

Biochemical Weapons: Lethality, technology, development, and policy.

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Definitions

BNLWRP Research Report No. 4 (December 2003) discussed the development of incapacitating chemicals as ‘non-lethal’ weapons and the debates surrounding both their lethality and legality.² Here this discussion is expanded to cover agents whose definitions fall somewhere in between that of a ‘traditional’ chemical agent (e.g. nerve, blood, and blister agents) and a ‘traditional’ biological agent (e.g. bacteria, viruses, and rickettsia). In this context Pearson’s CBW Spectrum is a useful concept (see *Table 1*):

*Table 1:
The CBW Spectrum³*

Classical CW	Industrial Pharmaceutical Chemicals	Bioregulators Peptides	Toxins	Genetically Modified BW	Traditional BW
Cyanide Phosgene Mustard Nerve Agents	Aerosols	Substance P Neurokinin A	Saxitoxin Ricin Botulinum Toxin	Modified/ Tailored Bacteria Viruses	Bacteria Viruses Rickettsia Anthrax Plague Tularemia
← Chemical Weapons Convention →		← Biological and Toxin Weapons Convention →			
← Poison →			← Infect →		

It is toxic agents in the mid-spectrum, where there is overlap between the legal prohibitions of the Chemical Weapons Convention (CWC) and those of the Biological and Toxin Weapons Convention (BTWC), that Wheelis terms “biochemical weapons”.⁴ Incapacitating chemicals such as the fentanyl derivative used during the siege of a theatre in Moscow in late 2002 would fall into the theoretical ‘Industrial Pharmaceutical Chemicals’ category and, as toxic chemicals, are covered by the CWC alone. However, due to advances in biotechnology and new methods of drug discovery, there is increasing blurring of the superficial boundaries between this category and that of ‘Bioregulators’ and ‘Toxins’. As Wheelis points out, the analogues of bioregulators and toxins are covered by the BTWC. He argues, therefore, that synthetic chemical analogues (i.e. drugs) that bind to the same specific binding sites on proteins in the body as the corresponding natural ligands are also

covered. The significance of this ‘double coverage’ is that would-be developers of such agents should not be able to exploit the loophole in the CWC that permits the use of certain chemicals for “law enforcement including domestic riot control purposes.” This is particularly important given the scientific and technological developments that would facilitate any offensive programme to develop such novel agents designed to incapacitate or to kill.

The Issue of Lethality

Before addressing the relevant science and technology it is worthwhile to revisit the issue of lethality. As discussed in the last BNLWRP report⁵, currently available incapacitating agents and associated delivery systems exclude them for being used for their stated purpose as ‘non-lethal’ weapons since they have comparable lethality to some conventional weapons.⁶ For the same reason they cannot be termed riot control agents (RCAs), defined by the CWC as:

Any chemical not listed in a Schedule, which can produce rapidly in humans sensory irritation or disabling physical effects which *disappear* within a short time following termination of exposure. [emphasis added]⁷

The reversibility of effects may be seen as a key aspect of any non-lethal weapon targeted at humans. However a model developed by the Klotz et al suggests that no existing agents would be able to perform this role and that it is unlikely a new agent would be sufficiently safe.⁸

Others are more optimistic about the future of incapacitating agents despite the events in Moscow in late 2002 when Russian authorities ended the siege of a theatre using an aerosolised fentanyl derivative, most likely carfentanyl⁹, with devastating results. (120 of the 800 hostages died as a result of exposure to the agent and many survivors needed hospital treatment.¹⁰) An anaesthesiologist with a professional interest in this area contributed an editorial to the *European Journal of Anaesthesiology* in early 2003. Recognising the risk of using fentanyl and other opioids as ‘non-lethal’ incapacitants, (a major side effect is respiratory depression), he noted:

However, remarkable progress has been made in the techniques to deliver immobilizing agents and in the development of safer, faster-acting potent compounds of extremely short duration in the last decade. Much of this work is either privileged or currently not available to the public and therefore unpublished.¹¹

For the sake of argument, let us assume that this classified or commercial proprietary research has solved the problem of combining high potency with a high safety-margin. Furthermore imagine this work has overcome the very significant obstacle of developing a biochemical agent that can be delivered in a safe and reversible but incapacitating dose to all individuals in a given area, notwithstanding the differences in age, size and health of those individuals and the problems of uneven concentrations and cumulative intake of the agent.¹² Some would argue that such an agent would be an acceptable addition to military arsenals or riot control stockpiles as a non-lethal weapon. However, the issue of lethality is a distraction. Agents designed to incapacitate rather than kill have been a common feature of several past offensive chemical and biological weapons programmes and there is no reason why new weapons agents should be placed in a privileged ‘non-lethal/less-lethal’ category that aims to exempt them from restrictions under the CWC and BTWC.

The glycolate agent BZ, a psychoactive compound that interferes with acetylcholine transmission in the central nervous system (CNS), was weaponized by the US in the 1960's as part of their chemical weapons programme.¹³ There are also reports that the Former Soviet Union developed a derivative of BZ as an incapacitating weapon¹⁴ and Iraq's chemical weapons programme is thought to have incorporated a glycolate compound known as Agent 15.¹⁵ Biological agents have also been considered for use as incapacitating rather than lethal weapons. In describing Soviet doctrine for use of biological weapons Ken Alibek pointed out that:

Operational biological weapons were intended for use against deep military targets about 100 to 150 kilometers behind the front lines, such as rear services and reinforcements. These agents, such as tularemia, brucellosis, glanders, and Venezuelan equine encephalomyelitis (VEE), would not generally kill soldiers, but would incapacitate them and thereby make it easier to destroy an enemy's defenses.¹⁶

The intent behind the use of these agents was not necessarily to kill but to incapacitate. That this incapacitation might be followed up with lethal (conventional) force, however, is a possibility for any such agent.¹⁷ BZ is listed as a Schedule 2 toxic chemical under the CWC, tularaemia is considered a Category A biological agent by the US Centers for Disease Control (CDC), and brucellosis, glanders, and VEE are Category B agents.¹⁸ There are no calls to introduce any of these as non-lethal or less-lethal weapons. If new biochemical agents are developed under the guise of non-lethal incapacitation it is likely that they will soon appear on similar threat lists. There have already been warnings of this 'double-edged sword'.¹⁹

Science and Technology

There is concern over the potential use of bioregulators as weapons in warfare or by terrorists. A paper in late 2001 stated that these organic compounds "...are capable of regulating a wide range of physiologic activities..." and if used as weapons "... could potentially cause profound systemic effects on multiple organ systems."²⁰ Bioregulators of concern discussed in the paper included cytokines, eicosanoids, neurotransmitters, hormones, and plasma proteases. Neurotransmitters mediate chemical transmission in the nervous system through their interactions with specific receptors. In the central nervous system (CNS) these neurotransmitter-receptor interactions have a major role in regulating consciousness, mood, anxiety, perception, and cognition. *Table 2* below gives some of the potential effects of neurotransmitters employed as weapons:

Table 2:
*Bioregulators and their clinical effects*²¹

Bioregulator Category	Agent	Clinical Effects
Neurotransmitters	Catecholamines	Consciousness, mood alterations, anxiety, hypertension, tachycardia, and sexual dysfunction.
	Amino acids	Effects on learning, memory, cognition, and pain sensitivity.
	Neuropeptides	Effects on cognition and sensory processing.

Neurotransmitters are of particular interest for this discussion because their sites of action, i.e. neuronal receptors, are the same as proposed ‘non-lethal’ incapacitating agents (or calmatives as they are sometimes known). Neurotransmitters are the naturally occurring ligands but these receptors can also be bound by synthetic chemical analogues (i.e. drugs). A report from The Applied Research Laboratory at Pennsylvania State University, who work closely with the US military’s Joint Non-Lethal Weapons Directorate (JNLWD), entitled *The Advantages and Limitations of Calmatives for Use as a Non-Lethal Technique*, states that potential ‘calmatives’ are “...compounds known to depress or inhibit the function of the central nervous system.”²² Arguing that potential calmatives might include “...sedative-hypnotic agents, anesthetic agents, skeletal muscle relaxants, opioid analgesics, anxiolytics, antipsychotics, antidepressants and selected drugs of abuse”, the authors identified a number of drug classes acting on specific CNS receptors as candidate agents (see *Table 3* below):

Table 3:
*Potential ‘calmatives’*²³

Drug Class	Site of Action
Benzodiazepines	GABA receptors
Alpha ₂ Adrenergic Receptor Agonists	Alpha ₂ -adrenergic receptors
Dopamine D3 Receptor Agonists	D3 receptors
Selective Serotonin Reuptake	5-HT transporter
Serotonin 5-HT _{1A} Receptor Agonists	5-HT _{1A} receptor
Opioid Receptors and Mu Agonists	Mu opioid receptors
Neurolept Anesthetics	GABA receptors
Corticotrophin-Releasing Factor	CRF receptor
Cholecystokinin B receptor antagonists	CCKB receptor

Alpha₂-adrenergic receptors, for example, are known to play an important role in sedation and work by the US military during the 1990’s to develop α₂ adrenergic agonists as weapons for the non-lethal weapons program has been documented.²⁴ μ opioid receptors are bound by opioid analgesics, such as fentanyl and derivatives, the effects of which were seen in Moscow. The CCK-B receptor is linked to anxiety and whereas the authors suggest CCK-B antagonists as potential calmatives, agonists have been shown to induce panic attacks.

The ‘classical’ neurotransmitter serotonin (5-HT) is widely distributed in the nervous system seems to have a role in various aspects of human behaviour including sleep, mood, anxiety and aggression. Studies in humans and animals have shown that increased serotonergic function is associated with decreased aggressive behaviour and vice-versa.²⁵ Studies with monkeys have lead to other conclusions: “It is clear that serotonin does not simply inhibit aggression; rather, it exerts a controlling influence on risky behavior, which includes aggression.”²⁶ A potential ‘calmative technique’ the Penn State authors suggest is the use of a selective 5-HT_{1A} receptor antagonist, to “...reduce symptoms of anxiety in an individual or individuals and promote a calmer and more compliant behavioral state.”²⁷

One of the overall recommendations made in the Penn State report was the formation of partnerships between weapons developers and the pharmaceutical and biotechnology industries in order to identify new incapacitants. The implications of such partnerships are considerable in terms of the emergence of new agents acting on these or other receptors in the central nervous system. The reasons for this are two-fold. Firstly, there is already a significant research focus in the pharmaceutical industry to develop more effective drugs to treat a variety of mental illnesses, and many of the receptor targets, as we have seen, are the same as those of interest to incapacitant developers. Secondly there have been considerable advances in recent years of mechanisms for discovery and screening of new compounds. In addition, as noted in a paper from 2002, “It is apparent that the past decade has brought an enormous increase in knowledge about the pharmacology and structural biology of receptors.”

Wheelis has discussed the main technologies leading a ‘revolution in the drug discovery process’: combinatorial chemistry, genomics, microarrays, proteomics, toxicogenomics, and database mining.²⁸

In his 2002 paper he summarised the implications thus:

Currently, new compounds are generated in large numbers by combinatorial methods and assayed for potential activity by ultra-high-throughput screening techniques. In the future, genomic and proteomic methods ... will encourage increasing use of computer modeling techniques to identify new drugs. These same scientific developments will also rapidly deepen our understanding of physiological processes in both healthy and diseased states. This understanding will provide the necessary knowledge base for identifying new drug targets and for predicting the consequences of interfering with their normal functioning.²⁹

A UK Background Paper on Scientific and Technological Developments relevant to the BTWC from the 2001 Review Conference had reached a similar conclusion:

In the future, bioinformatics linked with high throughput methods for proteome and genome analysis, such as microarrays, will increasingly allow the rapid targeting of biological macromolecules for any purpose, peaceful or otherwise.³⁰

Earlier this year (2004) a new piece of software was announced to further speed up drug discovery. Reportedly it “...can screen 10 million molecules per day for their potential drug interaction with a model of the biological target molecule.”³¹

Even without future advances, the ability to misuse these technologies for harmful purposes is already present. Dando’s test for neurotransmitter-receptor systems is to ask the following question:

In regard to neurotransmitters where there is some good reason to suspect that there could be interest in abuse, have chemicals with specific actions on specific receptor sub-types been developed?³²

As he shows in his paper and as we have seen earlier in this analysis, the answer is yes.³³

Current Military and Police Interest

The US military’s research in this area is co-ordinated by Joint Non-Lethal Weapons Directorate (JNLWD). It is currently unclear the level at which research and

development is ongoing. However, a major recommendation of the 2003 report on non-lethal weapons (NLWs) science and technology, produced by the Naval Studies Board of the US National Academy of Sciences (NAS), was for increased research on incapacitating chemicals, or ‘calmatives’, and their delivery systems.³⁴ The report indicated that ‘calmatives’ are now being studied at the US Army Edgewood Chemical Biological Center (ECBC) after a “...lull in R&D for 10 years”.³⁵

The Sunshine Project has obtained a number of documents on the US programme through Freedom of Information (FOI) requests.³⁶ Recently they obtained several research proposals by the US Army Edgewood Research, Development and Engineering Center (ERDEC) (now Edgewood Chemical Biological Center (ECBC)) dated 1994 to develop ‘calmatives’ and ‘immobilizing’ agents.³⁷ Their fate is unclear but, as the Sunshine Project notice points out, a company named OptiMetrics, Inc., which subsequently employed the author of those proposals, won a contract with the Department of Defense in early 2000 to carry out the first phase of a study to assess incapacitants for use in military and law-enforcement applications.³⁸ This phase, which is now complete,³⁹ is described in the contract solicitation as follows:

Phase I studies will consist of a Front End Analysis comprising the following elements: review existing data on the candidate agents; define scenarios of use and operational parameters; conduct range finding toxicological animal tests, and correlate results with those from previous studies.⁴⁰

Meanwhile, objectives listed in the JNLWD’s Technology Investment Project for ‘Front End Analysis of Non-Lethal Chemicals’ for the fiscal year 2001/02 included:

- Identify advances in the pharmaceutical industry and elsewhere for potential non-lethal applications
- Conduct military user workshops to identify range of desired operational effects
- Create a searchable database of potential candidates
- Provide a list of promising candidates to Judge Advocate General’s office for preliminary legal review⁴¹

There is no reason why the US should be the only state interested in such weapons development. As events in Moscow illustrated, Russia clearly has a programme in this area and so may other countries. A Russian paper given to the 2nd *European Symposium on Non-Lethal Weapons* in 2003 addressed future perspectives for the use of NLWs in Europe, including ‘calmatives’:

Some experience of gas application in dramatic conditions of terrorists [sic] attack was gained in Moscow in 2002, when 800 hostages were seized in a big concert hall. The main problem now is how to assess an impact of chemicals on a big crowd of civilians and terrorists between them in a concrete scenario and real conditions of application.⁴²

The paper then speculates about the future:

There has been significant success in the chemistry of calmatives, although the restriction of individual dosage is very important. There is still no perfect tranquillizing agent, but the problem of safety can be solved by the succeeding or simultaneous application of calmativ and antidote. This can minimize potential fatality.⁴³

The UK currently appears to be less interested in incapacitant development if we are to judge by the latest report of the Northern Ireland Office (NIO) Steering Group investigating alternatives to the baton round for policing. Work on calmatives by the Police Scientific Development Branch (PSDB) has been downgraded from Category

B to Category C. The latter category is defined as including "...technologies that were not considered of immediate interest or importance."⁴⁴

For now their conclusion states "... that use of calmatives in policing situations would not be a straightforward process."⁴⁵ It continues:

The decision to use any drug whether intended to induce a state of calm or complete unconsciousness requires knowledge of a subject's medical history, particularly the use of any prescribed or non-prescribed medication and any relevant medical conditions. There would also be considerable responsibility in terms of immediate and post-incident aftercare.⁴⁶

The caveat given is that:

PSDB will continue to monitor this area, focussing on international research programmes and future developments in delivery methods and potential tranquilising agents.⁴⁷

As for the UK military, the Ministry of Defence and the US Department of Defense have collaborated on non-lethal weapons, including related wargaming,⁴⁸ through a 5-year Memorandum of Understanding signed in February 1998.⁴⁹ With regard to 'calmatives', a 2000 report of this collaboration illustrates the well-known differences in the UK and US interpretations of the Chemical Weapons Convention (CWC).⁵⁰ The UK would consider any use of 'calmatives' or riot control agents (RCAs) in warfare as a violation of the CWC. The same document also sheds light on the US strategy for avoiding scrutiny of military research on these types of agents:

If there are promising technologies that DOD [Department of Defense] is prohibited from pursuing, set up MOA [Memorandum of Understanding] with DOJ [Department of Justice] or DOE [Department of Energy].⁵¹

This year there have been mixed messages emerging from within the US as regards the future of these types of biochemical weapons. The Council on Foreign Relations 'Independent Task Force' on non-lethal weapons published a report in February 2004 recommending the following course of action for the US (at least in relation to military use of such weapons⁵²):

Take measures within the organizations of the CWC and the BWC, in the UN Security Council, and in the North Atlantic Treaty Organization (NATO) and other military organizations to put teeth into the promised response to any use in warfare of CW or BW agents, lethal or nonlethal, in order that U.S. forbearance in such use would indeed result in a world in which legitimate governments did not develop, possess, or use lethal or nonlethal BW or CW in the theaters of conflict.⁵³

The Pentagon's Defense Science Board (DSB) appears to take a different view, however. Their task force report on 'Future Strategic Strike Forces', also published in February 2004, concludes that the US military should consider "Non-lethal effects directed at the physiological or psychological functions of specific individuals or the populace", adding, "Applications of biological, chemical, or electromagnetic radiation effects on humans should be pursued."⁵⁴ In the section on 'strategic payload concepts' the authors set out their views on the future of incapacitating agents:

- Calmatives might be considered to deal with otherwise difficult situations in which neutralizing individuals could enable ultimate mission success
- The principle technical issue is the balance between effectiveness (i.e., the targets are truly "calmed") and margins of safety (i.e., avoiding overexposure and resulting fatalities of neutral bystanders)
- The treaty implications are significant⁵⁵

Conclusion

In 2003 three analysts from the US Defense Intelligence Agency (DIA) authored a paper entitled *Biotechnology: Impact on Biological Warfare and Biodefense*.⁵⁶ They warn of future advanced biological warfare (ABW) agents "...rationally engineered to target specific human biological systems at the molecular level." They conceive that weapons designers of the future will be able engineer agents that produce a range of effects "...including death, incapacitation, neurological impairment." Bioregulator-type agents are perhaps one such ABW. A paper in 2002, *An Evaluation of Bioregulators as Terrorism and Warfare Agents*, argued, "They are a potential new class of weapons that can damage the nervous system, alter moods, trigger psychological changes and even kill."⁵⁷ The DIA authored paper also suggests that because ABWs could be designed to have a wide range of effects they "...will expand options for employment significantly and ultimately may decrease the current threshold for the use of biological warfare."⁵⁸

It is worth remembering that the Soviet biological weapons effort, ostensibly halted as early as 1992, included programs to develop bioregulators as weapons to replace classical chemical weapons.⁵⁹ Indeed, the authors of the 2002 review of bioregulators argue that "Some of these compounds may be potent enough to be many hundreds of times more effective than traditional chemical warfare agents".⁶⁰

Research into biochemical weapons under the auspices of non-lethal weapons development threatens to accelerate these proposed futures by legitimising work in this area that has so far been seen as prohibited by the BTWC and the CWC. The Council of Foreign Relations report on non-lethal weapons fortunately recognised this very significant danger:

Nonmilitary research in biology and medicine will lead to understanding that can greatly facilitate the development, production, and use of lethal and largely nonlethal chemical and biological agents. But NLW-focused research will hasten the day that such materials are available not only to the United States but also to those who would use them against us.⁶¹

As a possible way to avert these consequences Mark Wheelis has suggested a new international convention prohibiting the non-consensual manipulation of human physiology for other than legitimate medical purposes.⁶²

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- ⁵ Davison, N. and Lewer, N. (2003) *op. cit.*
- ⁶ Klotz, L., Furmanski, M., Wheelis, M. (2003) *Beware the Siren's Song: Why "Non-Lethal" Incapacitating Chemical Agents are Lethal*. Washington D.C.: Federation of American Scientists (FAS). Available from http://www.fas.org/bwc/papers/sirens_song.pdf
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- ⁸ *Ibid.*
- ⁹ Stanley, T. (2003) Human immobilization: is the experience in Moscow just the beginning? *European Journal of Anaesthesiology*. 20, pp. 427-8.
- ¹⁰ This figure may have been higher, see Walsh, P. (2003) Families claim death toll from gas in Moscow siege kept secret. *The Guardian*, 18 October 2003. Available from: <http://www.guardian.co.uk/international/story/0,3604,1065611,00.html>
- ¹¹ Stanley, T. (2003) *op. cit.*
- ¹² We discussed this in our last report based on the following paper: Federation of American Scientists Working Group on Biological Weapons (2003) *Position Paper: Chemical Incapacitating Weapons Are Not Non-Lethal*. Washington D.C.: Federation of American Scientists (FAS). Available from: http://www.fas.org/bwc/papers/pp_chemical_incapacitants.pdf
- ¹³ Ketchum, J. and Sidell, F. (1997) Incapacitants. *In: Textbook of Military Medicine: Medical Aspects of Chemical and Biological Warfare*. Washington D.C.: Office of the Surgeon General, Department of the Army.
- ¹⁴ MacKenzie, D. (2002) Russian gas may be secret crowd-control weapon. *New Scientist*, 28 October 2002. Available from: <http://www.newscientist.com/news/news.jsp?id=ns99992974>
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- ¹⁷ In Moscow there were reports that many of the hostage-takers were executed by Russian Special Forces whilst unconscious. [See: BBC News (2002) How special forces ended siege. *BBC News*, 29 October 2002. Available from: <http://news.bbc.co.uk/1/hi/world/europe/2363601.stm>]
In Vietnam, where the US military used the riot control agent CS gas in large quantities, its effects were to enhance rather than reduce lethal force. [See: Allison, G, Kelley, P & Garwin, R. (2004). *Nonlethal Weapons and Capabilities*. Report of an Independent Task Force Sponsored by the Council on Foreign Relations. New York. Available from: http://www.cfr.org/pdf/Nonlethal_TF.pdf]
- ¹⁸ The Centers for Disease Control and Prevention (CDC) in the United States categorises various biological agents as posing a threat to US national security. There are three categories: A, B & C. Category A agents are considered to pose the greatest threat. See: <http://www.bt.cdc.gov/agent/agentlist-category.asp>
- ¹⁹ See for example: Coupland, R. M. (2003) Incapacitating chemical weapons: a year after the Moscow theatre siege. *The Lancet*, Vol. 362, p. 1346; Wheelis, M. (2003) "Nonlethal" Chemical Weapons: A Faustian Bargain. *Issues in Science and Technology*. Spring 2003. Available from: <http://www.nap.edu/issues/19.3/wheelis.htm>; Meselson, M. and Perry Robinson, J. (2003) 'Non-Lethal' Weapons and Implementation of the Chemical and Biological Weapons Convention. *20th Pugwash Workshop Study Group on the Implementation of the CBW Conventions: The BWC Intersessional Process towards the Sixth Review Conference and Beyond*. Geneva, Switzerland, 8-9 November 2003. Available from <http://www.pugwash.org/reports/cbw/cbw20/cbw20-meselson-robinson.htm>
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- ²⁷ Lakoski et al. (2000), *op. cit.*
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- ²⁹ Wheelis, M. (2002) *op. cit.*
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- ³¹ National Science Foundation (2004) *Virtual Screening Lab Zeroes in on New Drugs*. National Science Foundation News Tip, 16 March 2004. Available from: <http://www.nsf.gov/od/lpa/news/04/tip040316.htm>
- ³² Dando, M. (2003) *The Danger to the Chemical Weapons Convention from Incapacitating Chemicals*. CWC Review Conference Paper No.4, Department of Peace Studies, University of Bradford.
- ³³ *Ibid.*
- ³⁴ National Research Council (2003) *An Assessment of Non-lethal Weapons Science and Technology*. Washington D.C.: National Academies Press. Available from: <http://www.nap.edu/books/0309082889/html>
- ³⁵ *Ibid.*
- ³⁶ See: The Sunshine Project web site (Incapacitating and Anti-Material (Bio)Chemical Weapons): <http://www.sunshine-project.org/incapacitants/>
- ³⁷ Sunshine Project (2004) *The Return of ARCAD*. The Sunshine Project News Release, 6 January 2004. Available from: <http://www.sunshine-project.org/publications/pr/pr060104.html>
- ³⁸ *Ibid.*
- ³⁹ Ruppe, D. (2002) United States: U.S. Military Studying Nonlethal Chemicals. *Global Security Newswire*, 4 November 2002. Available from http://www.nti.org/d_newswire/issues/2002/11/4/7s.html
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- ⁴³ *Ibid.*
- ⁴⁴ Northern Ireland Office (2004) *Patten Report Recommendations 69 and 70 Relating To Public Order Equipment. A Research Programme Into Alternative Policing Approaches Towards The Management of Conflict. Phase Four Report*. Northern Ireland Office: U.K. Available from: <http://www.nio.gov.uk/pdf/batonrep2004.pdf>
- ⁴⁵ *Ibid.*
- ⁴⁶ Northern Ireland Office (2004) *op. cit.*
- ⁴⁷ Northern Ireland Office (2004) *op. cit.*
- ⁴⁸ *US/UK Non-Lethal Weapons/Urban Operation Wargame*, US Marine Corps web site: <http://www.wargaming.quantico.usmc.mil/Programs/USUKNLW.cfm>
- ⁴⁹ House of Commons (2001) *Non-lethal weapons, House of Commons Hansard Written Answers for 10 Apr 2001 (pt 9)*. House of Commons: UK. Available from: <http://www.parliament.the-stationery-office.co.uk/pa/cm200001/cmhansrd/vo010410/text/10410w09.htm>
- ⁵⁰ *US/UK Non-Lethal Weapons (NLW)/Urban Operations Executive Seminar, 30 November 2000, London, UK*. Report available on The Sunshine Project web site: <http://www.sunshine-project.org/incapacitants/jnlwdpdf/usukassess.pdf>
- ⁵¹ *Ibid.*
- ⁵² Note: the report does not discuss law enforcement use of such agents.

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