ISSN 2474-8978

TOXICOLOGY AND FORENSIC MEDICINE

Open Journal

Openventio PUBLISHERS

Case Report

A Case of Dimethoate Poisoning Requiring Prolonged Skin Decontamination

Ponampalam R, MBBS, FRCS (Ed), FAMS, GDOM*

Department of Emergency Medicine, Singapore General Hospital, Outram Road 169608, Singapore

Corresponding author
Ponampalam R, MBBS, FRCS (Ed), FAMS, GDOM
Senior Consultant, Department of Emergency Medicine, Singapore General Hospital, Outram Road 169608, Singapore; Tel. (65) 63213558; Fax: (65) 63214873;
E-mail: ponampalam@singhealth.com.sg

Article information
Received: September 1st, 2020; **Revised:** September 25th, 2020; **Accepted:** September 28th, 2020; **Published:** October 28th, 2020

Cite this article
Ponampalam R. A case of dimethoate poisoning requiring prolonged skin decontamination. *Toxicol Forensic Med Open J*. 2020; 5(1): 11-15.
doi: 10.17140/TFMOJ-5-132

ABSTRACT

Background

Decontamination is a critical medical counter measure in reducing toxic exposure following poisoning. Little is known on the effectiveness of this procedure and its impact in the context of preventing secondary exposure of healthcare workers and secondary contamination of facilities. Presented here is a case of dimethoate poisoning that required a prolonged period of skin decontamination to remove residual skin contamination.

Case Report

A young gardener consumed dimethoate at the workplace witnessed by a colleague who called the emergency services immediately. Paramedics noted the patient to be drowsy with stable vital signs and 100% oxygen saturation. En-route to the hospital the patient vomited multiple times and was drenched in vomitus with a pungent odour. Upon arrival at the emergency department (ED), vital signs remained stable with a Glasgow Coma Scale (GCS) of 10. Due to gross external contamination from the vomitus and pungent odours emanating suggestive of chemical fumes off-gassing, the hospital decontamination shower was activated for patient decontamination. Staff donned protective suits and proceeded to disrobe and bag all the patient's clothing before showering the patient for 10-minutes using soap and water. Post-decontamination a chemical agent monitor (CAM) were used to screen for residual chemicals following the hospital's decontamination protocol. The chemical alarm was triggered twice, first around the left mastoid region and again just below the left breast. This required targeted re-showering for a further 10-minutes before patient was finally cleared of contamination. Subsequently, the patient was given atropine (2.4 mg) and pralidoxime (1 g) followed by an infusion at the intensive care unit (ICU). The patient made an uneventful recovery and was discharged 5-days later.

Conclusion

This case of dimethoate poisoning is notable for the prolonged period of skin decontamination to remove residual skin contamination and illustrates potential implications to patient and health care worker safety. Past mass casualty incidents involving chemicals, such as the sarin attack in Tokyo, highlight the high incidence of secondary exposures amongst healthcare workers due to the lack of casualty decontamination. As a result, many hospitals have developed capacity to conduct rapid and timely decontamination at their premises to prevent further complications from secondary chemical exposure. However, the effectiveness of this process of decontamination needs further evaluation.

Keywords

Contaminated casualty; Decontamination; Dimethoate; Poisoning; Hazardous material incident; Organophosphorus compounds.

INTRODUCTION

Organophosphorus (OP) compounds are widely used as pesticides in countries where agriculture forms a predominant part of the economy. Poisoning from exposure to OP are uncommon in the Singapore context with its limited use posing exposure hazard in certain high-risk occupations. However, with the increasing availability of potent industrial and chemical warfare agents, the possibility of it landing in the wrong hands is high and the potential for mass casualty incidents from terrorism have heightened. The sarin incident in Tokyo subway in 1995,[1] had set the stage for a new reality in todays' world. Disgruntled members of a cult had used nerve agents, usually meant as weapons in warfare, on unsuspecting civilians resulting in mass casualties. This incident had demonstrated a high incidence of secondary exposures amongst healthcare workers as a result of lack of casualty decontamination.[2,3] The significant morbidity and mortality from toxic exposures in chemical incidents are well appreciated and the acute and chronic consequences of secondary exposure to healthcare and emergency responder is notable.[4-9] Since the Tokyo incident, there have been many other occasions where nerve agents have been used by individuals and governments on civilians.[10,11] Appreciating this situation and the dire consequences of secondary exposure, there have been recommendations for countermeasures, such as mass casualty decontamination to be made readily available at healthcare facilities to deal with chemical contamination spread and to limit the damage from ongoing chemical exposures.[12-16] This case of dimethoate poisoning, a commonly used industrial OP, is notable for the prolonged period of skin decontamination to remove residual skin contamination and illustrates potential implications for patient and health care worker safety.

CASE REPORT

A young gardener consumed dimethoate at the workplace in a suicidal attempt. The victim developed vomiting, abdominal discomfort and urge to defecate and was noted to be increasingly drowsy by a colleague who called the emergency ambulance service.

Paramedics noted the patient to be drowsy and diaphoretic but otherwise haemodynamically stable with 100% oxygen saturation. While being evacuated a prehospital stand-by activation message was sent to the receiving emergency department (ED) to prepare for arrival of a critically ill patient. En-route the patient vomited multiple times and was drenched in vomitus.

On arrival in the resuscitation area of the ED, the patient was diaphoretic, with Glasgow Coma Scale GCS of 10 (E2V3M5) and pupils 2 mm reactive. The patient was afebrile with blood pressure of 116/72 mm of Hg and pulse rate of 106 per minute. The patient was tachypnoeic but maintaining airway with a respiratory rate of 20 per minute and oxygen saturation of 98% on room air. It was noted that vomiting had stopped, but patient's clothes were drenched in vomitus emanating a pungent odour suggestive of chemical fumes off gassing. There was excessive salivation and crepitation in the lung bases. The clinical picture was consistent with OP poisoning with features of cholinergic toxidrome.

As the patient was clinically stable, and in view of the significant external contamination with potential risk of further cutaneous absorption and secondary exposure to health care workers (HCW) and facility, decision was made to perform external decontamination at the hospital decontamination station (HDS)[17] located just outside the ED entrance.

The HDS shower was deployed and ED staff donned personal protective equipment (PPE) comprising impermeable decontamination suits with air purifying respirators prior to starting the decontamination process. The patient was disrobed, and the clothing bagged before proceeding with showering using water and liquid soap-soaked sponges. Following the hospital's decontamination protocol,[18] the patient was showered systematically from head to toe, covering the entire body surface area. The shower took 10-minutes and the patient was then brought to the drying area and dried before a systematic chemical agent screen was initiated from head to toe using the chemical agent monitor (CAM), ChemPro100i from Environics. After the initial shower, the first CAM scan sounded an alarm around the region of the patients left mastoid indicating the presence of an unidentified industrial chemical. The patient was moved back into the HDS to get a targeted shower for the specified area using soap and water for 5 more minutes. Following the second shower patient was again dried and scanned. The CAM alarm sounded the second time at a region below the left breast again indicating the presence of an unidentified industrial chemical. The patient was moved back into the HDS for a repeat targeted decontamination of the contaminated site for an additional 5 more minutes. Following this third and final shower, the CAM did not trigger again, and the patient was clothed with hospital gown before being brought back to the resuscitation area for further management. Notably it took a total of 20-minutes of showering with soap and water before the patient was declared clean, excluding preparation time for the deployment of the decontamination showers and crew. The entire process took a total of 56-minutes based on video footage from activation of the HDS until completion of the decontamination process.

Upon return to the resuscitation area patient was put on vitals monitoring and reassessed. A random blood glucose done was 13.8 mmol/L and electrocardiograph showed sinus tachycardia. Chest X-ray showed prominent pulmonary vasculature with mild congestion. Blood investigations including a full blood count, electrolytes, liver function, amylase were normal except for hypokalaemia of 2.9 mmol/L, glucose of 14.4 mmol/L and serum amylase of 203 U/L (38-149 U/L). The initial red blood cell cholinesterase was 4293 (7700-14600 U/L) and serum cholinesterase level was low 1502 (range 4700-12000 U/L) with further drop to below 1000 over the next 2 days in keeping with OP poisoning.

The patient was given a total of 2.4 mg atropine and was started on pralidoxime 1 g at the ED followed by continuous infusion of atropine and pralidoxime for the next 24-hours. The patient remained haemodynamically stable with improvement in respiration and clearing of crepitation's in the lungs. While in the ED, patient's consciousness level improved to GCS 13 (E3V4M6) becoming more responsive to questioning. The patient was admitted to the medical intensive care unit (ICU) for monitoring where clinical condition improved over the next 24-hours before being sent to the general ward. The patient was referred to psychiatrist for evaluation in the ward and had an uneventful recovery and was subsequently discharged well from hospital 5-days later.

DISCUSSION

Dimethoate is significantly absorbed *via* the dermal and respiratory route, when used as a pesticide by workers in the occupational setting. This exposure can be reduced with the use of appropriate dermal and respiratory protection.[19] Hence it is critical that these patients have proper decontamination as part of medical therapy to reduce absorption and toxicity. The standard decontamination protocol in our setting involves disrobing followed by 10-minute shower using soap sponges and water. In our patient, due to the persistence of skin contamination repeated showering was done for a prolonged total time of 20-minuted econtamination. The actual reason for this is uncertain but is postulated to be related to its chemical stability in aqueous solution and presence of petroleum distillates which resulted in persistence of the chemicals on the skin.

There are a variety of decontaminant solutions and powders that may contribute to effective decontamination. In a study, involving decontamination with reactive skin decontaminant lotion (RSDL) at different times in hairless guinea pigs percutaneously challenged with venomous agent X (VX) a potent low volatile nerve agent, it was noted that the compound persisted on the skin for prolonged period providing a long window of opportunity for decontamination even after 90-minutes post exposure.[20] The study concluded that, decontamination of VX-exposed skin is one of the most important countermeasures to mitigate the effects of exposure and the delay in absorption presents a window of opportunity for decontamination and treatment. However, the use of such decontamination solutions in the clinical context requires further study.

Most international mass casualty decontamination guidelines do not include screening for residual contamination post-decontamination due in part to resource and time constraints.[21-23] As demonstrated in our case, it is incorrect to assume that patients are cleared of contamination after initial rapid decontamination. However, it is unclear as to the clinical significance of residual chemical contamination following a single shower and further research will need to be done to demonstrate its effectiveness. To make the decontamination process robust, it will be prudent to screen casualties for residual contamination following initial decontamination to ensure patient safety from further cutaneous exposure and the safety of staff who will be managing the patient subsequently. Hence, the need for further evaluation using CAM post decontamination to confirm before being cleared for entry into the receiving hospital should be considered crucial to prevent escalation.[24]

Dimethoate belongs to the same class of toxic OP compounds used in chemical warfare as nerve agents. These nerve agent analogues are commonly used as pesticides and readily available are considered potential agents for chemical terrorism.[25]

Organophosphorus poisoning is known to occur from intentional ingestion or accidental exposure in the occupational setting. It has been the choice agent in some recent assassination attempts including Kim Jong-Nam and the former Russian spy Sergei Skripal and his daughter, Yulia.[26,27] In the last two decades, terrorism with OP agents have become an increasing concern and the potential for mass casualty incidents involving such chemicals remain high.[28,29] Lessons from past incidents involving OP exposure have demonstrated the risk of secondary exposure of emergency first responders, HCW and the significant impact on the hospital facility from secondary contamination.[30-32]

CONCLUSION

The chemical incidents in the past, had demonstrated the high incidence of secondary exposures amongst healthcare workers as a result of lack of casualty decontamination. This case report suggest that effective decontamination takes time to achieve its intended objective and need verification for quality control. Extrapolating this experience to hazmat mass casualty incidents, it is important to note that rapid decontamination of casualties in the field or hospital may have limitations. Measures to ensure effectiveness of decontamination are paramount to ensure staff and patient safety.[33]

REFERENCES

1. Okumura T, Takasu N, Ishimatsu S, Miyanoki S, Mitsuhashi A, Kumada K, et al. Report on 640 victims of the Tokyo subway sarin attack. *Ann Emerg Med.* 1996; 28(2): 129-135. doi: 10.1016/s0196-0644(96)70052-5

2. Okumura T, Suzuki K, Fukuda A, Kohama A, Takasu N, Ishimatsu S, et al. The Tokyo subway sarin attack: disaster management, Part 2: Hospital response. *Acad Emerg Med.* 1998; 5(6): 618-624. doi: 10.1111/j.1553-2712.1998.tb02471.x

3. Nozaki H, Hori S, Shinozawa Y, Fujishima S, Takuma K, Sagoh M, et al. Secondary exposure of medical staff to sarin vapor in the emergency room. *Intensive Care Med.* 1995; 21(12): 1032-1035. doi: 10.1007/BF01700667

4. Nishiwaki Y, Maekawa K, Ogawa Y, Asukai N, Minami M, Omae K, et al. Effects of sarin on the nervous system in rescue team staff members and police officers 3 years after the Tokyo subway sarin attack. *Environ Health Perspect.* 2001; 109(11): 1169-1173. doi: 10.1289/ehp.011091169

5. Miyaki K, Nishiwaki Y, Maekawa K, Ogawa Y, Asukai N, Yoshimura K, et al. Effects of sarin on the nervous system of subway workers seven years after the Tokyo subway sarin attack. J *Occup Health.* 2005; 47(4): 299-304. doi: 10.1539/joh.47.299

6. Larson TC, Orr MF, Auf der Heide E, Wu J, Mukhopadhyay S, Horton DK. Threat of secondary chemical contamination of emergency departments and personnel: An uncommon but recurrent problem. *Disaster Med Public Health Prep.* 2016; 10(2): 199-202. doi: 10.1017/dmp.2015.127

7. Melnikova N, Wu J, Yang A, Orr M. Acute chemical incidents with injured first responders, 2002-2012. *Disaster Med Public Health Prep.* 2018; 12(2): 211-221. doi: 10.1017/dmp.2017.50

8. Ponampalam R, Leong KF, Lim SH. Are we prepared to deal with hazardous material incidents? – An SGH perspective. *SGH*

Proceedings. 2002; 11(4): 238-241.

9. Ngo A, Ponampalam R, Leong M, Han LS. Chlorine and its impact on an emergency department. *Prehosp Disaster Med*. 2007; 22(2): 136-139. doi: 10.1017/s1049023x00004519

10. Note by the Technical Secretariat. Organisation for the Prohibition of Chemical Weapons. *Report of the opcw fact-finding mission in syria regarding alleged incidents in ltamenah, the Syrian Arab Republic*. 24 and 25 March 2017. 2018; 1636.

11. Vale JA, Marrs TC OBE, Maynard RL CBE. Novichok: a murderous nerve agent attack in the UK. *Clin Toxicol (Phila)*. 2018; 56(11): 1093-1097. doi: 10.1080/15563650.2018.1469759

12. Okumura T, Hisaoka T, Yamada A, et al. The Tokyo subway sarin attack--lessons learned. *Toxicol Appl Pharmacol*. 2005; 207(2 Suppl): 471-476. doi: 10.1016/j.taap.2005.02.032

13. Johnston GM, Wills BK. Chemical decontamination. In: *StatPearls*. Treasure Island (FL), USA: Stat Pearls Publishing; 2020.

14. Razak S, Hignett S, Barnes J. Emergency department response to chemical, biological, radiological, nuclear, and explosive events: A systematic review. *Prehosp Disaster Med*. 2018; 33(5): 543-549. doi: 10.1017/S1049023X18000900

15. Chilcott RP, Larner J, Matar H. UK's initial operational response and specialist operational response to CBRN and HazMat incidents: A primer on decontamination protocols for healthcare professionals. *Emerg Med J*. 2019; 36(2): 117-123. doi: 10.1136/emermed-2018-207562

16. Holland MG, Cawthon D. Personal protective equipment and decontamination of adults and children. *Emerg Med Clin North Am*. 2015; 33(1): 51-68. doi: 10.1016/j.emc.2014.09.006

17. Ponampalam R. A novel hospital-based mass casualty decontamination facility for hazardous material disasters. *Toxicol Forensic Med Open J*. 2019; 4(1): 18-23. doi: 10.17140/TFMOJ-4-129

18. Ponampalam R. Decontamination – Rationale and Step-By-Step Procedure. *SGH Proceedings*. 2003; 12(4): 213-221.

19. Aprea C, Terenzoni B, De Angelis V, Sciarra G, Lunghini L, Borzacchi G, et al. Evaluation of skin and respiratory doses and urinary excretion of alkylphosphates in workers exposed to dimethoate during treatment of olive trees. *Arch Environ ContamToxicol*. 2005; 48(1): 127-134. doi: 10.1007/s00244-004-0073-5

20. Joosen MJ, van der Schans MJ, Kuijpers WC, van Helden HP, Noort D. Timing of decontamination and treatment in case of percutaneous VX poisoning: A mini review. *Chem Biol Interact*. 2013; 203(1): 149-153. doi: 10.1016/j.cbi.2012.10.002

21. HHS. Guidelines for mass casualty decontamination during a hazmat/weapons of mass destruction incident. Volumes I and II. Web site. https://asprtracie.hhs.gov/technical-resources/resource/1807/guidelines-for-mass-casualty-decontamination-during-a-hazmat-weapon-of-mass-destruction-incident-volumes-i-and-ii. Accessed August 31, 2020.

22. Home Office. Guidance for the United Kingdom emergency services on decontamination of people exposed to hazardous chemical, biological or radiological substances, Home Office, London, 2013.

23. Primary Response Incident Scene Management (PRISM). Guidance for chemical. Incidents. Volume 1: strategic guidance for. Mass casualty disrobe and decontamination. Chilcott RP, Amlôt R, eds. Web site. https://www.medicalcountermeasures.gov/media/36872/prism-volume-1.pdf. Accessed August 31, 2020.

24. Okumura S, Okumura T, Ishimatsu S, Miura K, Maekawa H, Naito T. Clinical review: Tokyo - protecting the health care worker during a chemical mass casualty event: an important issue of continuing relevance. *Crit Care*. 2005; 9(4): 397-400. doi: 10.1186/cc3062

25. Worek F, Wille T, Koller M, Thiermann H. Toxicology of organophosphorus compounds in view of an increasing terrorist threat. *Arch Toxicol*. 2016; 90(9): 2131-2145. doi: 10.1007/s00204-016-1772-1

26. Chai PR, Boyer EW, Al-Nahhas H, Erickson TB. Toxic chemical weapons of assassination and warfare: Nerve agents VX and sarin. *Toxicol Commun*. 2017; 1(1): 21-23. doi: 10.1080/24734306.2017.1373503

27. Franca TCC, Kitagawa DAS, Cavalcante SFA, da Silva JAV, Nepovimova E, Kuca K. Novichoks: The dangerous fourth generation of chemical weapons. *Int J Mol Sci*. 2019; 20(5): 1222. doi: 10.3390/ijms20051222

28. Okudera H, Morita H, Iwashita T, Shibata T, Otagiri T, Kobayashi S, et al. Unexpected nerve gas exposure in the city of Matsumoto: Report of rescue activity in the first sarin gas terrorism. *Am J Emerg Med*. 1997; 15(5): 527-528. doi: 10.1016/s0735-6757(97)90201-1

29. The Technical Secretariat, Organisation for the Prohibition of Chemical Weapons. #Summary of the #report on activities carried out in support of a request for technical assistance by the #UK [#Salisbury Incident] (OPCW, Apr. 12 '18). Web site. https://hygimia69.blogspot.com/2018/04/summary-of-report-on-activities-carried.html. 2018; 1612. Accessed August 31, 2020.

30. Thompson J, Rehn M, Lossius HM, Lockey D. Risks to emergency medical responders at terrorist incidents: A narrative review of the medical literature. *Crit Care*. 2014; 18(5): 521. doi: 10.1186/s13054-014-0521-1

31. Geller RJ, Singleton KL, Tarantino ML, Drenzek CL, Toomey KE. Nosocomial poisoning associated with emergency department

treatment of organophosphate toxicity--Georgia, 2000. *J Toxicol Clin Toxicol*. 2001; 39(1): 109-111. doi: 10.1081/clt-100102889

32. Stacey R, Morfey D, Payne S. Secondary contamination in organophosphate poisoning: Analysis of an incident. *QJM*. 2004; 97(2): 75-80. doi: 10.1093/qjmed/hch020

33. Kenar L, Karayilanoglu T. Prehospital management and medical intervention after a chemical attack. *Emerg Med J*. 2004; 21(1): 84-88. doi: 10.1136/emj.2003.005488