

Health effects from unintentional occupational exposure to opioids among law enforcement officers: Two case investigations

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Abstract

Recent increases in the rate of drug overdose-related deaths, the emergence of potent opioids such as carfentanyl, and media reports of incidents have raised concerns about the potential for work-related exposure to a variety of illicit drugs among law enforcement officers (LEOs), other emergency responders, and other workers in the United States. To characterize the risk associated with unintentional occupational exposure to drugs, we retrospectively investigated two incidents that occurred in 2017 and 2018 where LEOs were exposed to opioid and stimulant drugs and experienced health effects. We interviewed five affected LEOs and others. We reviewed records, including emergency department documentation, incident reports, forensic laboratory results, and when available, body camera footage. Multiple drug types, including opioids and nonopioids, were present at each incident. Potential routes of exposure varied among LEOs and were difficult to characterize with certainty. Health effects were not consistent with severe, life-threatening opioid toxicity, but temporarily precluded affected LEOs from performing their essential job duties. While health risks from occupational exposure to drugs during law enforcement activities cannot currently be fully characterized with certainty, steps to prevent such exposures should be implemented now. The creation and implementation of appropriate controls plus education and training are both important to protecting first responders from these hazardous agents. To more fully characterize potential exposures, timely prospective toxicological evaluation of affected responders is recommended.

KEYWORDS

fentanyl, first responders, illicit drugs, law enforcement officers, opioids

1 | INTRODUCTION

In 2016, there were an estimated 701 000 sworn law enforcement officers (LEOs) employed full-time by approximately 15 300 US law

enforcement agencies.¹ LEOs are known to be at risk of occupational exposure to illicit drugs—opioids, stimulants, and others—in a variety of settings.^{2–5} In this context, we define illicit drugs as drugs that are either (1) illegal to process, sell, and consume, or (2) are legally

TABLE 1 Summary of officers' activities during the incidents and selected health information

HHE	Officer	Activities	Symptoms reported	Symptom onset location and timing	Clinical impression of emergency department physician
1	LEO 1	Traffic stop and vehicle search	Feeling of disorientation, lightheadedness, feeling "sleepy," and "blurry vision"	At the scene of the traffic stop, within several minutes	Chemical exposure
2	LEO 2	Initial entry into room, detained and assisted subjects while maintaining scene security	Dizziness, increased sweating, blurry vision, weakness, feeling of warmth, feeling "drunk"	At the scene of the response, approximately 75 min after initial response and approximately 3 min after assisting subject	Acute dizziness, possible accidental overdose
2	LEO 3	Initial entry into room, detained subjects, took photos, returned to police department to process warrant	Lightheadedness, dizziness, feeling "groggy," numbness in both hands and tongue	At police headquarters, approximately 25 min after initial response	Acute dizziness (resolved), possible fentanyl exposure
2	LEO 4	Initial entry into room, detained and assisted subjects while maintaining scene security	Lightheadedness, dizziness, headache, blurry vision, feeling "high"	In the ambulance, approximately 90 min after initial response	Acute dizziness, possible fentanyl exposure
2	LEO 5	Handled equipment from the scene of the response and cleaned gear and vehicle; both activities at police headquarters	Lightheadedness, dizziness, weakness, headache, blurry vision, increased sweating, feeling of warmth, feeling "drunk"	At the police department, approximately 30-45 min after initially assisting with handling of equipment	Dizziness, possible fentanyl exposure

Abbreviations: HHE, Health Hazard Evaluation; LEO, law enforcement officer.

prescribed by a physician but have either been misused by a patient with a prescription or illegally obtained by or for a person for whom the drug was not prescribed. Data on the general US population from 2015 to 2016 revealed a 100% increase in the rate of overdose deaths involving synthetic opioids, which includes fentanyl and its analogues.⁶ Synthetic opioid-related overdose deaths from 2010 to 2016 often also involved other drugs or alcohol.⁷ Fentanyl, which can be 50 to 100 times more potent than morphine, is increasingly mixed with substances such as cocaine and methamphetamine, and the number of law enforcement seizures of extremely potent fentanyl analogues such as carfentanil (up to 10 000 times more potent than morphine) have increased in 2016 and the first half of 2017.⁶ These trends raise concerns about the potential for work-related exposure to these hazardous chemical substances among LEOs, other types of responders, and correctional officers.

Print and electronic media have reported instances of exposures and health effects among first responders and other public service workers across the United States for the past several years.^{8,9} However, media reports provide incomplete or uncorroborated information about incidents involving work-related exposures to drugs among responders. Detailed investigations are needed to guide risk mitigation strategies. The purpose of this report is to (1) summarize the investigation of two exposure incidents among LEOs, (2) discuss current considerations for prevention of occupational exposure to fentanyl and fentanyl analogues, and (3) emphasize the need for risk mitigation strategies while additional investigations are undertaken to address data gaps.

2 | METHODS

This report summarizes two Health Hazard Evaluations (HHEs) conducted by the National Institute for Occupational Safety and Health (NIOSH) to evaluate incidents involving LEO responses to drugs that occurred in two states in 2017 and 2018.^{10,11} The HHEs were requested by law enforcement agencies to evaluate LEOs' health effects after unintentional occupational exposure to drugs, including fentanyl and fentanyl analogues. The objectives of the HHEs were to evaluate the potential exposure to drugs among LEOs and the reported health effects, and to provide recommendations to the agencies concerning prevention of occupational exposures to drugs among LEOs.

NIOSH investigators made site visits to each law enforcement agency to interview the LEOs who experienced health effects and others to understand the circumstances of the incidents and the workplace practices and procedures followed during the incident. NIOSH investigators also reviewed medical records related to the incident, law enforcement agency documentation of the incident, and forensic laboratory testing results of samples collected as evidence. In HHE 2, body camera video footage of the incident was available and reviewed.

3 | RESULTS

Brief summaries of the two incidents are provided below.

3.1 | Health Hazard Evaluation 1

A police officer (LEO 1) performed a traffic stop and vehicle search (Table 1). Materials consistent with illicit drugs were found, including a purse containing a package of compressed powder and the contents of an unlabeled rubber container (Figure 1). When LEO 1 opened the rubber container outside of the vehicle, a gust of wind blew powder from inside the rubber container onto LEO 1, who reported that the powder was “all over me and my uniform.” LEO 1 was wearing a short-sleeved uniform and no gloves. LEO 1 attempted to brush the powder off and used hand sanitizer to clean LEO 1's hands and arms.

Within 5 minutes of opening the container, LEO 1 became disoriented and lightheaded, and had “blurry vision.” A second officer called for an ambulance, which arrived approximately 10 minutes after symptom onset. Emergency medical service (EMS) providers assisted with decontamination by washing LEO 1's exposed skin with water. EMS providers noted that LEO 1 was alert upon their arrival. LEO 1's initial vital signs were blood pressure of 175/127 millimeters of mercury (mmHg) (120/80 mmHg or above is currently defined as abnormal), respiratory rate of 17 breaths per minute (normal resting respiratory rate is 12–15 breaths per minute), and heart rate of 105 beats per minute (normal is <100 beats per minute). EMS providers noted that LEO 1's pupils were 4 mm (normal range is 2–4 mm in diameter depending on ambient light) and reactive. During transport to the emergency department (ED), LEO 1 noted intermittent symptoms of “trouble thinking and staying awake.”

LEO 1 arrived at the ED approximately 42 minutes after symptom onset. LEO 1 reported “mild blurry vision” in the ED, which resolved after several hours. Physical examination in the ED noted that LEO 1 was alert and there were “no constricted pupils.” Vital signs measured during EMS transport and during the ED visit included heart rate ranging between 80 and 85 beats per minute, respiratory



FIGURE 1 Materials found during HHE 1. LEO 1 opened the rubber container on the right. Forensic laboratory testing later showed that the powder remaining in the container included fentanyl and methamphetamine. The material in the paper wrapper on the left contained fentanyl. HHE 1, Health Hazard Evaluation 1; LEO 1, Law Enforcement Officer 1 [Color figure can be viewed at wileyonlinelibrary.com]

rate ranging from 15 to 21 breaths per minute, and blood pressure ranging from 149/77 to 159/104 mm Hg. No laboratory tests were done on LEO 1 in the ED. Symptoms resolved in the ED and the ED physician's discharge assessment was “chemical exposure.” The forensic laboratory identified fentanyl and methamphetamine in the powder remaining in the rubber container (Table 2).

3.2 | Health Hazard Evaluation 2

Four police officers (LEOs 2–5) developed symptoms while responding to a 911 call about an unconscious person with a possible drug overdose in a hotel room (Table 1). Three of the four officers (LEOs 2–4) responded to the hotel room. Upon entry, they saw drug paraphernalia and powders scattered in various parts of the hotel room in plain view. Two people were in the hotel room. The overdose victim mentioned in the 911 call was in the hotel room's bathroom. Officers noted hearing the toilet flush multiple times. The overdose victim was observed by the LEOs to be intoxicated, but was conscious and refused emergency medical care. LEOs 2–4 detained the two subjects and secured the hotel room while awaiting the processing of a search warrant. LEOs 2–4 were wearing short-sleeved uniforms. LEOs 2 and 3 wore gloves upon entry into the hotel room and LEO 4 put on gloves shortly after entering the hotel room. LEOs 2–4 took turns leaving the hotel room to retrieve and put on half-facepiece respirators with P-100 filters after what appeared to be drugs in powder form were observed. LEO 3 returned to police headquarters to process a search warrant to further search the hotel room; this involved working on a computer and handling a camera that LEO 3 had used to take photographs in the hotel room.

At police headquarters, LEO 3 was assisted by LEO 5. LEO 5 handled the camera and other items that had been in the overdose victim's hotel room; those items had no visible signs of contamination with materials from the hotel room. While at police headquarters, LEOs 3 and 5 both developed lightheadedness and dizziness. LEO 3 also reported feeling “groggy” and complained of numbness in both hands and tongue, while LEO 5 reported weakness, headache, blurry vision, increased sweating, a feeling of warmth, and “feeling drunk” as well. The two officers who remained to secure the hotel room while the search warrant was obtained (LEOs 2 and 4) developed symptoms at the scene or soon after leaving the scene. Of note, LEO 2's initial symptoms, which included blurry vision, feeling of warmth, weakness, dizziness, lightheadedness, and feeling “drunk,” progressed such that LEO 2 was assisted outside the hotel room before slumping against the wall and subsequently to the ground. LEO 4 administered one dose of intranasal naloxone to LEO 2 with rapid improvement in symptoms.

Before transport to the ED, LEOs 2–5 underwent decontamination procedures consisting of removing clothing and equipment, showering or being washed with water, and donning fresh garments. LEOs 2–5 were not reported to have respiratory depression. In the ED, LEOs 2–5 had normal body temperatures, normal to elevated blood pressures, and normal to elevated heart rates. LEOs 2–4 had normal to elevated respiratory rates during their monitoring period; LEO 5 had a respiratory rate ranging from 9 to 20 breaths per minute

TABLE 2 Substances identified by the forensic laboratory from specimens gathered at the scenes of the responses

HHE	Substance	Form	Weight, g	DEA schedule
1	Fentanyl	Compressed tan powder	9.98	II
1	Fentanyl, methamphetamine	Tan powder and chunks ^a	1.56	II
1	Methamphetamine	Crystals	0.006	II
1	Buprenorphine	Sealed packages ^b labeled "Suboxone sublingual film" containing orange strips	0.28	III
2	Dibutylone	Residue	-	I
2	N-ethylpentylone	Powder, solid material, residue	2.87	I
2	Heroin	Powder	0.14	I
2	Para-fluoroisobutyl fentanyl	Residue	-	I ^c
2	Cocaine	Residue, liquid in syringe	-	II
2	Methamphetamine	Residue, liquid in syringe	-	II
2	Fentanyl	Powder, residue	0.14	II

Abbreviation: DEA, Drug Enforcement Administration.

^aRubber container opened by LEO 1, which resulted in release of powder.

^bOne of the packages was randomly tested. The orange strips were visually consistent with Suboxone, a pharmaceutical product containing 2 mg of naloxone and 8 mg of buprenorphine.

^cTemporary placement.¹²

in the ED. On physical examination, LEOs 2–5 were alert and oriented; none had documented constricted pupils. Electrocardiograms did not reveal any electrocardiographic abnormalities. LEOs 3–5 had blood tests which ruled out several medical conditions including volume depletion and hypoglycemia; LEO 2 did not have blood tests. Urine samples from LEOs 2–5 tested negative in a screen for cannabinoids, phencyclidine, cocaine, opiates (a subset of opioids), amphetamines, benzodiazepines, and barbiturates. LEOs 2–5 were discharged from the ED after several hours of observation and improvement of symptoms. After the incident, forensic laboratory testing of evidence samples confirmed that opioids, cocaine, methamphetamine, and cathinones ("bath salts") were present in the hotel room (Table 2).

4 | DISCUSSION

The current opioid epidemic has drawn attention to the risk of unintentional occupational exposure to extremely hazardous opioids, such as fentanyl and its analogues, and other stimulant drugs, among first responders.^{13–16} This report summarizes two NIOSH HHEs* involving five LEOs experiencing health effects during and immediately after participating in response incidents involving opioid and stimulant drugs. Since LEOs work in a dynamic environment with no "typical" workplace exposures, these two incidents were chosen to illustrate different types of scenarios that might lead to exposure and health effects. Forensic laboratory data were also available. Other evaluations of incidents involving first responders with unintentional occupational exposures to drugs, with similar implications for

prevention, are available at <https://www.cdc.gov/niosh/topics/fentanyl/resources.html>.

4.1 | Issues related to health effects

In these two incidents, the five LEOs experienced a variety of health effects that precluded them from continuing to perform their essential law enforcement job duties. The health effects experienced by the officers were not consistent with severe (life-threatening or late-stage) opioid toxicity. Signs and symptoms of severe or late-stage opioid toxicity include profound lethargy or other indications of central nervous system depression; shallow, slow, or absent breathing; constricted pupils or miosis; slow heart rate; and low body temperature.^{17,18} Low-dose exposure to opioids may result in milder symptomatology; a continuum of signs and symptoms experienced upon exposure to opioids has been described.^{14,19} Nonspecific symptoms such as nausea and lightheadedness, reported by the LEOs in these two incidents, are consistent with symptoms along this continuum. The improvement in symptomatology in LEO 2 with the administration of intranasal naloxone suggests that opioids were a substantial component of the mixed exposure.

Low-level exposure to combinations of opioids and other drugs, particularly stimulants such as cocaine or amphetamines, might be consistent with the variety of health effects experienced by the LEOs in these two incidents. Exposure to a combination of opioids and stimulants might produce health effects not characteristic of a pure opioid or a pure stimulant exposure. For example, toxicity from stimulants involves elevated heart rate and blood pressure, increased alertness, sweating, nausea and vomiting, and hallucinations.^{20,21} Cocaine also has local anesthetic effects such as numbness and tingling.²² Additionally, nonpharmaceutical grade or illicit drugs might contain adulterants or contaminants that might, by themselves

*The NIOSH HHE program conducts evaluations of workplaces to learn whether workers are exposed to hazardous materials or harmful conditions and to provide recommendations on preventing exposures and work-related health effects (<https://www.cdc.gov/niosh/hhe/HHEprogram.html>).

or in combination, lead to a variety of health effects in exposed individuals.^{23,24}

In addition to a drug's pharmacological characteristics, other factors such as perceived risk might contribute to the observed health effects. The concept of "perceived risk," or the subjective judgement that individuals make about the type and severity of any risk, has been associated with increased anxiety and symptom reporting separate from physical exposure to a hazard.²⁵ In the context of these incidents, perceived risk refers to an individual's belief that he or she has been exposed to opioids or other chemicals, and the extent to which he or she believes such exposure will result in negative consequences. The relationship between physical symptoms and physiological dysfunction can be variable and context-dependent.²⁶ Although conceptual frameworks for understanding this relationship are under development, it has been proposed that the degree to which a person experiences perceived risk might affect how bodily sensations are experienced as symptoms.²⁵⁻²⁷ The possible relationships between perceived risk, the types of exposures, and the clinical status of the LEOs discussed in this report were not assessed. Validated tools could be adapted to assess LEOs' perceived risk in future investigations of incidents involving exposure to drugs and health effects experienced.^{25,28,29}

4.2 | Issues related to risk characterization—Hazard and exposure

Potential routes of occupational exposure to drugs include inhalation, mucous membrane absorption, ingestion, absorption through the skin, or a combination. Brief skin contact with powdered fentanyl or its analogues is not expected to lead to toxic effects if visible contamination is promptly removed.^{14,30,31} In these two investigations, all these routes of exposure were possible. Contamination of gloves or bare hands with subsequent hand-to-face contact can lead to mucous membrane exposure, highlighting the need for training (eg, glove changes performed in the proper manner and avoidance of touching the face). Alcohol-based hand sanitizer (eg, as used by LEO 1) may increase absorption of fentanyl powder and should be avoided.^{15,31}

Quantifying the risk associated with potential exposure to drugs present in incidents involving emergency responders is difficult for a number of reasons. A complete characterization of all substances present at incidents involving drugs is unlikely to occur. Both incidents involved multiple types of drugs identified through forensic testing, a finding consistent with recent data showing an expanding number of poly-drug combinations implicated in fatal opioid overdoses.³² While laboratory analyses might be conducted after the response is completed, such analyses are typically conducted for law enforcement purposes, and may not accurately represent the actual amounts of various substances present at the scene of the response. For example, not all of the substances present at the scene of a response may be sent to the laboratory for analysis. Although authorities are aware of many fentanyl analogues, the specific

analogues that responders might face in any given situation are difficult to anticipate.³³

Whether real-time analyses of substances can be performed during a response depends on a number of factors.^{34,35} Field portable devices for presumptive drug testing currently available are often expensive. Not all responding agencies can afford the equipment, or they may have limited staff trained to operate and interpret results in the field.³⁵ The selectivity and sensitivity of these tools are highly variable and operators need training to understand the capabilities and limitations of the instrument they are using. For example: (1) these instruments can only identify drugs that have a match to drugs in the instruments' library and (2) some technologies can detect trace quantities of drugs while others can only detect bulk quantities.³⁶ Responders should be knowledgeable about the limitations of the instruments they use because the absence of identification does not completely rule out the presence of a hazardous drug. Hazardous drugs may be present at concentrations below the instrument's detection level but still present at levels that may cause health effects in responders. Recent work has demonstrated the potential for techniques such as thermal desorption direct analysis in real-time mass spectrometry and ion mobility spectrometry to be used in the field for rapid and sensitive detection of fentanyl and a number of fentanyl analogues.³⁷

Issues related to routes of exposure also make risk characterization challenging. The specific work activities performed by LEOs and other responders will vary with every response. Potential occupational exposures to drugs typically occur in the setting of law enforcement or emergency medical care activities. The rapidly changing environment and public safety concerns during such responses might impede exposure assessment for occupational health prevention efforts. Responders might not know which parts of any specific scene are contaminated with a potentially toxic agent. Additionally, the work environment can vary by response. The incident in HHE 1 occurred during an outdoor response with hot, windy conditions. In HHE 2, LEOs 2-5 were faced with an indoor scene, where factors such as the type of ventilation and room size can present markedly different potentials for exposure. When the officers in HHE 2 arrived at the hotel room, they heard the toilet being flushed multiple times by the overdose victim. In some situations, subjects using illicit substances might hide or dispose of those substances before interacting with police, for example, by dumping them into the toilet and flushing repeatedly. This process likely contaminates bathroom floors and surfaces.³⁸ Bathrooms, which usually are small spaces with limited ventilation, might also allow materials to remain airborne longer and be more concentrated.

The LEOs' negative urine drug screens in HHE 2 do not rule out the possibility of exposure to drugs. The ability to detect synthetic opioids in the blood (or serum) and urine is an area of active investigation, with known limitations.^{19,33} For example, routine urine toxicology tests currently used are designed to screen for opiates, which constitute the subset of opioids derived from the poppy plant and opioids that metabolize to morphine, such as heroin. Screening tests for opiates will not detect synthetic opioids such as fentanyl.¹⁹

Similarly, synthetic cathinones are not readily detected by most screening assays for amphetamines.³⁹ Other uncertainties include the timing of testing relative to potential exposure, the pharmacokinetics of the drug and exposure route, and the sensitivity of various tests. Urine drug screens for LEOs 2–5 included tests for amphetamines and cocaine, which were negative at cutoff values of 500 and 150 ng/mL, respectively. However, established cutoff levels for urine drug screening tests take into consideration the desirability of avoiding false-positive tests⁴⁰; results lower than established cutoff levels are reported as negative.

4.3 | Investigation limitations

There are several limitations with the investigations of these incidents. First, the evaluations were retrospective in nature. The interviews were conducted weeks to months following the exposure incident. However, to the best of our knowledge, these evaluations are the only organized review of exposures to opioids and other drugs among emergency responders to date. Limitations related to characterization of the risk (including both hazard and exposure components) facing the LEOs in these incidents are discussed above. Second, a standardized clinical or toxicological practice guideline is not available for use by healthcare providers. The health evaluations we reviewed varied in content and scope but all were appropriately based on the healthcare providers' clinical judgment and assessment of the occupational exposure scenario. However, through reviewing only the records from the acute ED evaluation and treatment, it was not possible to retrospectively assess the possibility that medical conditions not evaluated at the time might have contributed to the observed health effects. Since the medical evaluations were guided by clinical need based on the LEOs' presentation, toxicological data for characterizing occupational exposure was not always available.

4.4 | Prevention for first responders

The health effects experienced by the officers in these incidents were debilitating for some officers and did not allow any officers to continue conducting their essential law enforcement job duties. While the potential for risk associated with unintentional occupational exposure to drugs among responders is clear from these investigations, there are challenges that prevent complete characterization of that risk and the relationship of specific exposures to observed health effects. While these data gaps are being addressed through additional investigations, steps to prevent exposures and work-related health effects are indicated for all organizations employing responders or other public service workers who face similar risks. Although the etiology of health effects is not well-characterized, to assume that they are merely a reflection of responders' "perception" of risk, and that no protective measures need be taken to prevent responders' exposure to hazardous drugs, endangers the lives of both responders and the victims they are aiding.

Steps for prevention fall into two main categories: (1) creation and implementation of guidance of appropriate controls and (2) education and training. Both are important to help protect first

responders from exposure to hazardous agents and for first response work to be performed in a manner that minimizes the potential for health effects from illicit drug exposure. NIOSH and others have issued guidance on how to protect emergency responders from exposures to fentanyl and its analogues.^{15,16,30,31} Although a few details differ between the guidelines, these guidance documents are uniform in important prevention principles applicable to these work settings: on-scene risk assessment, work practices to minimize exposure, and personal protective equipment (PPE) selection based on the anticipated level of exposure. Training is needed to increase first responders' understanding of these topics and preparation, which can help prevent unintentional exposures and provide information on actual versus perceived risk in specific exposure situations. The latter might modulate the perception of risk associated with job duties involving drugs and minimize stress reactions. For example, one may be less likely to experience acute anxiety if he or she understands that incidental dermal exposure with suspected fentanyl products in powder form can be remedied by washing the affected skin with soap and water,¹⁶ as opposed to believing that any dermal contact will result in a life-threatening opioid overdose.

Recent data show that the current opioid epidemic frequently involves situations in which multiple drugs are abused.³² In the incidents described here, LEOs encountered multiple drugs at the response scenes. However, we believe the principles outlined in the current guidance focusing on fentanyl are applicable to these evaluations in the absence of guidance specific for many other opioid and stimulant drugs to which first responders might be exposed. In the context of the current opioid epidemic, it is increasingly likely that fentanyl will be present in a scene where other hazardous drugs are found.⁴¹ However, at the time of any given response, first responders will generally not know the identity of all the substances at the scene.⁴² The severity of harm that could result from exposure to inherently hazardous drugs like fentanyl and its analogues is the foundational reason why protective measures for responders need to be implemented for all incidents involving drugs. NIOSH guidance encompasses scene assessment, work practices, PPE, and training, which all help prevent occupational exposures in responders. Additionally, the availability of naloxone and training about appropriate indications for its administration and how best to administer it are important medical countermeasures to keep first responders safe.^{13,31}

4.5 | Next steps

Further efforts to gather more information to address knowledge gaps regarding the degree of risk from unintentional occupational exposure during incidents involving drugs are needed and can guide updates to current guidance.¹³ Improved surveillance of occupational exposures can provide valuable information about the frequency and circumstances of these incidents over time for a larger population of responders. Laboratory studies, such as laboratory simulations of exposure scenarios, should also be considered as a means of increasing basic knowledge concerning exposure.

Medical evaluations of potentially exposed responders who experience health effects represent opportunities to capture more information about the relationship among essential job duties, potential exposures to hazardous drugs, and health effects in future incidents. Guidelines or best practices for the initial evaluation and treatment of responders potentially exposed in these unique work settings and incidents are not currently available. Clinicians should continue to follow established clinical practice, including recommended practice guidelines where available, to evaluate and treat responders presenting with symptoms that could be related to potential occupational exposure to hazardous drugs including opioids and stimulants. Medical causes other than exposures to illicit drugs should also be considered as clinically appropriate. The creation and dissemination of guidelines for medical evaluation and treatment of potentially exposed responders should be an area of future investigation.

Current rapid point-of-care drug screening tests are limited in the ability to assess these types of occupational exposures. The tests are often designed to report only the presence or absence of a drug and the reporting limit for identification of an impaired user may be higher than what would be seen with a lower level of exposure. Timing of sample collection from the potentially exposed person is also critical. For example, serum fentanyl concentrations peak within minutes after an intravenous or transmucosal dose,^{43,44} so delayed serum testing might not detect exposure. The appearance of a drug or its metabolite in urine may take hours following exposure, also possibly contributing to missed detection of exposure.^{45,46} In a small study of outpatient surgical patients, fentanyl was detectable in urine samples up to 72 hours after surgery; the fentanyl metabolite norfentanyl was detected in approximately half of samples at 96 hours.⁴⁵ Pre-shift urine sampling was identified as a part of biomonitoring strategy for previous-day exposures among pharmaceutical workers producing fentanyl.⁴⁷ However, since windows of detection might differ by dose, route of exposure, and test characteristics,⁴⁸ their application in assessing occupational exposure among responders remains unclear. Methods such as liquid or gas chromatography-mass spectrometry have been used to evaluate for illicit and pharmaceutical drugs and metabolites in a mass overdose situation in a nonoccupational setting⁴⁹ and in forensic toxicology.^{33,50,51} Methods to test for fentanyl and fentanyl analogues involving other biological matrices such as hair and oral fluids are being developed.^{52,53} However, these tests are not currently widely available clinically. In the future, such tests might be able to provide more information about exposures and health outcomes among first responders with potential unintentional occupational exposure to hazardous drugs.

5 | CONCLUSION

The current US opioid epidemic has raised concerns about the potential for unintentional exposure to potent opioids like fentanyl and its analogues among LEOs and other responders while performing essential job duties. The two investigations summarized here report findings from five LEOs who developed work-related health effects during incidents in which opioids were present. Subsequent forensic testing revealed that

multiple types of hazardous drugs, including opioids such as fentanyl and stimulants such as cocaine or methamphetamine, were present at each incident. The health effects experienced by LEOs in these evaluations were not consistent with severe, life-threatening, late-stage opioid toxicity, but were severe enough that LEOs needed medical attention and could not continue performing their duties. Despite current knowledge gaps in exposure and hazard characterization in these situations, steps to prevent unintentional occupational exposure to hazardous drugs among responders should be undertaken now.

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CONFLICT OF INTERESTS

The authors declare that there are no conflict of interests.

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John Meyer declares that he has no conflict of interest in the review and publication decision regarding this article.

AUTHOR CONTRIBUTIONS

SKC, JLH-M, MAD, and DT contributed to the design of the work and the acquisition, analysis, or interpretation of data. SKC and DT drafted the manuscript. All authors revised the manuscript for important intellectual content, provided final approval of the version to be published, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

ETHICS APPROVAL AND INFORMED CONSENT

The work was performed at the National Institute for Occupational Safety and Health. Ethics review was not necessary because the evaluations were considered a public health activity. Written informed consent was obtained for medical record release.

DISCLAIMER

The findings and conclusions in this commentary are solely those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health, the Centers for Disease Control and Prevention, or the US Department of Health and Human Services.

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REFERENCES

- Bureau of Justice Statistics. Full-time employees in law enforcement agencies, 1997–2016 (NCJ 251762). <https://www.bjs.gov/content/pub/pdf/ftelea9716.pdf>. Accessed 3 October 2018.
- Burgess JL, Barnhart S, Checkoway H. Investigating clandestine drug laboratories: adverse medical effects in law enforcement personnel. *Am J Ind Med*. 1996;30:488-494.
- NIOSH. Health hazard evaluation report: evaluation of police officers' exposures to chemicals while working inside a drug vault—Kentucky. By Fent KW, Durgam S, West C, Gibbins J, and Smith J. Cincinnati, OH: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, NIOSH HETA No. 2010-0017-3133. <https://www.cdc.gov/niosh/hhe/reports/pdfs/2010-0017-3133.pdf>. Accessed 3 October 2018.
- NIOSH. Health hazard evaluation report: evaluation of law enforcement agents' potential exposures during a raid of a clandestine "spice" lab. By Ramsey JG, Tapp L, Burr G. Cincinnati, OH: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, NIOSH HHE Report No. 2014-0039-3246. <https://www.cdc.gov/niosh/hhe/reports/pdfs/2014-0039-3246.pdf>. Accessed 3 October 2018.
- Witter RZ, Martyny JW, Mueller K, Gottschall B, Newman LS. Symptoms experienced by law enforcement personnel during methamphetamine lab investigations. *J Occup Environ Hyg*. 2007;4:895-902.
- Centers for Disease Control and Prevention. Overdose deaths involving opioids, cocaine, and psychostimulants—United States, 2015–2016. *MMWR Morb Mortal Wkly Rep*. 2018;67:349-358.
- Jones CM, Einstein EB, Compton WM. Changes in synthetic opioid involvement in drug overdose deaths in the United States, 2010–2016. *JAMA*. 2018;319:1819-1821.
- Silva BM War on opioids: first responders on front lines. <https://turnto10.com/features/health-landing-page/war-on-opioids-first-responders-on-the-front-lines>. Accessed 9 March 2018.
- WSAZ News Staff. 29 Treated for fentanyl exposure at Ross Co. prison, substance identified as heroin/fentanyl combination. <http://www.wsaz.com/content/news/Ross-Correctional-Institution-on-lockdown-491990671.html>. Accessed 9 September 2018.
- NIOSH. Health hazard evaluation report: Evaluation of a New Hampshire law enforcement officer's unintentional occupational exposure to illicit drugs. By Chiu S, Hornsby-Myers J, Trout D. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, NIOSH HETA No. 2018-0132-3322. <https://www.cdc.gov/niosh/hhe/reports/pdfs/2018-0132-3322.pdf>. Accessed 3 October 2018.
- NIOSH. Health hazard evaluation report: Evaluation of law enforcement officers' potential occupational exposure to illicit drugs — Virginia. By Chiu S, Hornsby-Myers J, Trout D. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, NIOSH HETA No. 2018-0113-3325. <https://www.cdc.gov/niosh/hhe/pdf/2018-0113-3325.pdf>. Accessed 3 October 2018.
- Drug Enforcement Administration. Schedules of controlled substances: temporary placement of 4-fluoroisobutyl fentanyl into Schedule I. Temporary scheduling order. *Fed Regist*. 2017;82:20544-20548.
- Howard J, Hornsby-Myers J. Fentanyls and the safety of first responders: science and recommendations. *Am J Ind Med*. 2018;61:633-639.
- Lynch MJ, Suyama J, Guyette FX. Scene safety and force protection in the era of ultra-potent opioids. *Prehosp Emerg Care*. 2018;22:157-162.
- NIOSH. Fentanyl: preventing occupational exposure to emergency responders. <https://www.cdc.gov/niosh/topics/fentanyl/risk.html>. Accessed 3 October 2018.
- White House Office of National Drug Control Policy. Fentanyl safety recommendations for first Responders. <https://www.whitehouse.gov/ondcp/key-issues/fentanyl>. Accessed 3 October 2018.
- Boyer EW. Management of opioid analgesic overdose. *N Engl J Med*. 2012;367:146-155.
- Ropper AH, Samuels MA, Klein JP, eds. *Adams and Victor's Principles of Neurology*. 10th ed. New York: The McGraw-Hill Companies; 2014.
- Suzuki J, El-Haddad S. A review: fentanyl and non-pharmaceutical fentanyls. *Drug Alcohol Depend*. 2017;171:107-116.
- Baumann MH, Solis E, Watterson LR, Marusich JA, Fantegrossi WE, Wiley JL. Bath salts, spice, and related designer drugs: the science behind the headlines. *J Neurosci*. 2014;34:15150-15158.
- Krotulski AJ, Papsun DM, De Martinis BS, Mohr ALA, Logan BK. N-Ethyl pentylone (ephylone) intoxications: quantitative confirmation and metabolite identification in authentic human biological specimens. *J Anal Toxicol*. 2018;42:467-475.
- Aronson JK. Cocaine. In: Aronson JK, ed. *Meyler's Side Effects of Drugs*. 16th ed. Waltham, MA: Elsevier; 2016:pp. 492-542.
- Behrman AD. Luck of the draw: common adulterants found in illicit drugs. *J Emerg Nurs*. 2008;34:80-82.
- Cole C, Jones L, McVeigh J, et al. Adulterants in illicit drugs: a review of empirical evidence. *Drug Test Anal*. 2011;3:89-96.
- Gallacher J, Bronstering K, Palmer S, Fone D, Lyons R. Symptomatology attributable to psychological exposure to a chemical incident: a natural experiment. *J Epidemiol Community Health*. 2007;61:506-512.
- Van den Bergh O, Wittholft M, Petersen S, Brown RJ. Symptoms and the body: taking the inferential leap. *Neurosci Biobehav Rev*. 2017;74:185-203.
- Dalton P, Wysocki CJ, Brody MJ, Lawley HJ. The influence of cognitive bias on the perceived odor, irritation and health symptoms from chemical exposure. *Int Arch Occup Environ Health*. 1997;69:407-417.
- Kalkstein AJ, Sheridan SC. The social impacts of the heat-health watch/warning system in Phoenix, Arizona: assessing the perceived risk and response of the public. *Int J Biometeorol*. 2007;52:43-55.
- Marcon A, Nguyen G, Rava M, Braggion M, Grassi M, Zanolin ME. A score for measuring health risk perception in environmental surveys. *Sci Total Environ*. 2015;527-528:270-278.
- Interagency Board. Recommendations on selection and use of personal protective equipment and decontamination products for first responders against exposure hazards to synthetic opioids, including fentanyl and fentanyl analogues. Arlington, VA: Interagency Board. <https://www.interagencyboard.org/content/first-responder-pe-and-decontamination-recommendations-fentanyl-august-2017>. Accessed 3 October 2018.
- Moss MJ, Warrick BJ, Nelson LS, et al. ACMT and AACT position statement: preventing occupational fentanyl and fentanyl analog exposure to emergency responders. *Clin Toxicol*. 2017;56:391-400.
- CDC. Rising numbers of deaths involving fentanyl and fentanyl analogs, including carfentanil, and increased usage and mixing with non-opioids. Health Alert Network Update 413. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, Office of Public Health Preparedness and Response. 2018. <https://emergency.cdc.gov/han/han00413.asp>. Accessed 3 October 2018.
- Armenian P, Vo KT, Barr-Walker J, Lynch KL. Fentanyl, fentanyl analogs and novel synthetic opioids: a comprehensive review. *Neuropharmacology*. 2017;134(Part A):121-132.
- Hargreaves MD. Drugs of abuse—application of Handheld FT-IR and Raman spectrometers. In: Chalmers JM, Edwards HG, Hargreaves MD, eds. *Infrared and Raman Spectroscopy in Forensic Science*. West Sussex, UK: John Wiley & Sons; 2012:pp. 339-349.

35. Forensic Technology Center of Excellence. Landscape study of field portable devices for chemical and presumptive drug testing. Washington, DC: US Department of Justice, National Institute of Justice, Office of Investigative and Forensic Sciences. <https://forensiccoe.org/landscape-study-of-field-portable-devices-for-presumptive-drug-testing/>. Accessed 3 October 2018.
36. Baxter C Looking for my china girl. *CBRNe World*. 25–30. http://www.cbrneworld.com/_uploads/download_magazines/Looking_for_my_china_girl.pdf. Accessed 3 October 2018.
37. Sisco E, Verkouteren J, Staymates J, Lawrence J. Rapid detection of fentanyl, fentanyl analogues, and opioids for on-site or laboratory based drug seizure screening using thermal desorption DART-MS and ion mobility spectrometry. *Forensic Chem*. 2017;4:108-115.
38. Johnson DL, Mead KR, Lynch RA, Hirst DVL. Lifting the lid on toilet plume aerosol: a literature review with suggestions for future research. *Am J Infect Control*. 2013;41:254-258.
39. Ellefsen KN, Anizan S, Castaneto MS, et al. Validation of the only commercially available immunoassay for synthetic cathinones in urine: Randox Drugs of Abuse V Biochip array technology. *Drug Test Anal*. 2014;6:728-738.
40. Moeller KE, Kissack JC, Atayee RS, Lee KC. Clinical interpretation of urine drug tests: what clinicians need to know about urine drug screens. *Mayo Clin Proc*. 2017;92:774-796.
41. Creppage KE, Yohannan J, Williams K, et al. The rapid escalation of fentanyl in illicit drug evidence in Allegheny County, Pennsylvania, 2010–2016. *Public Health Rep*. 2018;133:142-146.
42. Liu L, Wheeler SE, Venkataramanan R, et al. Newly emerging drugs of abuse and their detection methods: an ACLPS critical review. *Am J Clin Pathol*. 2018;149:105-116.
43. Darwish M, Kirby M, Robertson P, Hellriegel E, Jiang JG. Single-dose and steady-state pharmacokinetics of fentanyl buccal tablet in healthy volunteers. *J Clin Pharmacol*. 2007;47:56-63.
44. Egan TD, Sharma A, Ashburn MA, Kievit J, Pace NL, Streisand JB. Multiple dose pharmacokinetics of oral transmucosal fentanyl citrate in healthy volunteers. *Anesthesiology*. 2000;92:665-673.
45. Silverstein JH, Rieders MF, McMullin M, Schulman S, Zahl K. An analysis of the duration of fentanyl and its metabolites in urine and saliva. *Anesth Analg*. 1993;76:618-621.
46. Food and Drug Administration Drugs of abuse home use test. <https://www.fda.gov/MedicalDevices/ProductsandMedicalProcedures/InVitroDiagnostics/DrugsofAbuseTests/ucm125722.htm>. Accessed 3 October 2018.
47. Van Nimmen NF, Poels KL, Severi MJ, Godderis L, Veulemans HA. Selecting an appropriate biomonitoring strategy to evaluate dermal exposure to opioid narcotic analgesics in pharmaceutical production workers. *Occup Environ Med*. 2010;67:464-470.
48. Verstraete AG. Detection times of drugs of abuse in blood, urine, and oral fluid. *Ther Drug Monit*. 2004;26:200-205.
49. Tomassoni AJ, Hawk KF, Jubanyik K, et al. Multiple fentanyl overdoses—New Haven, Connecticut, June 23, 2016. *MMWR Morb Mortal Wkly Rep*. 2017;66:107-111.
50. Marchei E, Pacifici R, Mannocchi G, Marinelli E, Busardò FP, Pichini S. New synthetic opioids in biological and non-biological matrices: a review of current analytical methods. *Trends Analyt Chem*. 2018;102:1-15.
51. Shoff EN, Zaney ME, Kahl JH, Hime GW, Boland DM. Qualitative identification of fentanyl analogs and other opioids in postmortem cases by UHPLC-ion trap-MSn. *J Anal Toxicol*. 2017;41:484-492.
52. Griswold MK, Chai PR, Krotulski AJ, et al. A novel oral fluid assay (lctof-ms) for the detection of fentanyl and clandestine opioids in oral fluid after reported heroin overdose. *J Med Toxicol*. 2017;13:287-292.
53. Palamar JJ, Salomone A, Bigiarini R, Vincenti M, Acosta P, Tofighi B. Testing hair for fentanyl exposure: a method to inform harm reduction behavior among individuals who use heroin. *Am J Drug Alcohol Abuse*. 2019;45:90-96.

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