thus the fourth Review Conference stated in its Final Declaration that ‘ ... the Convention unequivocally covers all microbial or other biological agents or toxins, naturally or artificially created or altered, as well as their components, whatever their origin or method of production ... ’.

Prior to the fifth Review Conference of the BTWC in late 2002 Pearson suggested adding this additional explanatory sentence:[29]

> Consequently, prions, proteins and bioregulators and their synthetically produced analogues and components are covered.

Of course, given the current state of disarray of the BTWC,[30] it is not surprising that the opportunity to strengthen the restraints on the misuse of bioregulators was not taken.

In such circumstances, it would be a sensible step forward if the Final Declaration of the CWC Review Conference were to state, in regard to the scope of the convention, that:[31]

> The Conference also reaffirms that the Convention unequivocally covers all chemicals regardless of their origin or of their method of production ...

and it should add:

> Consequently, toxins, prions, proteins, peptides and bioregulators and their biologically or synthetically produced analogues and components are covered.

That, at least, would provide a clear point of reference in the rapidly changing times ahead and help to safeguard the important prohibition at the heart of the CWC, both in regard to the specific example of bioregulators like neurotransmitters, and to a much wider range of substances that could also be subject to misuse. However, it is far from clear that it will be possible for the states parties to achieve this objective. In that event it will be necessary for non-governmental organizations such as professional scientific and medical societies, and bodies such as the International Committee of the Red Cross,[32] to generate the public and political interest that will eventually lead to a stronger preservation of the barriers against the ghastly prospect of the widespread misuse of the scientific and technological developments in the life sciences which will dominate the twenty-first century.

Notes

1. J. Perry Robinson, 2002, What should be the scope of the CWC? A Workshop report, *CBW Conventions Bulletin*, vol. 55, pp. 1–4, available at <http://www.fas.harvard.edu/~hsp/bulletin/cbwcb55.pdf>.
2. M.R. Dando, 1997, *A New Form of Warfare: The Rise of Non-Lethal Weapons*, London, Brassey's.
3. J.B. Alexander, 2001, An overview of the future of non-lethal weapons, *Medicine, Conflict and Survival*, vol. 17, pp. 180–93.
4. United States/United Kingdom, 2001, *US/UK Non-Lethal Weapons (NLW)/Urban Operations Executive Seminar: Assessment Report*, ONR-NLW-028, available at <http://www.sunshine-project.org>.
5. E. Harper, 2001, A call for a definition of a method of warfare in relation to the Chemical Weapons Convention, *Naval Law Review*, vol. XLVIII, pp. 132–60.
6. Dando, 1997, *op. cit.*; United States Army Foreign Science and Technology Center, 1985, Letter Report: Incapacitating agents, European Communist Countries: Low-molecular weight neurotoxins, psychotropics, alkaloids, organofluorines, and blue-green algal toxins, United States Army Intelligence Agency, AST-1620R-100-90 (16 July 1990); F.C. Conahan, 1994, *Human Experimentation: An Overview on Cold War Era Programs*, United States General Accounting Office, GAO/T-NSIAD-94-266 (28 September).
7. D.P. Fidler, 2001, 'Non-lethal' weapons and international law: Three perspectives on the future, *Medicine, Conflict and Survival*, vol. 17, pp. 194–206.
8. See Alexander, 2001, *op. cit*.
9. Dando, 1997, *op. cit*.
10. M.R. Dando, 2002, *Preventing Biological Warfare: The Failure of American Leadership*, London, Palgrave.
11. M.R. Dando, 2002, Bio-weapons convention fails to keep up with evolving threats, *Jane's Intelligence Review*, vol. 14, no. 2, pp. 30–32.
12. M. Meselson, 2000, Averting the hostile exploitation of biotechnology, *CBW Conventions Bulletin*, vol. 48, pp. 16–19, available at <http://www.fas.harvard.edu/~hsp/bulletin/cbwcb48.pdf>.
13. Society for Neuroscience, 1999, *Neuroscience 2000: A new era of discovery*, available at <http://web.sfn.org/content/Meetings_Events/Neuroscience2000/index.html>.
14. S. Alexander et al., 1999, *TiPS Receptor and Ion Channel Nomenclature Supplement 1999*, Cambridge, Elsevier Trends Journals.
15. E. Kagan, 2001, Bioregulators as instruments of terror, *Clinics in Laboratory Medicine*, vol. 21, no. 3, pp. 607–18.
16. United Kingdom, 2002, *Strengthening the Biological and Toxin Weapons Convention: Countering the Threat from Biological Weapons*, London, Foreign and Commonwealth Office, April.
17. News Chronology, 2000, *CBW Conventions Bulletin*, vol. 50, p. 38, available at <http://www.fas.harvard.edu/~hsp/bulletin/cbwcb50.pdf>.
18. United States, Joint Non-Lethal Weapons Directorate, Technology Investment Program, 2001, *TIP Panel selections. P 7*, (2nd quarter).
19. J.M. Lakoski, W. Bosseau Murray and J.M. Renny, 2000, *The Advantages and Limitations of Calmatives for Use as a Non-Lethal Technique*, Applied Research Laboratory, College of Medicine, Pennsylvania State University.
20. Dando, 1997, *op. cit*.
21. M.M. Bucheler, K. Hadamek and L. Hein, 2002, Two alpha (2)-adrenergic receptor subtypes, alpha (2A) and alpha (2C), inhibit transmitter release in the brain of gene-targeted mice, *Neuroscience*, vol. 109, no. 4, pp. 819–26.
22. J.E. Lachowicz, 2002, *Selective M_2 antagonists facilitate acetylcholine release and improve performance in behavioural models of cognition*. Presentation 115.2 in the Symposium on 'Advances in Muscarinic Receptor Research' at the International Congress of Pharmacology, San Francisco, California, 7–12 July.
23. United States Army Foreign Science and Technology Center, 1985, *op. cit.*; Conahan, 1994, *op. cit*.
24. N.M. Rupniak, 2002, New insights into the antidepressant actions of substance P (NK1 receptor) antagonists, *Canadian Journal of Physiology and Pharmacology* vol. 80, no. 5, pp. 484–94.
25. J. Brodwejn and D. Koszycki, 2001, Cholecystokinin and panic disorder: Past and future clinical research strategies, *Scandinavian Journal of Clinical and Laboratory Investigation Supplement*, vol. 234, pp. 19–27.
26. E. Hattori et al., 2001, Identification of a compound short tandem repeat stretch in the 5'-upstream region of the cholecystokinin gene, and its association with panic disorder but not with schizophrenia, *Molecular Psychiatry*, vol. 6, no. 4, pp. 465–70.
27. M. Wheelis and M.R. Dando, in press, On the brink: Biotechnology and the future of bioweapons control, *Bulletin of the Atomic Scientists*.
28. Perry Robinson, 2002, *op. cit*.

29. G.S. Pearson, 2001, *New Scientific and Technological Developments of Relevance to the Fifth Review Conference*, Department of Peace Studies, University of Bradford (BTWC Review Conference Paper No. 4).
30. For more information about the BTWC, see Review Conference Papers 6, 7, 8 and 9 from the Project on Strengthening the Biological and Toxin Weapons Convention at the University of Bradford, at <http://www.brad.ac.uk/acad/sbtwc/>.
31. G.S. Pearson, 2002, *Relevant Scientific and Technological Developments for the First CWC Review Conference; The BTWC Review Conference Experience*, Department of Peace Studies, University of Bradford (First CWC Review Conference Paper No. 1), available at <http://www.brad.ac.uk/acad/scwc/cwcrcp/cwcrcp_1.pdf>.
32. International Committee of the Red Cross, 2002, *Biotechnology, Weapons and Humanity*, Geneva, ICRC (summary report of a meeting at Montreux, 23–24 September).