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Synthetic Opioids in Operational Environments – Part II: Decontamination

As discussed in Part I of this series (*CBRNe World*, December 2017)[1], the US is in the midst of an opioid epidemic. This resulted in over 60,000 deaths in 2016, which corresponds to more than 1,100 people dying per week, or 160 deaths per day, across the US. The death rate is still climbing. Sadly, responses to synthetic opioids are the new 'white powder' calls. This paper focusses on current knowledge and suitable decontamination methods that can be applied to responders, objects, and surfaces when dealing with synthetic opioids.

Fentanyl and fentanyl analogues are predominantly a respiratory hazard to emergency responders. While they are also a dermal hazard, the material penetrates the skin and moves into the blood stream very slowly, so is unlikely to be the source of a toxic dose for emergency responders. For example: in the case of fentanyl, for an average 165lb (75kg) person, the dose required for an analgesic effect is estimated to be 2.5micrograms, an anaesthetic effect occurs between 25 and 125micrograms, and the lethal dose is 2.5milligrams. While the effects of fentanyl via inhalation are seen almost immediately, the effects from dermal exposure take hours.

An appropriate decontamination approach

Let's quickly review our knowledge of fentanyl. For this article, we will focus on the solubility (hydrochloride salt, citrate salt, oxalate salt, or free base), pH of the solution, concentration of the threat material and chemical behaviour.

The solubility of the different variants of synthetic opioids is an important factor when considering decontamination.

Water solubility: hydrochloride salt > citrate salt > oxalate salt > >> free base

Lipid solubility: free base >>> oxalate salt > citrate salt > hydrochloride salt

One way to increase the water solubility of lipid soluble materials is to add a surfactant (soap) to the solution. Regarding pH effects, measurements in cadaver skin demonstrated that the free base form of fentanyl is 218 times more permeable than the ionised (salt) forms with the maximum solubility reaching a plateau at pH9. Fentanyl also changes from its ionised form to the free base form at pH above neutral and it then becomes harder to destroy using oxidation. At pH3, 99.9% of the fentanyl would remain in its ionised (salt) form.[2] Therefore, it is important to maintain fentanyl solution pH below neutral so the salt stays in its ionised form since the free base form is harder to destroy using oxidation and passes more rapidly through the skin.

Higher concentrations of the threat material have a better chance of getting operationally relevant doses across the skin barrier.

Therefore, to minimise the amount of material available for personnel exposure and to assist decontamination, the duration, concentration, and surface area of the threat must be minimised, the pH must be maintained at neutral or below, and the temperature should remain at ambient.

There is much uncertainty about the way chemicals destroy fentanyl and its analogues. Recent studies have shown peracetic acid is effective, as is the related product, Dahlgren Decon.[3] However, bases were found to be ineffective, and there was much uncertainty about the efficacy of bleach solutions, including calcium hypochlorite. A comprehensive project has recently started at the University of Queensland in Australia to understand the destruction of fentanyl and its analogues in operational settings, however, we can still make informed decisions about suitable decontamination approaches with what we know.

Evidence-based decontamination guidance

Mucous membrane and skin exposure

The single most important factor when dealing with synthetic opioids, is to protect the respiratory tract. This is closely followed by protecting mucous membranes, such as the eyes, nose, and mouth. The skin should also be protected and opportunities for contact with fentanyl minimised.

From a decontamination perspective, if the eyes and mucous membranes are suspected of having been contaminated, they should be flushed with copious amounts of saline or water to remove and minimise the dose. Immediate medical support should then be provided.

Areas of direct skin contact with any residue suspected of containing synthetic opioids should be washed immediately with copious amounts of water. As soon as feasible, skin surfaces should additionally be washed with soap and water, applying a skin-safe, low-pH soap to the skin surface using a sponge or wash cloth with minimal pressure. The body should be rinsed with clean water at low-pressure and all body surfaces should be wiped with a towel until they are dry.

If an expedient decontamination method is not available, an emergency

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All kinds of vehicles have been used in drug manufacture, including buried school buses ©CBRNe World

decontamination procedure can be employed using a non-alcohol-based, low pH wipe to remove as much potential contamination as possible. It should be noted that the efficacy of wipes for removing threat materials, including synthetic opioids, has not been well characterised.

Harsh oxidising chemicals like bleach or peracetic acid should not be applied directly to the skin. Avoid any soaps or solutions at basic pH (pH > 7) as the increased pH will increase skin absorption. Avoid any wipes or solutions that are alcohol-based as alcohol has also been shown to double the rate of skin absorption.[4] Furthermore, avoid wipes with any other solvents present as there is little information available about their performance and effects on fentanyl skin permeation. Once dry, provide clean clothes or a temporary garment and monitor for any clinical symptoms of fentanyl exposure.

PPE, sensitive equipment, and evidence packaging

First, ensure the PPE, sensitive equipment and evidence packaging is not a source of contamination spread. Consider performing an initial gross decon using a highly absorbent wipe to remove any obvious signs of contamination from the PPE or equipment.

The next step is to select the decontamination agent and use a technical decontamination process to reduce contamination to a level that is non-detectable. At present the most appropriate solutions are those containing a surfactant and oxidant, specifically 4–5% peracetic acid or 8-10% hydrogen peroxide. They can be utilised to destroy residual amounts of synthetic opioids as long as the pH is modified to between five and seven. The pH modification will ensure that the material is not destructive to the sensitive equipment and materials, and will provide a secondary vapour suppression capability.[5]

Based on published data on the Dahlgen Decon product[3], the solution should remain in contact with the PPE or sensitive equipment for five minutes to ensure complete destruction of all fentanyl and fentanyl analogues. In addition, the solutions should be used within six to 12 hours of mixing to maintain appropriate concentrations and their effectiveness. Avoid using solutions at the pH extremes as they can be harsh on sensitive equipment and PPE materials.

If in doubt about the success of the process, it can be repeated. Sensitive equipment, PPE areas where high levels of contamination are visible or areas within three to four inches (76-102mm) of an interface that will be opened when doffing the gear can also be wiped to remove any residual decontaminant. Trace detection techniques can be used to monitor decontamination effectiveness.

Any potential evidence should be captured and managed following evidentiary best practice. The outside of the evidence packaging container should be decontaminated as if it were sensitive equipment (see process above) to minimise any potential for secondary contamination.

Surfaces/area

Following a synthetic opioid response, there are likely to be areas within a facility or in the environment where the response entity must destroy any residual materials to ensure continued public safety.

First, if possible prevent the surface from being a source of contamination spread. Then consider an initial gross decon step using a highly absorbent wipe to remove any obvious signs of contamination from the surface. This is likely to be most useful for small areas of contamination.

As for decontamination of PPE, sensitive equipment and evidence packaging, select the decontamination agent and use a technical decontamination process to reduce the surface contamination to a non-detectable level. Select the appropriate oxidising decontaminant solution to decontaminate areas where there is bulk material, or where trace material was thought to be, present. A variety of oxidising decontamination solutions are available[6], each with its own benefits and challenges (see Table 1). Be sure to keep hypochlorite and dichloroisocyanuric acid solutions separate as they can react violently when mixed.

For peracetic acid-based solutions, studies have shown that the decontamination solution should stay in place for a minimum of 10 minutes for bulk contamination and at least five minutes for trace contamination prior to removal.[3] Note that the contact times are determined based upon residual material on a surface. If bulk material remains, required contact times will increase and volumes of decontamination solution should be increased to ensure that the decontamination solution can penetrate through the materials.

The selection of suitable criteria for what is clean and for re-occupancy should also be determined prior to starting decontamination. Unlike with methamphetamines there is, unfortunately, little information available about suitable reoccupancy criteria after decontamination, so you should seek assistance from your local public health unit. All personnel should be appropriately protected when carrying out decontamination.

The complexity of decontaminating surfaces is highlighted in a recent case. In November 2017 a 69-year-old woman's death in Pennsylvania was believed to have been due to lethal opioid exposure while cleaning up after her 45-year-old son's overdose the previous day.[7] This highlights a number of issues including what is clean and what is a suitable health-based reoccupancy value especially for sites where there are sensitive populations, like children. As similar incidents become more prevalent, it will likely fall upon the emergency response community to decontaminate these scenes prior to allowing reoccupation. It is important to consult your local public health unit prior to such activities.

Based on the current state of knowledge regarding suitable decontaminants for situations as described above, the following table summarises the decontamination guidance provided. Green represents suitable solutions, yellow represents potential solutions and red represents solutions that should not be attempted.

Decon Solution	Active Ingredients for Oxidation	Skin	Sensitive Equipment, PPE, and Evidence Packaging	Surface and Area	Cost
Industrial / Household Chemicals					
Water			Relying upon physical removal, not oxidation		$
Soap & water	None		Relying upon physical removal, not oxidation		$
Clorox bleach	Sodium hypochlorite		pH ~10; dilute to 5% hypochlorite	30 min	$
HTH bleaching powder	Calcium hypochlorite		pH ~10; dilute to 5% hypochlorite	30 min	$
BruTab	Dichloroisocyanuric acid, sodium salt		pH ~6	10 min (releases chlorine gas)	$
Hydrogen peroxide	Hydrogen peroxide, 10%		pH ~5	10 min	$
Peracetic acid (PAA)	Peracetic acid, 5%		pH ~3	5 min (releases PAA fumes)	$
Military / Commercial Decon Solutions					
Dahlgren Decon	Peracetic acid		pH 7	5 min	$$$
Decon 7 or DF200	Hydrogen peroxide (pH increased by addition of quaternary ammonium compounds)		pH 9.8	10 min	$$

Table 1. Decontamination solutions for synthetic opioids

1. Baxter, C and Logan, M (2017) Synthetic Opioids in Operational Environments – Part I: Detection, CBRNe World, December 2017: 25-30.
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4. Grond, S, Radbruch, L, and Lehman, K (2000) Clinical Pharmacokinetics of Transdermal Opioids: Focus on Transdermal Fentanyl. Clin Pharmokokinet, 38: 59-89.
5. Donabed, J, Harvey, M, and Howarth, J (2016) The Effects of pH Adjustment on Peracetic Acid Vapor Production. EnviroTech White Paper.
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7. Fox News (2017) Woman Dies After Cleaning up Son's Fatal Drug Overdose, Coroner Says (http://www.foxnews.com/health/2017/11/15/woman-dies-after-cleaning-up-sons-fatal-drug-overdose-coroner-says.html)

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