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Review

The Use of Chemical Weapons in the Syrian Conflict

René Pita * and Juan Domingo

Chemical Defense Department, CBRN Defense School, 28240 Hoyo de Manzanares, Spain;
E-Mail: jdomingoalvarez@gmail.com

* Author to whom correspondence should be addressed; E-Mail: renepita@telefonica.net;
Tel.: +34-91-856-2484; Fax: +34-91-856-2430.

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Abstract: This paper aims at explaining the lessons learned from the chemical attacks that took place in 2013 in the Syrian military conflict, especially the sarin attacks on the Ghouta area of Damascus on August 21. Despite the limitations the UN Mission found while investigating the use of chemical weapons (CW) in Syria, some interesting conclusions for the scientific and medical community can be obtained from its reports. These include the advantages of the Chemical Weapons Convention procedure for the investigation of alleged CW use, when compared with the United Nations mechanism for similar investigations, the difficulties of differential diagnosis based only on clinical signs and symptoms and the impact of secondary contamination when responding to a CW attack.

Keywords: Syria; chemical weapons; Organization for the Prohibition of Chemical Weapons; sarin; weapons of mass destruction

1. Introduction

The Syrian upraising, which started in 2011, brought great concern among the Chemical Defense Community, due to the fact that, until October 14, 2013, Syria was one of the seven non-State Parties of the Chemical Weapons Convention (CWC). The CWC is an international treaty that entered into force in 1997 and prohibits the development, production, acquisition, stockpiling, retention, transfer or use of chemical weapons (CW) [1,2]. In 1968, Syria acceded to the 1925 Geneva Protocol, which prohibits the use of CW, but not other activities, like production or stockpiling; therefore being a weaker treaty than the CWC.

Furthermore, different intelligence analyses considered that Syria had an important CW capability, which included blister agents, like sulfur mustard, and nerve agents, like sarin and VX [1–4]. The motivation for Syria's chemical weapons program was often understood to be a strategic deterrent against Israel, developed after its defeats in the Six Days War in 1967 and the Yom Kippur War in 1973.

The Syrian government had been ambiguous in its public statements about its chemical capability. The 2005 Syrian report to the UN 1540 Resolution Committee stated that the "Syrian Arab Republic does not possess any chemical weapons, their means of delivery, or any related materials" [5]. However, President Bashar al-Assad's statements about Syria's CW, while not directly admitting their existence, differed. For example, in a 2009 interview, asked about Syria's intention to produce CW, al-Assad replied: "Chemical weapons, that's another thing. But you don't seriously expect me to present our weapons program to you here? We are in a state of war" [6].

Soon after the Syrian conflict started, both factions, the Bashar al-Assad regime and the Syrian opposition, were accusing each other of CW use. These accusations are not rare in military conflicts to discredit the opponent [7]. The Syrian conflict has been and still is of special concern, not only because the Syrian government has a chemical capability, but also because there are many actors in the conflict apart from the Free Syrian Army, including terrorist organizations, such as Jabhat al-Nusra and the Islamic State of Iraq and al-Sham (ISIS).

Some accusations of CW use in Syria were accompanied by videos on the Internet that showed the alleged remains of chemical munitions and victims of poisoning by chemical warfare agents. Some of the munitions shown were thermobaric aerial bombs or devices that could be used to disseminate riot control agents, while images of the clinical signs of victims were not enough to indicate a chemical warfare agent toxidrome [8]. In some cases, videos of alleged CW use seemed to be part of propaganda campaigns coming from both sides of the conflict.

2. The Khan Al Asal Attack and the Activation of the UN Mission

An inflexion point on CW accusations took place on March 19, 2013, when the Syrian government accused terrorist groups of firing a chemical rocket at Khan Al Asal (southeast of the city of Aleppo). The alleged attack took place at 07:30 h, killing 25 people and injuring more than 110 [9]. The Syrian government formally requested the UN Secretary-General to establish a mission to investigate the attack, thus activating the UN Secretary-General's Mechanism (SGM) for investigation of alleged use of chemical and biological weapons. The SGM was established by UN General Assembly Resolution 42/37C of 1987 and by UN Security Council Resolution 620 (1988).

As Syria was not a CWC State Party at that time, it was not possible to activate an investigation of alleged use by the Organization for the Prohibition of Chemical Weapons (OPCW), in accordance with Part XI of the CWC's Verification Annex. However, soon after the activation of the SGM, a UN Mission team was organized based on an agreement between the UN and the OPCW signed in September, 2012, for OPCW fact-finding missions as part of the SGM. The Syria UN Mission team included not only OPCW personnel, but also medical staff from the World Health Organization (WHO). On March 26, Dr. Åke Sellström was appointed Head of the Mission by the UN General Secretary.

Nevertheless, two days after the Khan Al Asal attack, the UN Secretary-General received accusations from France and the UK that included not only the Khan Al Asal attack, but additional attacks in Otaybah on March 19, 2013, and in Homs on December 23, 2012 [9]. In these cases, France and the UK accused the Syrian government of being responsible for the three attacks. From March 26 until June 27, 2013, the UN Secretary-General received allegations of nine additional attacks from France, Qatar, the UK and the USA: Salquin on October 17, 2012; Darayya on March 13 and April 25, 2013; Adra on March 24 and May 23, 2013; Jobar from April 12 to14, 2013; Sheik Maqsood on April 13, 2013; Saraqueb on April 29, 2013; and Qasr Abu Samrah on May 14, 2013 [9].

These accusations were often accompanied by the results of analyses of environmental and biomedical samples where sarin decomposition products or metabolites, respectively, had been identified. However, these samples analyzed by the laboratories lacked a proper chain-of-custody and the investigations were carried out by individual governments outside the multilateral arms control and disarmament treaty regime framework. The UN Mission required sampling to be done by its own teams following the complete and unbroken chain-of-custody and the analyses made in OPCW-designated laboratories.

Agreeing to the inspection mandate dragged on until mid-summer. This was mainly because the Syrian government only accepted the investigation of the Khan Al Asal attack. The guidelines and procedures of the SGM establish that, if requested, any UN Member State should permit an investigation on its territory. However, the acceptance of and adherence to the guidelines and procedures rests at the discretion of the Secretary-General and of the affected Member States [10].

By contrast, in the case of CWC State Parties, once a request is received by the OPCW Director-General, the team shall be dispatched at the earliest opportunity, provided the safety of the team is guaranteed. The OPCW inspection team shall have the right of access to any area that could be affected by the alleged use of CW, including hospitals or refugee camps, and shall have the right to collect samples and to interview and examine persons who may have been injured by the alleged use of CW. These and other rights of the inspection team are clearly included in Part XI of the CWC Verification Annex [11]. Thus, a CWC State Party on whose territory the use of CW is alleged to have taken place shall comply with all of them. In the case of the SGM, any obligations imposed on a nation usually means having a Resolution by the UN Security Council, where the five permanent members have the power of veto.

Finally, at the end of July, 2013, an agreement was reached, and the Syrian government accepted the deployment of the UN Mission team for the investigation of three out of the 12 alleged attacks: Khan Al Asal, Saraqueb and Sheik Maqsood [9]. The UN Mission traveled to Damascus on August 18. The task was to investigate whether CW had been used, not who had used them.

3. The UN Mission Investigation of the Ghouta Area August 21, 2013, Attacks

Early in the morning of August 21, just a few days after the arrival of the UN Mission to Damascus, allegations of CW use causing a large number of casualties in the opposition-controlled area of Ghouta in the Damascus suburbs appeared in the media and social networks [12]. These included Internet videos allegedly showing victims of the attack. The epidemiological pattern of the incident, with a high number of patients in a short period of time (most of them without thermal or blast effects produced by explosive devices) was consistent with a chemical event. Some of the clinical signs, like miosis, excessive secretions (rhinorrhea and salivation), shortness of breath and convulsions, were consistent with exposure to a nerve agent. For example, three hospitals in Damascus supported by Médecins Sans Frontières (MSF) reported that they received about 3600 patients (of whom, 355 died) with neurotoxic symptoms in less than 3 h [13]. Neurotoxic symptoms were consistent with nerve agent poisoning, and antidotal treatment with atropine was administered. MSF also reported secondary contamination of first responders, although videos available on the Internet and media reports did not mention this fact. Intelligence reports from different nations have estimated that between 350 and 1500 people were killed in the Ghouta attacks [14–16].

Immediately, dozens of allegations were formally sent to the UN Secretary-General. As a consequence, the UN Mission's initial task was changed into investigating the Ghouta area attacks. From August 26 to 29, temporary ceasefires were agreed upon, so that investigation teams could access multiple locations, take samples and conduct interviews [17].

Thirty environmental samples from rocket (capable of carrying a chemical payload) impact sites and surrounding areas were collected. OPCW procedures for chain-of-custody were followed, and samples arrived at OPCW-designated laboratories, where sarin, its byproducts (e.g., diisopropyl methylphosphonate, DIMP) and degradation/thermal decomposition products (e.g., isopropyl methylphosphonic acid, IMPA, and methylphosphonic acid, MPA) were identified [17]. Furthermore, biomedical samples (blood, urine and hair) were collected from 34 selected patients that had persistent clinical signs and symptoms, of which 91% tested positive for sarin in one laboratory and 85% in another laboratory [17].

Interviews with victims, first responders and medical personnel were carried out in order to establish the epidemiological pattern. The UN Mission requested to see 80 survivors; out of them, 36 were selected to be diagnosed by medical experts, reporting and showing clinical signs that were considered consistent with nerve agent poisoning. The main symptoms reported were loss of consciousness (78%), shortness of breath (61%), blurred vision (42%), eye irritation/inflammation (22%), excessive salivation (22%), vomiting (22%) and convulsions/seizures (22%) [17]. In the physical examination by the UN Mission, 39% of the survivors were confused or disoriented and 14% had miosis.

Based on all of the evidence collected in Ghouta, the UN Mission team concluded that "on 21 August 2013, chemical weapons have been used in the ongoing conflict between the parties in the Syrian Arab Republic, also against civilians, including children, on a relatively large scale" [17].

4. The UN Mission Investigation of Other Attacks

After the Ghouta area attack, the UN Secretary-General received reports of CW use from the Syrian government at Bahhariyeh on August 22, Jobar on August 24 and Ashrafiah Sahnaya on August 25 [9]. Once the Ghouta report was finalized, the UN Mission returned to Syria on September 25 to investigate the remaining 15 alleged attacks.

In order to conduct on-site visits, team members took into account not only whether scientific and probative data could be retrieved, but also personal safety and security considerations. Based on such considerations, the UN Mission decided to investigate six attacks that took place in 2013:

Khan al Asal on March 19, Saraqueb on April 29, Sheik Maqsood on April 13, Bahhariyeh on August 22, Jobar on August 22 and Ashrafiah Sahnaya on August 25.

In December, 2013, the UN Mission published its final report, including the facts obtained in these six additional investigated attacks. The methodology followed was similar to that used in Ghouta. It comprised interviews with victims, first responders and medical staff, to establish the epidemiological pattern and also environmental and biomedical sampling.

In the Khan Al Asal attack, the UN Mission was unable to collect environmental samples, and only two blood samples were taken. No traces or signatures of chemical warfare agents were detected in them. Based solely on interviews, the UN Mission concluded that it "collected credible information that corroborates the allegations that chemical weapons were used" [9]. In the Jobar, Saraqueb and Ashrafiah Sahnaya attacks, interviews and biomedical samples that tested positive suggested a possible use of sarin. In the Bahhariyeh attack, all blood samples collected tested negative for sarin, while in the Sheik Maqsood attack, a lack of information made it impossible for the UN Mission to draw any conclusions regarding possible CW use.

5. Discussion

5.1. Difficulties in the Investigation of Alleged Use of CW

The UN Mission was already in Damascus when the August 21 attacks in the nearby Ghouta area occurred. This allowed the team to collect "fresh" evidence of the attack, including interviews and environmental and biomedical samples. By contrast, when the Mission returned to Syria on September 25 to investigate the other attacks, it experienced greater difficulties. They included: locating survivors to interview, obtaining biomedical samples and gaining access to alleged attack scenarios that had not been corrupted (common in military conflicts) [18]. Furthermore, although biomarkers of CW had been reported even several days or weeks after exposure [19], the probabilities of positive detection decrease with time.

The initial delay in the deployment of the investigation team based on the SGM contrasts with how the CWC deals with an investigation of alleged use. Once the request is received, the OPCW Director-General shall dispatch the team at the earliest opportunity. However, if it has not been dispatched within 24 h from the receipt of the request, the Director-General shall inform the OPCW Executive Council and the CWC States Parties concerned about the reasons for the delay.

5.2. Establishing Responsibilities of Alleged Use

The UN Mission's task in Syria was to focus on the technical question of whether CW had been employed, but not to establish attribution. These kinds of teams must be objective in their conclusions, and collected evidence may not suffice for establishing which faction used CW or even whether they were working in a fabricated scenario where deception to misdirect attribution of responsibility is at work. For example, the first UN investigation teams sent to the Iran-Iraq War in the 1980s did not mention Iraq as being responsible for the chemical attacks. It was not until early 1986 when an investigation team deployed in the Al Faw peninsula stated that Iraqi forces were responsible for CW use. Members of the team had taken samples of an Iraqi-manufactured aerial bomb where sulfur mustard was identified, and they were able to interview an Iraqi pilot—a war prisoner—who explained details about the Iraqi chemical attacks [7].

Intelligence services of France, the UK and the USA assessed, with varying degrees of confidence, that the Syrian government was responsible for the Ghouta attacks, but the sources and methodologies used to reach this conclusion have not been made public [14–16]. These methodologies usually include human intelligence (HUMINT), signals intelligence (SIGINT) and geospatial intelligence (GEOINT).

The UN Mission's explosive ordnance disposal (EOD) experts found a 140-mm rocket and another one of 330-mm in the Ghouta investigation, both in enough good condition to establish the original azimuth of the rockets' trajectory [17], but the range of these rockets and the varying location of held territories and military units of both factions in Damascus made it difficult to clearly establish responsibilities. However, different flying path vector analyses trying to establish responsibility have been published, which led to an interesting dispute based on the range of the munitions and the distance of military units to the targeted areas [20–25].

Another interesting point of discussion related with the responsibility of the attacks is based on the identification of hexamethylenetetramine or hexamine in many environmental samples taken by the UN Mission in the Ghouta area [17]. When Syria acceded to the CWC and sent its declaration to the OPCW, it was already known that Syria had binary sarin. A "conventional" binary weapon is a munition in which chemical substances are held in separate containers that will react once mixed or combined as a result of being fired, launched or otherwise initiated to produce a chemical agent. Binary sarin can be formed from a mixture of methylphosphonyl difluoride (DF) with isopropanol. Binary weapons were developed in the Cold War for safety and security reasons. The precursors have lower toxicity than sarin and are stored in separate containers, so that in case of accidental leakage, the consequences will not be as severe as those produced in a sarin leak. However, Syrian binary sarin was prepared by mixing the precursors before filling the munitions to be launched. Most probably, this "crude" system of binary weapons was developed because of problems with the stability of sarin once the mix was made.

When DF is mixed with isopropanol, hydrogen fluoride (a very corrosive gas) is also produced. To neutralize the hydrogen fluoride produced, basic amines are also included [7]. As hexamine has been included in Syria's CW declaration to the OPCW [26], some authors maintain that if it was used to neutralize hydrogen fluoride, hexamine findings are a clear fingerprint of the Syrian regime's binary sarin [23,27–29]. However, if opposition forces or terrorist groups in Syria had access to sarin, it is highly probably that it came from governmental stockpiles.

All in all, neither the analyses of the rockets' trajectories and ranges nor the presence of hexamine seem to be evidence enough to clearly establish who was responsible for the Ghouta sarin attacks. Dr. Åke Sellström stated that the UN Mission did not have "information that would stand in court," even adding that both sides in the Syrian conflict could have had the opportunity and capability to carry out the attacks [30].

5.3. Differential Diagnosis

While the epidemiological pattern of what occurred on August 21, 2013, in Ghouta was consistent with a chemical event, differential diagnosis based on clinical signs and symptoms was not sufficient to establish nerve agent poisoning. Smoke and incendiary munitions had already been used since the start of the Syrian conflict, and smoke inhalation could also produce similar clinical signs and deadly asphyxia, as seen in the videos appearing in social networks.

One of the main clinical signs described in nerve agent exposure is miosis [31]. Miosis has been reported in accidental cases of nerve agent exposure [32–34], in the 1980–1988 Iran-Iraq War's nerve agent casualties [35], in the Japanese cult, Aum Shinrikyo, sarin attacks in Matsumoto in 1994 [36–40] and in the Tokyo metro in 1995 [40–45]. Even mild cases without systemic effects usually presented miosis, a local effect of nerve agents in the eyes, which can last for several weeks, even after the patient has received systemic atropine treatment [32–34,36,37,45]. However, miosis was not very common in the videos released on the Internet in the initial days following the Ghouta event. Moreover, only 14% of the survivors examined by the UN Mission in Ghouta area had miosis five to seven days after the attack [17].

5.4. Secondary Contamination

One of the main lessons learned from the Aum Shinrikyo sarin attacks in Japan was to avoid secondary contamination of first responders and hospital personnel [37,38,42,43,46–51]. Therefore, the use of personal protective equipment by first responders and the decontamination of casualties before evacuation to hospitals are now considered essential. This led many pre-hospital emergency services and hospitals all over the world to make important investments to acquire personal protection and decontamination capabilities in order to be ready in case of chemical events.

However, once again, the available videos of the Ghouta attacks from different sources do not show an important incidence of secondary contamination, when it was clear that casualties were arriving at the medical centers and being treated without having previously been decontaminated. Although the UN Mission included questions about the presence of secondary contamination in the interviews, no relevant detailed information is included in the Ghouta attacks report [17], and only four cases are described in the final report [9]: three first responders with secondary contamination in the Khan Al Asal attack and one paramedic in the Saraqueb attack. However, blood samples of the two first responders in Khan Al Asal tested negative for sarin.

Although the UN Mission had important limitations in its investigations to provide a full picture of the extent of secondary contamination, one can argue that casualty decontamination has been overrated. We do not think this is the case, but it is important that decontamination procedures include case-by-case assessments based on, among others, the chemical agent involved. For example, sarin is a highly volatile liquid with low persistence. Therefore, patients that could have been exposed to liquid sarin (e.g., those close to the munition detonation) may have needed more important decontamination efforts. In case of vapor exposure, undressing and a shower with water may be sufficient. A complex decontamination process, including contamination control with chemical detector devices at the entrance and at the exit of a decontamination station, may only slow down the arrival of patients to the medical treatment facilities.

6. Conclusions

The advantages of the CWC procedure for the investigation in cases of alleged use, when compared with the SGM, show the importance of achieving universal membership to the CWC. However, establishing responsibilities of use seems to be a difficult task, and success would depend on the intrinsic characteristics of each case. On January 31, 2014, six nations still had not acceded to the CWC: Angola, Egypt, Israel, Myanmar, North Korea and South Sudan.

The clinical signs and symptoms observed in the Ghouta attacks show how difficult it might be to identify a toxidrome to start adequate antidotal treatment. The capabilities for rapid identification of the toxic agent by clinical laboratories at medical treatment facilities or through a laboratory network would be useful for correct diagnosis. Finally, decontamination efforts to avoid secondary contamination should be based on a case-by-case assessment.

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Author Contribution

Both authors contributed equally to this work.

Conflicts of Interest

The authors declare no conflict of interest.

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