AN INVESTIGATIVE APPROACH FOR INCIDENTS INVOLVING CHEMICAL WARFARE AGENTS (CWAs)

Isabelle Radgen-Morvant[1]
School of Criminal Justice, University of Lausanne, Switzerland

Natalie Kummer
School of Criminal Justice, University of Lausanne, Switzerland

Abstract: During the last decades, the need for more awareness and adapted practices regarding the forensic investigation of incidents involving chemical warfare agents (and more globally the CBRN incidents) has been highlighted. The lack of a global approach and specific investigation strategies for these events has been mentioned in numerous publications, which have also underlined the need of capabilities development in this field. Since 2016 The Organisation for the Prohibition of Chemical Weapons (OPCW) has launched a Temporary Working Group on Investigative Science and Technology with the focus to increase forensic capabilities. One of the reasons why the investigative approach is not yet a matter of course may be that the first attempts of forensic investigations were based on a direct implementation of forensic methodology within the standard operating procedures in place to manage the CBRN incidents. However, this may not have been the best strategy as the priorities, actors involved and scene dynamic are different between incidents involving chemical warfare agents and what may be considered as a more "traditional" crime scene. Therefore, the investigative approach of incidents involving chemical warfare agents need to be adapted and specific capabilities need to be developed (e.g. to work with a PPE or to handle contaminated evidence). These capabilities are multiple and the investigative methods have to be adapted since the start of the investigation at the scene itself up to the analysis that may be done in the laboratory.

Keywords: CBRN, Chemical Warfare Agents (CWAs), Investigative Approach, OPCW

1 isabelle.radgen-morvant@unil.ch

INTRODUCTION

Chemical warfare agents are often mentioned in relation to Biological, Radiological and Nuclear (CBRN) threats. The CBRN threats are different from hazmat situations by the fact that a CBRN threat implies an intentional attack with a malicious motivation and the intent to harm a large numbers of people. Therefore, the CBRN threats are equally referred to as Weapons of Mass destructions (WMD) (Prockop, 2006; Ganesan, Raza, & Vijayaraghavan, 2010). These weapons are considered as unconventional due to the great destructive power, the psychological impact and the lasting traces they leave on touched areas and peoples.

HISTORICAL REVIEW

Since the dawn of time, humans used toxic materials to get rid of their enemies or to harm opponents. The CBRN threats emerged at the beginning of the 20th century after the industrial revolution (Tucker, 2006; Spector, 2017). The great advancement in technologies and the numerous discoveries in science in the 1850s gave humans a better understanding of physical and chemical properties These new knowledge helped to have great improvement in living conditions and to optimize production processes but it also accelerated the development of mortal and heavily destructive means such as chemical and biological weapons.

World War I (WWI) was the first milestone in the ill-fated development of chemical weapons. As the trench war was setting a static frontline, the German scientist Fritz Faber proposed to use toxic chemical to breach the enemy lines and achieve a breakthrough in war (Mangerich & Esser, 2014). The first chemical attacks occurred in Belgium in 1915 where chlorine gas was released on the French troops. However, the chemical used rapidly became more and more potent as researches were done and at the end of WWI, the most common Chemical Warfare Agent (CWA) was mustard gas (Tucker, 2006; Pita, 2009; Spector, 2017).

After the events of WWI, the international community understood the necessity to prohibit chemical and biological weapons that not only had disastrous outcome for contaminated people but also impacted psychologically every person that witnessed chemical attacks. The Geneva protocols in 1925 helped to set some limitations and to define the first pieces for war laws (International Committee of the Red Cross, 2016). In the Geneva protocol, state parties agreed on the prohibition of use of toxic and asphyxiating gas in war (Tucker, 2006; OPCW, 2017b).

However, the use of chemicals as weapons was reiterated in World War II (WWII). This time chemicals were not used on the battlefield against enemy troops but to kill thousands of innocent people in the sadly famous death camps in Germany and Western Europe. These events, along with the atomic bombings of Hiroshima and Nagasaki in August 1945, changed the dimension and the perception of warfare (Tucker, 2006). The images and outcome of these events deeply affected human minds and will probably stay in the collective memory.

However after WWII, the CBRN agents where not directly banished as one might imagine. The race for armament only began and large sums of money were invested by Russia and the United States of America, as well as by other European countries, to further research, develop and produce the CBRN weapons (Tucker, 2006; Spector, 2017). The deterrent power of such weapons being considered as high enough to prevent enemies attack, the CBRN agents are not only material but also psychological weapons (Gouweloos, Dückers, te Brake, Kleber, & Drogendijk, 2014; Krieger, Amlôt, & Brooke Rogers, 2014).

The psychological damage may also be an interesting mean for non-state actors to disrupt societies. Several terrorist organization tried over the years to acquire knowledge and materials to synthesize CWA (Zanders, 1999; Tucker, 2000; Meulenbelt & Nieuwenhuizen, 2015). The major event that involved the use of chemical warfare agents by a non-state actor organization is certainly the sarin attack in the Tokyo subway in 1995 by the Aum Shinrikyo Cult (Tucker, 2000, 2006).

In 1997, the Chemical Weapons Convention (CWC), ratified by almost all state parties, entered in force. For its implementation, the Organization for the Prohibition of Chemical Weapons (OPCW) has been created the same year (OPCW, 1993, 2017b). Despite this treaty, several incidents involving CWA have been observed in recent years, not only during the Syrian war since 2013 but also for example in the death of Kim Jon-Nam in Malaysia in 2017 (OPCW, 2017a). Recent and past events showed the international community and the OPCW the need to extend their capabilities and the need not only to be able to identify CWA but also to attribute attacks to its perpetrators (Tucker, 2010; Zanders & Balci, 2013; Smallwood, Trapp, Mathews, Schmidt, & Sydnes, 2013; Borrett, Timperley, Forman, & Tang, 2018).

FORENSIC IMPLEMENTATION

Chemical threats are not always intentional and great efforts have been made to assess and mitigate chemical risk in various situations. The handling of a chemical threat is primary based on the mitigation of the risk and the reduction of damages. Well-documented risk management strategies have been widely developed and are *de facto* available (Linney, Kernohan, & Higginson, 2011; George Calder & Bland, 2015;). But because the awareness of implicating the forensic science in the investigative process has been achieved only recently, the forensic capabilities are still lacking in the field of the CBRN and not yet well integrated in the risk management strategies (OPCW, 2016; Borrett et al., 2018; Forman et al., 2018;).

First strategies proposed were based on the idea of a direct implementation of forensic science methods in the already existing CBRN intervention protocols (Murch & Tech, 2012; Peña-Fernández, Wyke, Brooke, & Duarte-Davidson, 2014). However, due to some major differences in between these two domains, such approach suffers from some limitations. The aim of the first responders and forensic scientists, as much as their priorities and the way of handling the same situations, are fundamentally different (Calder & Bland, 2015). The investigation of the CBRN events is complicated for forensic scientists as their work is impeded by contaminations and safety issues. Currently, the first responders are to intervene before forensic scientists to ensure safety and this without regard for potential evidence that may be destroyed by their actions. It seems therefore essential to rethink the intervention on incidents involving chemicals agents to integrate forensic teams since the early stage of the intervention. The global approach need to be adapted and standard operating procedures need to be implemented. Even though the CBRN events are highly unpredictable, having procedures that involve forensics from the beginning could help to preserve evidence without stopping the first responder to do their tasks (Linney et al., 2011). In a CBRN intervention, it is crucial to identify accurately and as soon as possible, the agents employed in order to respond effectively to the incident. From a forensic point of view, it is required to develop systematic processes for the assessment, collection, preservation and interpretation of material collected on the CBRN crime scenes.

Based on the existing CBRN and forensic processes, both fields could learn from one another to develop performant forensic investigations of the CBRN incidents.

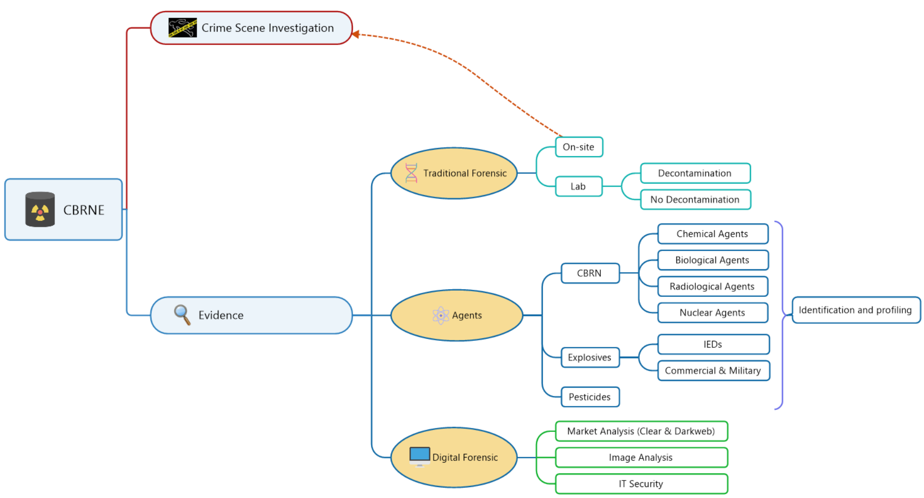

Figure 1: *Field where forensic procedures could be develop and research efforts need to be undertaken.*

So far, little attention has been given to the possible use of traditional forensic evidence from the CBRN incidents. The collection and treatment of seized specimens is challenging due to the fact that they are contaminated by highly dangerous substances. Further researches need to be undertaken in order to evaluate the best ways to proceed. As an example, finger marks detection or DNA recovery may be more or less influenced by the chemical decontamination mean used. Briefly, the seized specimens could either be directly analysed on-site, which requires that the forensic scientist wears personal protective equipment (e.g. respiratory protective device and body surface protective equipment), or transferred to a CBRN laboratory that may handle the contaminated items. For the forensic investigation of specimens in laboratory, two solutions may be foreseen; the analysis in the CBRN facilities or the decontamination prior to the transfer toward forensic institutes (Borrett et al., 2018; Kummer, Augustyns, Van Rompaey, & De Meulenaere, 2019; OPCW, 2018). Lacking concrete research on the detection and analysis of traditional forensic exhibits collected from a CBRN crime scene, there is yet no methodology nor procedure to collect, handle and harness the potential of traditional forensics in such cases.

The analysis of the chemical agent itself is essential to determine the threat, but may also provide additional information. One research aspect is the source inference based on the chemical impurity profiling of the CWAs. Since 2010, several research projects (Hoggard, Wahl, Synovec, Mong, & Fraga, 2010; Fraga, Bronk, Dockendorff, & Heredia-Langner, 2016; Fraga, 2018) have investigated the possibility to cluster together products to precursor batches through the impurity profiles. However, these studies have mainly been realised in laboratory condition. To estimate the utility of these techniques in real case scenarios, it is necessary to evaluate the impact of contextual factors on the impurity profiling of CWA.

One other emerging area in forensic science is the digital field. Although, cybersecurity is a growing concern, the digital environment equally offers new investigative opportunities. The use of image analysis, to better understand ground movement for example, could help prevent some attack or detect at earlier stage a possible CWA incident. Additionally, open source intelligence, combined with image analysis and the current monitoring of the chemicals, could help gather information to help prevent proliferation of CWA (Minas, 2010).

In short, it is visible that at all stages of the CBRN forensic investigation (Fig. 1), new methods and capabilities need to be develop. In addition, it seems essential to define an investigative approach to react to the CWA incidents and to elaborate an appropriate framework with adapted vocabulary. By targeted research on all the above-mentioned aspects, capabilities and readiness of all involved parties will be increased.

CONCLUSION

Since its beginning, chemical warfare has been considered as brutal and inhuman. Recent incidents with chemicals weapons have shown that CBRN threats are still topicality. The events in Syria, England and Malaysia have highlighted the need to attribute and understand chemical attacks. Forensic science has tools that could help to answer these questions if involved in the investigation process since its starts. To expand their forensic capabilities and to develop new combined approach to be able to exert their deterrent power, the OPCW has created a temporary working group, which aims to evaluate the possibilities of forensic science in the field of CWA. It seems now necessary that the CBRN experts and forensic scientists work together to fill these gaps and strengthen the chemical weapons convention for a world free of chemical weapons.

REFERENCES

1. Borrett, V., Timperley, C. M., Forman, J. E., & Tang, C. (2018). Investigative science and technology supporting the Organization for the Prohibition of Chemical Weapons (OPCW). *Australian Journal of Forensic Sciences*, 1–12. https://doi.org/10.1080/00450618.2018.1559356
2. Calder, A., & Bland, S. (2015). Chemical, biological, radiological and nuclear considerations in a major incident. *Surgery (Oxford)*, *33*(9), 442–448. https://doi.org/10.1016/j.mpsur.2015.07.006
3. Forman, J. E., Timperley, C. M., Aas, P., Abdollahi, M., Alonso, I. P., Baulig, A., van Eerten, D. (2018). Innovative technologies for chemical security. *Pure and Applied Chemistry*, *90*(10), 1527–1557. https://doi.org/10.1515/pac-2018-0908
4. Fraga, C. G. (2018). Chemical forensics. *Talanta*, *186*, 585. https://doi.org/10.1016/j.talanta.2018.04.057
5. Fraga, C. G., Bronk, K., Dockendorff, B. P., & Heredia-Langner, A. (2016). Organic Chemical Attribution Signatures for the Sourcing of a Mustard Agent and Its Starting Materials. *Analytical Chemistry*, *88*(10), 5406–5413. https://doi.org/10.1021/acs.analchem.6b00766
6. Ganesan, K., Raza, S. K., & Vijayaraghavan, R. (2010). *Chemical warfare agents*. 29.
7. Gouweloos, J., Dückers, M., te Brake, H., Kleber, R., & Drogendijk, A. (2014). Psychosocial care to affected citizens and communities in case of CBRN incidents: A systematic review. *Environment International*, *72*, 46–65. https://doi.org/10.1016/j.envint.2014.02.009
8. Hoggard, J. C., Wahl, J. H., Synovec, R. E., Mong, G. M., & Fraga, C. G. (2010). Impurity Profiling of a Chemical Weapon Precursor for Possible Forensic Signatures by Comprehensive Two-Dimensional Gas Chromatography/Mass Spectrometry and Chemometrics. *Analytical Chemistry*, *82*(2), 689–698. https://doi.org/10.1021/ac902247x
9. International Committee of the Red Cross. (2016). *Geneva Convention: Convention (I) for the Amelioration of the Condition of the Wounded and Sick in Armed Forces in the Field*. https://doi.org/10.1017/9781316755709
10. Krieger, K., Amlôt, R., & Brooke Rogers, M. (2014). Understanding public responses to chemical, biological, radiological and nuclear incidents — driving

factors, emerging themes and research gaps. *Environment International*, *72*, 66–74. https://doi.org/10.1016/j.envint.2014.04.017

11. Kummer, N., Augustyns, B., Van Rompaey, D., & De Meulenaere, K. (2019). Forensic investigation of incidents involving chemical threat agent: Presentation of the operating procedure developed in Belgium for a field-exercise. *Forensic Science International*, *299*, 180–186. https://doi.org/10.1016/j.forsciint.2019.03.037
12. Linney, A. C. S., George Kernohan, W., & Higginson, R. (2011). The identification of competencies for an NHS response to chemical, biological, radiological, nuclear and explosive (CBRNe) emergencies. *International Emergency Nursing*, *19*(2), 96–105. https://doi.org/10.1016/j.ienj.2010.04.001
13. Mangerich, A., & Esser, C. (2014). Chemical warfare in the First World War: Reflections 100 years later. *Archives of Toxicology*, *88*(11), 1909–1911. https://doi.org/10.1007/s00204-014-1370-z
14. Meulenbelt, S. E., & Nieuwenhuizen, M. S. (2015). Non-State actors' pursuit of CBRN weapons: From motivation to potential humanitarian consequences. *International Review of the Red Cross*, *97*(899), 831–858. https://doi.org/10.1017/S1816383116000011
15. Minas, H. (2010). Can the Open Source Intelligence emerge as an indispensable discipline for the intelligence community in the 21st Century ? *Research Institute for European and American Studies*.
16. Murch, R., & Tech, V. (2012). *Forensic Science Applied to CBRNE Evidence*. 16.
17. OPCW. The Convention on the prohibition of the development, production, stockpiling and use of chemical weapons and on their destruction. , CWC § (1993).
18. OPCW. (2016). *Report of the scientific advisory board's workshop on chemical forensics* (No. SAB-24/WP.1).
19. OPCW. (2017a). OPCW Executive Council Condemns Chemical Weapons Use in Fatal Incident in Malaysia. Retrieved 13 September 2019, from OPCW website: https://www.opcw.org/media-centre/news/2017/03/opcw-executive-council-condemns-chemical-weapons-use-fatal-incident
20. OPCW. (2017b). *Origins of the Chemical Weapons Convention and the OPCW*. *Fact Sheet 1*. Retrieved from https://www.opcw.org/sites/default/files/documents/Fact_Sheets/English/Fact_Sheet_1_-_History.pdf
21. OPCW. (2018). *Scientific Advisory Board's Recommendations to the 4th Review Conference of Chemical Weapons Convention*.
22. Peña-Fernández, A., Wyke, S., Brooke, N., & Duarte-Davidson, R. (2014). Factors influencing recovery and restoration following a chemical incident. *Environment International*, *72*, 98–108. https://doi.org/10.1016/j.envint.2014.05.001

23. Pita, R. (2009). Toxin weapons: From World War I to jihadi terrorism. *Toxin Reviews*, *28*(4), 219–237. https://doi.org/10.3109/15569540903246136
24. Prockop, L. D. (2006). Weapons of mass destruction: Overview of the CBRNEs (Chemical, Biological, Radiological, Nuclear, and Explosives). *Journal of the Neurological Sciences*, *249*(1), 50–54. https://doi.org/10.1016/j.jns.2006.06.017
25. Smallwood, K., Trapp, R., Mathews, R., Schmidt, B., & Sydnes, L. K. (2013). Impact of scientific developments on the Chemical Weapons Convention (IUPAC Technical Report). *Pure and Applied Chemistry*, *85*(4), 851–881. https://doi.org/10.1351/PAC-REP-12-11-18
26. Spector, D. E. (2017). Chemical Weapons. In *The SAGE Encyclopedia of War: Socail Science Perspectives* (SAGE Publications,Inc.). Thousand Oaks.
27. Tucker, J. B. (2000). *Toxic Terror: Assessing Terrorist use of Chemical and biological Weapons*. MIT Press.
28. Tucker, J. B. (2006). *War of nerves: Chemical warfare from Wolrd War I to Al-Quaeda*. New York: Pantheon Books.
29. Tucker, J. B. (2010). The Future of Chemical Weapons. *The New Atlantis*, 27.
30. Zanders, J. P. (1999). Assessing the risk of chemical and biological weapons proliferation to terrorists. *The Nonproliferation Review*, *6*(4), 17–34. https://doi.org/10.1080/10736709908436776
31. Zanders, J. P., & Balci, Y. (Eds.). (2013). *The future of the CWC in the post-destruction phase*. Paris: Inst. for Security Studies.