

## Chemical Weapons



Chemical weapons are prohibited, but recent chemical weapons attacks in Malaysia, Syria, Iraq and the UK have raised concerns about their use. This POSTnote gives an overview of chemical weapons, including modes of delivery and effects on human health. It also examines the status of international disarmament, and defence against chemical weapons in the UK.

### Background

'Chemical weapons' refers to the use of toxic chemicals to inflict deliberate harm to humans or animals. Chemical weapons were first used on a large scale during World War I, causing an estimated 90,000 deaths and 1.3 million casualties.<sup>1,2</sup> They are prohibited by the Chemical Weapons Convention (CWC, Box 1), which entered into force in 1997.<sup>3</sup> There are 193 states committed to the CWC, which is implemented by the Organisation for the Prohibition of Chemical Weapons (OPCW, Box 1).<sup>3,4</sup>

There have been numerous recent reports of chemical weapons attacks. An analysis by Human Rights Watch identified 85 attacks in Syria between August 2013 and February 2018.<sup>5,6</sup> Joint OPCW-UN investigations in Syria attributed four chemical weapons attacks to the Syrian Government, and two to Daesh.<sup>7</sup> Other instances include reported uses of chemical weapons by Daesh in Iraq, and the alleged assassination of Kim Jong-nam using the nerve agent VX.<sup>8,9</sup> In the UK in 2018, four people were taken seriously ill and one person died following exposure to a Novichok, a type of nerve agent (Boxes 2 and 3).<sup>10-12</sup>

The international response to events in Syria has so far included official investigations, airstrikes on chemical weapons infrastructure and a new method to attribute responsibility for chemical weapons use.<sup>13-16</sup> In March 2018, the UK Government announced a £48m investment in the

### Overview

- Chemical weapons use toxic chemicals for deliberate harm to humans or animals.
- Chemical weapons attacks take many forms, depending on the chemical agent, method of exposure, and the target.
- Many toxic chemicals that could be used as weapons also have legitimate uses.
- The Chemical Weapons Convention has driven efforts for disarmament and control.
- The Organisation for the Prohibition of Chemical Weapons oversees disarmament, monitors chemicals and investigates alleged attacks.
- Incident response involves many agencies working to treat victims, minimise impacts, and support investigation.

Chemical Weapons Defence Centre at Porton Down, which will include new chemical analysis laboratories.<sup>17</sup> It also announced £11m to strengthen the UK's response to chemical weapons attacks in March 2019.<sup>18</sup>

Chemical weapons attacks can occur in different contexts, including armed conflict, assassinations and terror attacks; and may be carried out by state or non-state actors.<sup>19</sup> As of January 2019, nearly 97% of the stockpiles declared by states under the CWC had been verifiably destroyed.<sup>3</sup> However, there are concerns that some states possess undeclared stockpiles, and that the threat from non-state actors is increasing.<sup>20-22</sup> In addition, the issue of attributing responsibility for chemical weapons use has created political tensions between some CWC States Parties.<sup>23,24</sup>

This POSTnote provides an overview of:

- Types of chemical weapons and modes of delivery
- Chemical weapons control (disarmament and inspection)
- Investigations of alleged incidents (including attribution)
- UK measures for preventing, preparing for and responding to a chemical weapons attack.

### Types of Chemical Weapon

A chemical weapons system has several components – a chemical warfare agent, a delivery device and associated equipment (such as dispersal equipment). If intended for chemical weapons use, the CWC considers each of these a chemical weapon, whether stored together or apart.<sup>25</sup>

**Box 1: The Chemical Weapons Convention**

The Chemical Weapons Convention (CWC), which entered into force in 1997, is an arms control treaty that bans the development, production, acquisition, stockpiling, retention, transfer and use of chemical weapons.<sup>26</sup> It was passed into UK law by the Chemical Weapons Act 1996.<sup>27</sup> States not signed up to the CWC are Egypt, North Korea, and South Sudan. Israel has signed but not ratified the CWC.<sup>28</sup> The CWC requires States Parties to:

- Declare and destroy stockpiles within a certain timeframe
- Comply with a verification regime to monitor certain chemicals
- Adopt national laws against prohibited activity.

The Organisation for the Prohibition of Chemical Weapons (OPCW) is the international body responsible for implementing the CWC. It:

- Verifies the destruction of declared chemical weapons stockpiles
- Monitors certain chemicals and production facilities
- Carries out investigations into alleged attacks, which aim to be scientifically rigorous and impartial<sup>29,30</sup>
- Assists states to prepare for and respond to incidents.<sup>4</sup>

**Chemical Warfare Agents**

Toxic chemicals are chemicals that can cause death, temporary incapacitation or permanent harm.<sup>31</sup> A limited number of toxic chemicals have historically been used as weapons. However, the CWC definition of chemical weapons includes any toxic chemicals, and the reactants used in their production (precursors), if intended to cause harm to humans or animals.<sup>25</sup> Chemical warfare agents are grouped into types depending on their effects (Box 2).<sup>32</sup> The CWC specifies 'allowed purposes' for toxic chemicals, such as industrial or research use.<sup>33</sup> Many toxic chemicals and precursors are 'dual-use', meaning they have permitted uses but could be used as weapons.<sup>34</sup> For example, chlorine is used for water treatment, but can also be used as a choking agent (Box 2).<sup>35,36</sup> The OPCW monitors certain toxic chemicals and precursors to ensure that they are only used for allowed purposes (Box 4).

**Modes of Delivery**

Chemical weapons require a method to deploy the toxic chemicals.<sup>32</sup> Methods include explosive release (for example, using bombs or grenades), dispersal as a spray or a gas, or novel methods (such as gels or creams).<sup>19,37,38</sup> The method depends on the properties of the chemical, including its persistence (how quickly it disperses).<sup>32</sup> Non-persistent agents disperse quickly on release. They include volatile liquids that readily evaporate, such as sarin, and gases, such as chlorine.<sup>36</sup> Persistent agents, such as VX, are less volatile, so they cause longer term contamination.<sup>36</sup>

'Binary weapons' are stored as two less toxic precursors that are mixed together when needed to form the toxic agent.<sup>32</sup> This reduces the risk of detection or unintended exposure. For example, some sarin munitions hold two precursors in separate compartments until deployment.<sup>39</sup>

**Forms of Attack**

Chemical weapons attacks take different forms depending on the capability and the aims of those carrying them out.<sup>40</sup> Military applications have traditionally disseminated chemical weapons using explosives or sprays, either to attack or as a tactic to prevent access to terrain.<sup>38,41,42</sup>

**Box 2: Types of chemical warfare agents**

- **Nerve agents** are the most toxic of known chemical agents and can cause irreversible damage or death.<sup>43</sup> They affect the normal functioning of the nervous system and can cause convulsions and loss of muscle control.<sup>44</sup> Three main classes are known: the G-series (sarin, tabun and soman), the V-series (including VX) and Novichok agents. While open literature reports some information on Novichoks, many details remain protected or unknown.<sup>45,46</sup> They fall under the CWC definition of a chemical weapon but, unlike other nerve agents, are not named in its Schedules (Box 4). Since the events in the UK, the OPCW has worked to clarify the chemical definition of 'new types of nerve agents',<sup>47</sup> and is considering two sets of proposals for specific chemicals, and families of chemicals, to be added to the Schedules.<sup>48</sup>
- **Blister agents** cause skin blistering, eye irritation and lung damage.<sup>36</sup> Exposure is rarely fatal if appropriate medical care is available.<sup>49,50</sup> They are typically liquids that are dispersed into the air. Examples include sulphur mustard and lewisite.
- **Choking agents** irritate the lungs and can be fatal.<sup>36</sup> They are typically gases such as phosgene, ammonia and chlorine.
- **Blood agents** interfere with the body's ability to use oxygen and are potentially fatal.<sup>49</sup> They can be gases or liquids. Examples include hydrogen cyanide and cyanogen chloride.<sup>51</sup>
- **Riot control agents** are irritants, such as tear gas or pepper spray, which temporarily cause pain to the eyes, airways or skin.<sup>52</sup> Their use is permitted for law enforcement.<sup>25</sup> However, there are concerns about dangerous or otherwise inappropriate misuse.<sup>53</sup>
- **Central Nervous System (CNS)-acting agents** cause unclear thoughts or alter consciousness, with symptoms including paralysis and hallucinations.<sup>54</sup> Examples include BZ, anaesthetics, and opioids.<sup>55-57</sup> They may cause temporary incapacitation, but can be fatal. Due to the potential dangers of their misuse, some States Parties are calling for tighter controls.<sup>58</sup>
- **Herbicides** damage plants or crops.<sup>59</sup> The use of herbicides in warfare is prohibited by other aspects of international law.<sup>26,60</sup> However, herbicides are classed as chemical weapons if used for intentional harm to humans or animals.<sup>25</sup>
- **Toxins** are naturally occurring chemicals that can be classified as both biological and chemical weapons.<sup>61</sup> For example, ricin and saxitoxin are listed in the CWC.<sup>26,49</sup> To date, there have been two prosecutions under the Chemical Weapons Act 1996 for the production or purchase of chemical weapons, both involving ricin.<sup>62</sup>

An assassination is likely to use a localised method such as contamination with a persistent agent. In Salisbury (Box 3), police identified a door handle as a likely exposure route.<sup>63</sup>

The likelihood of a terror attack involving chemical weapons is assessed to be lower than for some other methods, which are more reliable and easier for terrorists to use.<sup>64,65</sup> However, policymakers and experts, including the OPCW, have expressed concern over terrorists' continued interest in the use of chemical weapons.<sup>8,22,66,67</sup> Due to the extremely toxic nature of nerve agents, a small quantity could have severe impacts. However, they are complex and dangerous to produce or acquire.<sup>68</sup> A chemical terror attack may use less toxic, more readily accessible chemicals and delivery methods (such as improvised explosive devices).<sup>66,69,70-72</sup>

**Chemical Weapons Control**

As part of its remit, the OPCW oversees the destruction of chemical weapons stockpiles and carries out inspections.

**Destroying Stockpiles**

States signed up to the CWC are required to declare and

**Box 3: Nerve agent use in the UK in 2018**

Five people were poisoned by a nerve agent in two separate, but related, UK incidents in 2018.

**Salisbury Incident** (March 2018): Sergei Skripal and his daughter Yulia were poisoned by a toxic chemical, and a police officer was exposed during the response.<sup>73</sup> Analysis by the MoD's Defence Science and Technology Laboratory (DSTL) and the OPCW confirmed that the chemical was a Novichok nerve agent (Box 2).<sup>74,73</sup> The victims survived after intensive medical care.<sup>75,76</sup> The UK Government identified Russia as responsible for the attack.<sup>11</sup>

**Amesbury Incident** (June 2018): Charlie Rowley and Dawn Sturgess fell ill after exposure to a Novichok, via a perfume bottle which police believe to have been discarded by the suspects after the Salisbury attack.<sup>77</sup> Dawn Sturgess died in hospital.<sup>78,79</sup>

destroy their chemical weapons stockpiles. The first deadline for destruction was 2007. Due to the difficulty and expense of destruction, no States Parties met the original deadline and the OPCW agreed to a series of extensions.<sup>80</sup> States signed up after 2007 are required to complete destruction 'as soon as possible'. The US is the only state which still possesses a declared stockpile, with destruction expected to end in 2023.<sup>19</sup> Although a Novichok was identified in the UK incidents, no State Party has declared any Novichoks to the OPCW.<sup>81</sup> Destruction of Syria's declared stockpile was completed in 2016, but further attacks have led to questions about gaps and inconsistencies in its declaration.<sup>82-84</sup>

States Parties are responsible for the destruction of their own stockpiles, under monitoring by the OPCW.<sup>80</sup> Other states may provide support in certain circumstances.<sup>85,86</sup> Chemical weapons are destroyed in a controlled way using heat, chemical reaction or biological degradation.<sup>87,88</sup>

During conflict, there may be instances when chemical weapons are destroyed on the battlefield, leading to a risk of chemicals being dispersed unintentionally.<sup>89,90</sup> Certain measures can reduce the risk, for example, high explosive power can incinerate the chemical as much as possible, but still carries some risk to the vicinity.<sup>91,92</sup> In 2018, the UK and US Governments launched a competition to find methods for battlefield disposal of chemical and biological weapons.<sup>93</sup>

**Inspections**

States Parties to the CWC are required to declare chemical weapons and monitored chemicals (Box 4), and associated production, storage and destruction facilities to the OPCW.<sup>94</sup> The OPCW then carries out inspections at the declared facilities.<sup>94</sup> If non-compliance is suspected, States Parties can request that the OPCW carries out a short-notice 'challenge inspection' in another State Party.<sup>95,96</sup> No challenge inspections have ever been requested.<sup>94</sup>

**Investigating Alleged Use**

Various bodies investigate alleged chemical weapons use, including journalists, NGOs, governments, and international bodies.<sup>97-100</sup> However, the OPCW is the primary internationally recognised body for official investigations. The OPCW carried out its first formal investigations in response to incidents in Syria.<sup>82,83</sup> States may also request technical assistance from the OPCW to support their own

**Box 4: Schedules of Toxic Chemicals in the CWC**

Toxic chemicals and precursors monitored under the CWC are placed into one of three groups.<sup>34</sup>

**Schedule 1** chemicals have primarily military purposes and few or no legitimate uses. Examples include nerve and blister agents.<sup>34</sup>

**Schedule 2** chemicals have legitimate uses but are not produced in large quantities. Examples include certain chemicals used to manufacture fertilizers and pesticides.<sup>34</sup>

**Schedule 3** chemicals have significant legitimate uses. They are produced in large commercial quantities. Examples include chemicals used to manufacture paint thinners, cleaners and lubricants.<sup>34</sup>

investigations. For example, the UK requested OPCW analyses of samples in 2018 (Box 3).<sup>11,74</sup>

**Reviewing Evidence**

Chemical weapons investigations may use:

- Material evidence, such as environmental samples, remnants of munitions, and biomedical samples from humans or animals (such as blood, urine or hair).<sup>31</sup>
- Testimonial evidence, such as accounts from eyewitnesses, first responders and victims.<sup>31</sup>
- Documentary evidence, such as videos, images and medical or military records.<sup>31,101</sup> Smartphones and social media can provide a large amount of open source documentary evidence, however this can also contribute to conflicting reports about an incident.<sup>102-106</sup>

Investigators verify the source of evidence, document how it is handled, and use OPCW Designated Laboratories to analyse samples.<sup>107</sup> However, timely access to evidence can be challenging, especially if there are security concerns at the site, or if any parties do not cooperate.<sup>108,109</sup> It may not be possible to confirm that all evidence is free from interference.<sup>110</sup> Other challenges relate to impartiality, including potential bias in witness accounts.<sup>111</sup> Where there is room for doubt, this can be used to dispute findings. For example, although most States Parties have accepted the OPCW's findings in Syria, Russia has stated that there were several shortcomings, including that some analyses were carried out without visiting the sites.<sup>112-114</sup>

**Attributing Responsibility**

Attributing responsibility for a chemical weapons attack enables the international community to hold perpetrators accountable, deterring future use.<sup>21,115</sup> However, attribution carries large political implications. Until recently, the OPCW did not seek to name perpetrators. Attribution for chemical weapons attacks in Syria was carried out via an OPCW-UN joint mechanism from 2015 until 2017, when its mandate expired after several vetoes by Russia at the UN Security Council.<sup>116</sup> In response, the UK led a joint initiative to give the OPCW its own attribution powers.<sup>14</sup> In June 2018, 82 States Parties voted in support of the move, while 24 opposed it, many with concerns that it may compromise the neutral role of the OPCW.<sup>13, 22</sup> A new OPCW budget for attribution was approved in November 2018.<sup>117,118</sup> This was followed by a five-yearly review of the CWC where, for the first time in CWC history, States Parties did not reach consensus on the final report.<sup>23,118,119</sup>

If states do not comply with the CWC, the OPCW can impose CWC-related measures on States Parties, such as restricting voting or trade rights.<sup>31,120</sup> In serious cases, it may bring the issue to the attention of other States Parties or the UN.<sup>120</sup> Other bodies may use OPCW evidence.<sup>121</sup> For example, the EU can impose sanctions for those involved in chemical weapons use.<sup>122</sup>

## Chemical Defence in the UK

Various UK military and civilian bodies are responsible for chemical, biological, radiological and nuclear (CBRN) defence (Box 5). This includes a system of integrated measures to prevent, prepare for, respond to, and recover from a chemical weapons attack.

### Prevention

The first line of defence against a chemical weapons attack is the control of chemicals via the CWC and legislation such as the Chemical Weapons Act 1996.<sup>27,62</sup> The UK's counter-terrorism strategy includes a range of measures to detect and prevent terrorist access to materials of concern, with support from the chemicals industry and other businesses.<sup>123-125</sup> The Centre for the Protection of National Infrastructure (CPNI) recommends security measures for organisations to mitigate against a chemical weapons attack, such as mail screening.<sup>126</sup>

### Planning and Preparedness

Planning and preparedness involves a range of measures to ensure that the response to a CBRN incident is timely and effective.<sup>127,128</sup> The Government's National Risk Assessment includes an assessment of CBRN threats.<sup>65,129</sup> The emergency services have developed joint guidelines for responding to CBRN incidents. They, the Government, and the armed forces hold practice response exercises.<sup>130</sup> The Defence CBRN Centre and the National CBRN Centre provide training to military and civilian organisations.<sup>131</sup>

### Incident Response

#### *Emergency Response*

In a UK CBRN incident, emergency services and local authorities would coordinate a response at local level, with support from the National CBRN Centre.<sup>132,133</sup> This includes an initial response by the first emergency services at the scene, such as the removal of clothing and improvised decontamination, using materials close to hand. A more extensive response follows, involving multiple agencies. Specialist units are deployed that can treat victims, protect the public and investigate the incident while remaining protected from contamination.<sup>132,134</sup> The armed forces may also provide support.<sup>135</sup> Responders can access scientific advice from DSTL and Public Health England via the Emergency Coordination of Scientific Advice mechanism.<sup>129</sup> A Science and Technical Advice Cell (STAC) may provide advice to the police commander,<sup>129</sup> while the Scientific Advisory Group for Emergencies (SAGE) advises the Cabinet Office Briefing Room (COBR) meetings, if called.<sup>136</sup>

The Government has highlighted the importance of clear communication with the public during civil emergencies.<sup>137</sup> There is debate about whether there is a need for pre-

#### **Box 5: Government Bodies Involved in UK CBRN Defence**

Several Government bodies are responsible for CBRN capability, including the Cabinet Office (Civil Contingencies Secretariat), the Home Office, and Defra (CBRN Emergencies Team).<sup>128,138,139</sup> NHS bodies plan the health system response.<sup>140</sup> The UK National Authority, within BEIS, is responsible for implementing the CWC.<sup>62</sup> The MoD manages the chemical defence capabilities of the armed forces, including a Specialist Counter CBRN Unit.<sup>141,142</sup> CBRN threats are within the remit of bodies working on national security, such as the Centre for Protection of National Infrastructure (CPNI) within MI5, and the National Counter Terrorism Security Office (NaCTSO).<sup>126,143</sup>

emptive public education about CBRN risks. While this may improve public understanding, there are concerns it could lead to undue panic.<sup>40,129,144</sup> The Commons Science and Technology Committee recommended that the Government produce guidance for the public on CBRN incidents.<sup>129</sup>

#### *Medical Counter-measures*

Depending on the type, chemical agents can take effect in minutes or hours.<sup>36</sup> Emergency medical counter-measures, such as skin decontamination kits or nerve agent antidote injectors, can provide treatment prior to full medical care.<sup>145-147</sup> Subsequent medical treatment generally focusses on managing symptoms and signs, such as treating burns in blister agent victims.<sup>36,49</sup> Antidotes are available for some agents, such as cyanide, lewisite and nerve agents.<sup>36,49</sup> Specialist ambulances deployed to CBRN incidents contain some medical counter-measures.<sup>148</sup>

#### *Detection, Identification and Monitoring*

The fire service, police and armed forces have detection, identification and monitoring (DIM) capabilities.<sup>132</sup> 'Detection' confirms whether a substance of concern is present, using techniques such as colour-changing paper and electronic detectors.<sup>149,151</sup> 'Identification' refers to more detailed analyses to determine which material is involved.<sup>149</sup> 'Monitoring' is the process of continuing to check whether hazardous material is present.<sup>149</sup>

DIM technologies vary depending on whether the sample is a solid, liquid or gas, and the detail and accuracy required. For example, specialist ambulance crews have personal gas detectors to warn of hazards, while fire service DIM teams have a larger range of equipment that enables them to identify substances.<sup>148,152</sup> The MoD and Home Office have recently tested robots and drones for remote detection.<sup>153</sup>

### Environmental Decontamination and Recovery

The process of decontamination varies according to the scenario and the agent used.<sup>154</sup> For example, non-persistent agents dissipate quickly, whereas persistent agents remain for longer.<sup>36</sup> It may be more cost-effective to dispose of contaminated objects rather than decontaminate them; some emergency service vehicles used in the UK incidents were disposed of in landfill.<sup>155</sup> The process of recovery can be long, expensive, and disruptive to businesses and communities.<sup>126,156</sup> The Government has provided £7.5m to support business and tourism in Salisbury.<sup>157</sup> It also supports insurance cover for terrorism, including CBRN incidents.<sup>158</sup>

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