The struggle to ban chemical weaponry: Lessons from World War I to the present

Peter Nicholls examines the development and use of chemical weapons over the last 100 years, especially during World War I, highlighting some of the ethical debates involving scientists and policy-makers.

The reappearance of chemical weapons with casualties in the hundreds in Syria is a depressing development whatever the political or military context and whoever is responsible.[1] Of all the scientific disciplines, chemistry may sustain the closest relationships between the research and its commercial uses, as illustrated by Primo Levi's well-known experiences as a chemist in 1940s Italy.[2] Since the days of alchemy, the discipline has been a struggle for wealth and power as well as knowledge. And then from a profitable commercial role it attracts the interest of the state and the military.

The road to chemical weapons use in WWI

Lewisite ($Cl\text{-}CH{=}CH\text{-}As(Cl)_2$) was first synthesised in 1904 by a young graduate student, Julius Arthur Nieuwland, who also happened to be a catholic priest, during studies for his doctorate.[3] Exposure to his own compound sent him to hospital. He worried about its use as a possible poison gas and decided not to publish too much. But his discovery was taken up again in 1918, too late for military use in World War I but in time for massive inter-war stockpiling in the USA, Japan and elsewhere.[4]

The turn of the nineteenth to the twentieth centuries had seen an increased development of chemicals and microbes to be employed in war. Use was only seen as morally problematic by political and military leaders in a series of very slow steps. Covert or even treacherous use was regarded by many as acceptable. For example, in the North American 'Indian' wars of the late eighteenth century, Lord Amherst[5,6] welcomed the availability of small pox infested blankets given to the fractious Native Americans.

So it was also considered acceptable for one of the most accomplished German scientists, Fritz Haber, friend of Einstein, to develop a German gas warfare programme in WWI.[7,8] Haber, who went on to win the 1918 Nobel prize in chemistry for his creation of the Haber process for nitrogen fixation, also 'optimized' the military use of the gases chlorine (Cl_2) and phosgene ($COCl_2$) which initially had some success in causing enemy soldiers to abandon their trenches and retreat. The group Haber assembled (James Franck, Otto Hahn, Richard Willstatter, Heinrich Wieland and others, many eventual Nobelists) worked on both chemical attack and defence (the two sharing much of the science). It was an amazing team that would be hard to match for scientific ability in any field. Willstatter and Wieland went on to begin modern enzymology and Franck and Hahn to become nuclear physicists, in Franck's case helping develop the atomic bomb. Franck thus has the dubious distinction of having worked on two weapons of mass destruction.

Haber paid a high personal price for his work. After a reported argument over the work, his young wife Clara committed suicide, shooting herself with Haber's own officer's revolver. To assuage his grief

Table 1a. A partial list of poison gas preparation and usage in World War 1 (and immediately thereafter)[a,c]

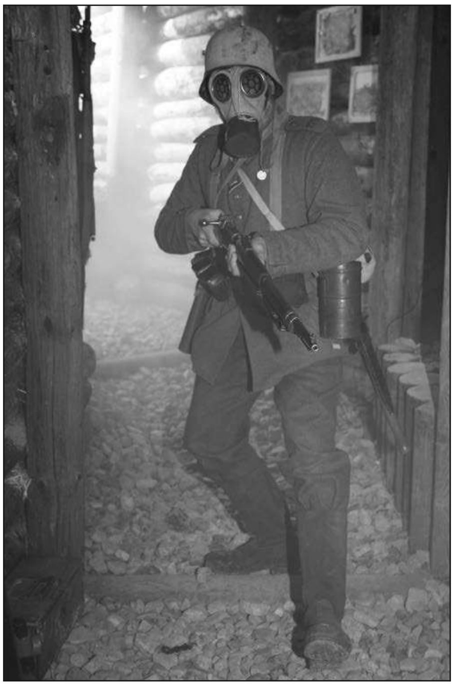
Gas	Type	Date of first significant use	First use location	Responsibility	Casualties	Deaths
ethyl bromacetate	tear gas	Aug 1914	Western front	France	?	0
xylyl bromide	tear gas	Jan 1915	Russian front	Germany	?	?
chlorine	respiratory	Jan/Apr 1915	Ypres	Germany	7,000	350
chlorine	respiratory	Aug 1915	Russian front	Germany	>>9,000	>>1,000?
chlorine	respiratory	Sept 1915	Loos	Britain	low	0?
phosgene	respiratory	Dec 1915	Ypres	Germany	>1,000	69
mustard gas	vesicant	Jul 1917	Ypres	Germany	?	?
hydrogen cyanide	systemic respiration	1917	Arras	France & Britain	low	very low
lewisite	vesicant/ respiratory	stockpiled/ not used	---	USA	0	0
diphenyl chlorarsine	tear gas/ irritant	1919	Russia	UK	?	?
Total WW1	**all**	**1914-1918**	**all fronts**	**all combatants**	**1,240,000**	**~88,500**

Table 1b. Recent examples of poison gas preparation and usage in war[b,c]

Gas	Type	Date of first significant use	First use location	Responsibility	Casualties	Deaths
sarin	nerve	1984+	Iran	Iraq	~100,000?	~20,000?
sarin/tabun	nerve	1988	Kurdistan	Iraq	?	~5,000
sarin/tabun	nerve	2013	Ghouta	Syria?	3,600	400-1,400

References

a. Wikipedia entry (2014) http://en.wikipedia.org/wiki/Chemical_weapons_in_World_War_I and other websites referenced therein.
b. Wikipedia entry (2014) http://en.wikipedia.org/wiki/Ghouta_chemical_attack and other websites referenced therein.
c. Spiers, E. M. (2010) A history of chemical and biological weapons. Reaktion books..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World War I soldier in a gas-mask (reconstruction)

Haber returned immediately to the front, before her body was buried. His team continued to develop the chemical weapons. Their effectiveness varied. As recent Syrian and Iraqi events show, they are deadly in terrorist mode against civilians. Military usefulness in WWI was relatively low against well-protected and gas-masked troops. Less well-equipped soldiers on the Eastern front were decimated. Chlorine, phosgene, and mustard gas ($Cl(CH_2)_2S(CH_2)_2Cl$) were all tried out on the battlefield by both sides – see Table 1.

The UK and chemical weapons

After the war, the Royal Air Force dropped diphenyl chloroarsine, an irritant agent designed to cause uncontrollable coughing, on Bolshevik troops in Russia in 1919.[6] Winston Churchill, then secretary of state 'for war and air', suggested that the RAF should use chemical agents in the Middle East during an Iraqi 'revolt' in 1920. We do not know whether gas was actually used[6] but the then British Manual of Military Law[9] stated that the rules of war applied only to conflict "between civilised nations" and "they do not apply in wars with uncivilised States and tribes". Churchill's position was also without nuance, as illustrated by the quotes in Box 1.

Such views were independent of political party and not just a shibboleth of right-wingers. Geneticist, enzymologist and communist J. B. S. Haldane also enthusiastically endorsed gas warfare in a little book (Callinicus) dedicated to this topic, named after a supposed Greek philosopher probably invented by Haldane for the role.[11] Churchill and Haldane were expressing these views before the invention of the brutally lethal nerve gases. Whether sarin and tabun would have caused them to rethink their position we do not know.

Box 1. Winston Churchill's comments on chemical weapons, 1919

"I do not understand this squeamishness about the use of gas. We have definitely adopted the position at the Peace Conference of arguing in favour of the retention of gas as a permanent method of warfare. It is sheer affectation to lacerate a man with the poisonous fragment of a bursting shell and to boggle at making his eyes water by means of lachrymatory gas."

"I am strongly in favour of using poisoned gas against uncivilised tribes. The moral effect should be so good that the loss of life should be reduced to a minimum. It is not necessary to use only the most deadly gasses: gasses can be used which cause great inconvenience and would spread a lively terror and yet would leave no serious permanent effects on most of those affected."

Source: War Office[10]

The 'defence' of the weapons was of course only needed if there was a critique. International legal and moral doubts had begun quite early. A 'use' ban was proposed in the Hague convention of 1899 and reemphasized by the Geneva agreements of 1905. Article 23 states that it is especially prohibited to employ poison or poisoned armaments.[12] The initial impetus was against the poisoning of food and water supplies, a treacherous activity with a seedy history that long predated any chemical knowledge. Gas was new. Only after its use in WWI did the nations pay serious attention, which led to the Geneva protocols of 1925.

Britain signed and ratified the relevant Geneva Protocol on 9 April 1930, which banned the use of toxic gases and bacteria in war, although not the development and production of these weapons. The UK military consequently carried out extensive testing of chemical weapons from the early 1930s onwards until fairly recently. In the Rawalpindi experiments, hundreds of Indian soldiers were exposed to mustard gas in an attempt to determine the appropriate dosage to use on battlefields.[13] Many of the subjects suffered severe burns from their exposure to the gas. Subsequent illnesses caused by carcinogen use were not tracked.

It took until the 1990s for the UK to get rid of its stocks, signing the Chemical Weapons Convention on 13 January 1993 and ratifying it on 13 May 1996. Britain had a long time to conform. There was a 70 year gap between the 'use' ban and the 'possession' ban.

Moving towards a total ban

The usual pattern with weapons of mass destruction, when the initial Churchillian and Haldanian enthusiasm has worn off, is firstly to claim that the research programmes involved are only defensive in nature, and finally that they even have positive aspects, usually medical benefits. Such attempts to make threat research defensive, and then useful, have been a common theme in the negotiations over the banning or control of chemical, biological, and nuclear weapons.

Post-WWI the US military was anxious not to lose its chemical warfare programmes.[14] Chlorine gas was therefore touted as a common cold cure. President Calvin Coolidge and his wife allowed themselves to be used as guinea pigs to show the benefits of breathing low levels of Cl_2.[15] As far as we know they survived the experiment unscathed. Similarly the UK biological warfare centre at Porton Down is now characterised as a medical research facility.[16]

UK nuclear weapons work at Aldermaston is similarly justified in part by its advocates because it is related to transparency and nuclear disarmament verification. Iran justifies its work to enrich uranium to levels greater than 10% U-235 by reference to the production of medically important radiochemicals. We do have a partial nuclear weapons possession ban, the Nuclear Non-Proliferation Treaty (in force since 1968!), but it is flawed because it provides no time frame for the agreed nuclear disarmament by the five recognised nuclear weapons states (USA, Russia, China, France and the UK). There is no current legally binding ban on the *use* of nuclear weapons although the 1996 advisory opinion of the International Court of Justice has some force. *De facto* if not *de jure* the military use of such weapons is banned. Had the possibility of nuclear weapons been foreseen by those who negotiated the Geneva Conventions of 1925 they would almost certainly been placed in the same category as chemical and biological weapons.

The medical 'defence' often has some validity which means that all of us in the chemical and biochemical research business need to remain vigilant. Some poisons do have beneficial effects at low concentrations – a kind of scientifically accepted homeopathy. There are even those who think this applies to radiation (the hormesis theory). But certainly sulphide, carbon monoxide and nitric oxide (breathing of which probably eventually killed its discoverer Joseph Priestley) all show beneficial hormonal 'gasotransmitter' action at low levels while acting as respiratory inhibitors at higher levels. The commonest respiratory inhibitor, cyanide, was ineffective as a military poison gas but came to be of practical use starting during WWI as an insecticide, a defence against vermin in the trenches. It was also adopted as a US execution device, and ultimately by the Nazi's as the reagent of choice for the Holocaust under the name of Zyklon B. Some early twentieth century physicians recommended very low cyanide levels as therapeutic in some respiratory ailments. (It is not available on the NHS!)

We have become more cautious about laboratory use of volatile poisons (see Box 2) and their availability is controlled by cautious risk assessment. Does the ongoing chemical disarmament of Syria presage a corresponding control and subsequent removal of chemical weapons? We hope so but we still await ratification of the Chemical Weapons Convention, not only by Syria but also by states such as Israel and Egypt. Disarmament of all kinds remains a slow process.

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Update

According to the latest update (20 October 2014) from the Organisation for the Prohibition of Chemical Weapons, over 97% of Syria's stockpile has now been destroyed. See:
http://www.opcw.org/special-sections/syria/destruction-statistics/

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Box 2. Personal experience: the Janus faces of biochemistry

Academic biochemistry comes with spin-off dangers as well as benefits. As a graduate student in the late 1950s I had industrial contacts, but chose to stay academic. Like Nieuwland (see main text) I came across a strong enzyme inhibitor.[i] But the enzyme involved, catalase, is not immediately required for life by the organism. It plays a long term role in controlling 'reactive oxygen' species and thus has consequences for health and longevity. And my inhibitor, sodium hypophosphite, is not volatile so could not be used as a gas weapon. But I thought for a moment about possible similarities to the organophosphate analogues that led to the development of nerve gases.

Later, in research on cell respiration, I used of 'British antilewisite', BAL, ($HSCH_2$-CH(SH)-CH2OH), an antidote developed by UK World War II chemical warfare defence research chemists.[ii,iii] There was a real fear during WWII that lewisite would be used as a weapon, either in battle or as a terror device against civilians. Chemically reactive 'gas warning' boards were set up on posts quite widely in town and country, and children were trained in gas mask use. I had to carry mine to and from school for a while. My baby brother had one with a Mickey Mouse 'face'… BAL is something of a kill or cure antidote. Effective in alleviating lewisite poisoning it is itself a respiratory inhibitor.[iv] Many UK scientists were involved, with a large Cambridge contingent, notably Peter Mitchell (later a senior colleague in my field, Nobel 1978). They made a significant contribution by creating a BAL version less toxic than the original.[v] Fortunately the antidote was never needed in WWII, and its research role as respiratory inhibitor was later replaced by more specific compounds.

I am still in the poisons business – using cyanide, nitric oxide and sulphide as research tools in studying the mechanisms and control of oxidative enzymes. My PhD supervisor David Keilin would cheerfully mouth pipette cyanide and one day 'froze' his tongue by taking a small aliquot into his mouth. His co-worker Ted Hartree used to prepare the 8% HCN constant boiling solution (Scheele's acid) by distilling HCN from KCN and acid. There was a useful large bottle of this immensely toxic acid stored in the refrigerator. Using it neat for a few minutes gave me a headache. Casual attitudes to laboratory safety reflected a more general lack of concern about dangers, both to researchers and others. Today the university is obligated both under health and safety laws, and by national legislation (Chemical Weapons Act 1996 and subsequent regulations) due to UK ratification of the Chemical Weapons Convention, to maintain careful control of and report on toxic chemical holdings. 'COSHH' assessments are in place everywhere and we are obligated to train students and other new workers in correct handling and usage. Some chemicals are banned. Much of this was unthinkable when I was a research student. The past is indeed another and harsher country.

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