Evaluation of Occupational Exposures to Illicit Drugs at Controlled Substances Laboratories

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Introduction

Request

Management at a police forensic sciences division was concerned about potential unintentional occupational exposure to illicit drugs among employees working in controlled substances laboratories.

Workplace

The police forensic sciences division operated three controlled substances laboratories. Each laboratory served a specific geographic region. Employees of the laboratories performed forensic analyses on a wide variety of evidence submitted by multiple law enforcement agencies. Because the request focused on occupational exposures to illicit drugs, we focused our evaluation on employees who routinely handled and/or analyzed suspected controlled substance evidence and those who worked in areas of the facility where suspected controlled substances were present. Specifically, we included evidence inventory employees, forensic laboratory chemists, and contracted facility environmental services and maintenance employees in various portions of the evaluation.

We conducted first site visits in June 2018 and second site visits in January 2019. At the time of our first visit, 24 forensic laboratory chemists, evidence inventory employees, and contracted facility environmental services and maintenance employees worked across the three controlled substances laboratories. During our second visit to each of these laboratories, forensic laboratory chemists were invited to participate in air and handwipe sampling. All noncontractor, nonsupervisory employees were members of a union.

To learn more about the workplace, go to Section A in the Supporting Technical Information

Our Approach

We visited each of the three laboratories twice to learn more about potential health concerns and to measure exposures. During our site visits, we completed the following activities:

- Observed work processes, work practices, and conditions.
- Measured forensic laboratory chemists' exposures to cocaine, fentanyl, heroin, and methamphetamine in air, on hands, and on surfaces in the forensic chemistry laboratories and in office areas.
    - There are no occupational exposure limits set by the federal government or consensus organizations regarding the result of these types of sampling. Other types of guidelines are used for comparison purposes when available.
- Assessed the fume hoods and the airflow between laboratory areas, hallways, and office areas.

- Held confidential medical interviews with all 24 employees in the controlled substances laboratories.
- Reviewed relevant records including safety and health program documents, facility floor plans and maintenance reports, and laboratory surface sampling results completed prior to our visits.

To learn more about our methods, go to Section B in the Supporting Technical Information

Our Key Findings

Detectable levels of cocaine, fentanyl, heroin, and methamphetamine were in the air, on surfaces, and on hands

- Some forensic laboratory chemists had detectable levels of cocaine (11 of 12), fentanyl (4 of 12), heroin (9 of 12), and methamphetamine (3 of 12) in their personal air samples.
- None of the fentanyl levels in air were higher than the occupational exposure limit set by a pharmaceutical company. The other controlled substances do not have occupational exposure limits.
- Some employees with reportable levels of cocaine, heroin, fentanyl, and methamphetamine in their air samples had worked on casework that contained those drugs on the day of sampling.
- We also measured detectable levels of illicit drugs in the air samples of some employees who had not worked with those drugs that day.
- We found detectable levels of cocaine (13 of 13), fentanyl (9 of 13), heroin (13 of 13), and methamphetamine (9 of 13) on most employees' hands before leaving the laboratory at the end of the day and those levels were always higher than those measured at the beginning of the day.
- Laboratory benchtop surface samples had detectable levels of cocaine (13 of 13), heroin (13 of 13), fentanyl (13 of 13), and methamphetamine (12 of 13).
- Two laboratory bench samples, the keyboard cover sample, one keyboard with no cover, and the laboratory shelf sample exceeded a proposed fentanyl-contamination remediation limit. No surfaces exceeded a workplace surface limit developed by a pharmaceutical fentanyl manufacturer.
- Seven surfaces, all in the laboratories, exceeded the most common state limit on methamphetamine contamination in remediated spaces.
- Several employees who had positive handwipe samples for methamphetamine, heroin, and cocaine had not worked with evidence containing those drugs on the day we did handwipe sampling.

Work practices and conditions may have contributed to unintentional employee exposures to cocaine, fentanyl, heroin, and methamphetamine

- Six of the eight fume hoods in the laboratory bench areas did not have average face velocities that met American National Standards Institute (ANSI) and American Industrial Hygiene Association (AIHA) guidelines. Most had average face velocities that were faster than guideline values, and some were fast enough (above 150 feet per minute) to cause turbulence.
- The respiratory protection program was not sufficiently specific or instructive to employees and resulted in potential exposure control gaps.
- Employees sampled unknown powders on their laboratory benchtop without engineering controls or local exhaust ventilation designed to prevent exposure.
- Employees reported that spills of controlled substances did occur. For example, the weigh paper could sometimes get caught on the enclosed balances. The current weighing protocols increased the risk of controlled substances becoming airborne during transfer from the original packaging to the weigh paper and from the weigh paper onto the scales.
- Employees reported cleaning practices such as dry sweeping floors and dry wiping laboratory surfaces. These practices can suspend dust and other contaminants in the air.
- Employees put paper between the laboratory bench and evidence to prevent controlled substances contamination of the bench. We observed employees shaking that paper onto the ground before disposing it into the waste bin.
- Employees reported eating or drinking in controlled substances laboratories and inconsistently washing hands before eating, drinking, or leaving the laboratory. Some sinks in the laboratories were missing soap and/or paper towels.

Interviewed employees did not report any exposure incidents or symptoms that could be related to handling cocaine, methamphetamine, or opioids at work in the previous three months

- One forensic laboratory chemist reported a brief episode of lightheadedness when phencyclidine, known as PCP, was handled in the controlled substances laboratory.
- Review of the Occupational Safety and Health Administration (OSHA) 300 Logs of Work-Related Injuries and Illnesses from 2013–2017 showed three occasions in which nonspecific symptoms were reported associated with handling evidence containing suspected PCP.

Laboratory management improved controls to protect employees from exposure to controlled substances between our first and second visit

- Based on recommendations we provided to laboratory management, employees, and employee representatives after our first visit, the laboratory made the following improvements:
    - Expedited timelines for renovating existing and building new laboratory facilities.

- Included all forensic laboratory chemists in the respiratory protection program.
- Provided additional training on how to correctly put on (don) and take off (doff) N95 filtering facepiece respirators.
- Fit tested all forensic laboratory chemists qualitatively for the provided N95 filtering facepiece respirators.
- Enforced the requirement of eye protection while working in the laboratory spaces.
- Removed all latex gloves from the laboratories.
- Provided laboratory coats with tight-cuffed sleeves to forensic laboratory chemists.

To learn more about our results, go to Section B in the Supporting Technical Information

Our Recommendations

The Occupational Safety and Health Act requires employers to provide a safe workplace.

Benefits of Improving Workplace Health and Safety:

- Improved worker health and well-being
- Better workplace morale
- Easier employee recruiting and retention
- Enhanced image and reputation
- Superior products, processes, and services
- May increase overall cost savings

The recommendations below are based on the findings of our evaluation. For each recommendation, we list a series of actions you can take to address the issue at your workplace. The actions at the beginning of each list are preferable to the ones listed later. The list order is based on a well-accepted approach called the "hierarchy of controls." The hierarchy of controls groups actions by their likely effectiveness in reducing or removing hazards. In most cases, the preferred approach is to eliminate hazardous materials or processes and install engineering controls to reduce exposure or shield employees. Until such controls are in place, or if they are not effective or practical, administrative measures and personal protective equipment might be needed. Read more about the hierarchy of controls at https://www.cdc.gov/niosh/topics/hierarchy/.

We encourage the company to use a health and safety committee to discuss our recommendations and develop an action plan. Both employee representatives and management representatives should be included on the committee. Helpful guidance can be found in "*Recommended Practices for Safety and Health Programs*" at https://www.osha.gov/shpguidelines/index.html.

Recommendation 1: Reduce employees' exposures to cocaine, fentanyl, heroin, and methamphetamine

Why? We have no indication that the work exposures to cocaine, fentanyl, heroin, and methamphetamine that we detected have impacted employees' health. However, following sound occupational health practice, we recommend minimizing workplace exposures to controlled substances.

How? At your workplace, we recommend these specific actions:

Improve the availability of enclosed or semi-enclosed ventilated spaces in controlled substances laboratories.

- Consult with a ventilation engineer about adding enclosed or semi-enclosed ventilated workstations that are designed for handling powders with biologically active ingredients when building new facilities or renovating existing facilities. Utilize consensus standards published by ANSI/AIHA and ASHRAE when designing new laboratory spaces.
- Provide ventilated work space in controlled substances laboratories where forensic laboratory chemists can handle evidence (e.g., powder hoods, fume hoods) until these permanent changes are made.
- Improve the current fume hood maintenance plan. This includes conducting regular fume hood maintenance, as well as maintaining records of hood maintenance.
- Test and record fume hood performance. One method of testing performance is measuring hood face velocity when the sash is at working height. Trained staff can measure the velocity with a vane or hot wire anemometer. If the average face velocity is not within 80–120 feet per minute or if there are areas of low or no airflow at the hood face, the hood fan may need to be maintained or the contents of the fume hood may need to be reorganized or removed. More information about chemical fume hood performance and maintenance can be found in ASHRAE Standard 110 and ANSI/AIHA Z9.5.
- Establish and encourage employees to follow a consistent policy for when to use fume hoods or other ventilated enclosures for controlled substance analysis.

Update laboratory protocols to reduce employees' exposure to controlled substances during handling and analysis.

- Eliminate the requirement to take net weights of evidence whenever it is not strictly needed for law enforcement purposes or legal proceedings. This will reduce the risk of controlled substances becoming airborne during transfer from packaging to scales.

- Eliminate the requirement to use enclosed analytical balances for weighing powders. This will reduce the risk of spills from weigh paper or boats catching on the sides of the balance enclosure during transfer of controlled substances onto these balances.
- Educate all employees on work practices that minimize possible aerosolization of and surface contamination with evidence materials. For example, instruct employees to refrain from shaking possibly contaminated paper onto the laboratory bench or ground before disposal.

Review and update cleaning protocols to keep laboratory surfaces as free as practicable of contaminants.

- Use wet cleaning methods or a vacuum equipped with a high efficiency particulate air filter for cleaning contaminated laboratory surfaces.
- Do not dry sweep or use dry wiping when cleaning laboratory surfaces.
- Provide, at a minimum, annual training to ensure compliance with approved cleaning practices.
- Update cleaning protocols as necessary to reflect the most up-to-date research on surface cleaning and contaminant removal for drugs commonly found in submitted evidence.

Remind all employees to wash their hands before leaving areas where controlled substances are handled or stored and before eating, drinking, smoking, applying cosmetics, or using the bathroom.

- When designing new laboratories or renovating existing laboratories, include in the design handwashing antechambers that are separated from the controlled substances laboratory to limit cross-contamination of the handwashing area. The sinks should be touchless: either foot or sensor activated.
- Educate employees about the importance of handwashing to remove contaminants from their hands and reduce the risk of absorbing the contaminants into the body. Handwashing should last 20 seconds at minimum.
- Ensure that all handwashing stations are always stocked with soap and disposable paper towels. Provide hands-free soap and water dispensers at these handwashing stations whenever possible to avoid cross-contamination of handwashing areas.
- Do not use hand sanitizers or bleach solutions to clean skin potentially contaminated with fentanyl, although we did not observe employees do this during our visits.
- Offer smoking cessation programs at no cost to employees. Encourage employees who smoke to participate in smoking cessation programs.

Remind employees that eating, drinking, or storing food or drinks in areas where controlled substances are handled or stored is prohibited.

Encourage employees with possible work-related health concerns to talk to their healthcare providers about their workplace exposures to controlled substances.

Review and update personal protective equipment plans for employees working in areas where controlled substances are handled or stored.

- Improve the facility respiratory protection program:
    - Update the health and safety program manual with clear instructions for when filtering facepiece respirators are required.
        - Currently some instruction has been provided to employees via the health and safety program manual and separate email(s).
        - Particulate filtering facepiece respirators are recommended for work tasks likely to produce aerosolized powders or small particles in the absence of appropriate engineering controls, such as ventilation.
    - Provide adequate supplies of disposable filtering facepiece respirators so employees do not have to reuse these respirators.
    - Improve respirator training and provide annual refresher training (e.g., proper donning, doffing, strap placement).
    - Ensure that employees undergo medical evaluation and clearance prior to initial respirator use and at least annually afterwards. Encourage employees to report any symptoms experienced while wearing a respirator to a medical provider and the respiratory protection program manager.
    - Perform quantitative fit testing because it provides an objective measure of respirator fit.
    - Use odor or flavor challenges for qualitative fit testing rather than irritant smoke. An alternative to qualitative fit testing would be quantitative fit testing. More information about qualitative fit testing can be found in the ANSI/AIHA/ASSP Z88.10-2010 Respirator Fit Testing Method Standard and in the OSHA Respiratory Protection Standard 29 CFR 1910.134 Appendix A.
    - Determine if half-mask elastomeric respirators are required for specific tasks. If so, ensure that these respirators are properly cleaned, maintained, and stored and that the appropriate respirator cartridges are always changed when necessary. In

addition, ensure that employees are medically cleared, appropriately fit tested, and properly trained for this type of respirator.

    - Clarify respiratory protection program responsibilities for contracted employees.

- Require forensic laboratory chemists to turn in their laboratory coats for regular laundering. This should occur at least weekly. Ensure appropriately sized, clean replacement laboratory coats are always available for employees to use while laundering other coats.
- Require used laboratory coats to remain in laboratory spaces on a designated hook or rack. Advise employees to refrain from bringing used coats into nonlaboratory office spaces.
- Require all employees working in the central receiving area to wear disposable nitrile gloves when handling packaged evidence.

Recommendation 2: Improve communication between employees, management, and submitting law enforcement agencies

Why? Employees' health can be affected by a perceived lack of response to concerns, especially if employees believe that an exposure is hazardous. We identified several communication issues between employees, employees and management, and management and submitting agencies during our evaluation.

How? At your workplace, we recommend these specific actions:

Work with forensic laboratory chemists to establish effective ways for them to communicate to nearby employees about the suspected types of controlled substances being analyzed.

Provide clear communication to employees about new or revised policies or procedures well in advance of implementation whenever possible.

Work with submitting agencies to improve adherence to submission guidelines to ensure controlled substances are consistently packaged according to guidelines.

- Remind evidence inventory employees to ask the representative from the submitting agency to repackage evidence if guidelines are not met. Tell employees to reject evidence that is not safely packaged according to guidelines.

Recommendation 3: Address other health and safety issues we identified during our evaluation

Why? A workplace can have multiple health hazards that cause worker illness or injury. Similar to the ones identified above, these hazards can potentially cause serious health symptoms, lower morale and quality of life for your employees, and increase costs to your agency. We saw the following potential issues at your workplace:

- Employees reported uncertainty about how to use the naloxone kits available in the laboratory facilities in the event of an emergency.
- The eyewash station in one of the controlled substances laboratories was inadequate for use in the event of an emergency because it lacked a safe and continuous water source.
- The emergency shower in one of the controlled substances laboratories was blocked.
- Employees reported indoor environmental quality concerns, including temperature and air quality concerns.

Although these hazards were not the focus of our evaluation, they could cause harm to your workers' health and safety and should be addressed.

How? At your workplace, we recommend these specific actions:

Provide hands-on naloxone use training to employees with a training version of the naloxone delivery device.

- Information on the use of naloxone is available from CDC's Opioid Overdose webpage at https://www.cdc.gov/drugoverdose/index.html.
- Further information about workplace naloxone use programs is available at https://www.cdc.gov/niosh/docs/2019-101/pdfs/2019-101.pdf.

Ensure that all eyewash stations in laboratory facilities meet the ANSI Z358.1-2014: Emergency Eyewash and Shower Standard.

- Ensure portable or plumbed eyewash stations can provide clean water at 0.4 gallons per minute at 30 pounds per square inch for at least 15 minutes.
- Test eyewash stations and safety showers weekly.
- Further information about the impact of eyewash maintenance is available at https://www.osha.gov/Publications/OSHA3818.pdf.

Ensure that all emergency showers in laboratory facilities are easily accessible for use in the event of an emergency.

Start a formal indoor environmental quality management program.

- The basic elements of a good indoor environmental quality management plan include the following:
    - Work with facility maintenance representatives to ensure proper operation and maintenance of heating, ventilation, and air conditioning systems.
    - Provide effective and timely communication with employees about indoor environmental quality issues, ideally before they arise.
    - Educate employees about their responsibilities regarding indoor environmental quality.
    - Continue to proactively address issues that can affect indoor environmental quality (e.g., prompt remediation of areas of water incursion by knowledgeable personnel).
- Further information is available at https://www.cdc.gov/niosh/topics/indoorenv/.

Supporting Technical Information

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Section A: Workplace Information

Building

Each of the three controlled substances laboratories was housed in a larger building with other law enforcement or forensic science activities.

- Laboratory A became operational in 2006 and was designed to be dedicated laboratory space.
- Laboratory B became operational in 2012 and was designed to be dedicated laboratory space.
- Laboratory C was in a retrofitted space in a police barracks building that was built in the 1960s or 1970s. In the 1990s, a portion of the building was renovated into the laboratory space now occupied by Laboratory C.

Employee Information

- In total, 24 forensic laboratory chemists (chemists), evidence inventory employees, and contracted facility environmental services and maintenance staff were working across the three laboratories at the time of our first visit in June 2018. All noncontractor, nonsupervisory employees were members of a union.
- Each laboratory operated a single shift Monday through Friday, and employees worked 8–10 hours per day. Overtime hours were available for chemists but were not mandatory. The length of the workweek ranged from 4–6 days depending on each employee's schedule.
- The median age of employees was 36.5 years (range: 23–64 years).
- The median job tenure was 6 years (range: 3 weeks–27 years).

Process Description

- Suspected illicit drug evidence collected by law enforcement agencies was brought to the facilities' central receiving areas by submitting agency representatives.
- Evidence inventory employees evaluated the packaged evidence in the facilities' central receiving areas to ensure that it was packaged according to facility requirements. Evidence, in most cases, had to be in sealed packages with accompanying submission paperwork. Evidence inventory employees were not to accept needles, except in very limited circumstances with prior approval from forensic sciences division management.
- Inappropriately packaged evidence was rejected, and submitting agencies were advised on how to repackage the evidence for submission.
- Submitted evidence came in a wide variety of physical forms and could include powders, crystals, plants and other organic matter, pills, capsules, liquids, impregnated strips or paper, and

drug paraphernalia. The chemists received a description of the evidence from the submitting law enforcement agent with the suspected contents.

- Appropriately packaged evidence was logged in by evidence inventory officers, and suspected illicit drug evidence was assigned to a chemist for analysis. The evidence was kept in the drug vault until the chemist collected it for analysis.
- Chemists analyzed suspected illicit drug evidence in the controlled substances laboratory. The specific types of analyses performed were dictated by the evidence being evaluated. In general, chemists visually inspected the evidence packaging and contents, measured gross weights that included the packaging materials, measured net weights without the packaging materials before and after taking a portion for analysis, and performed a minimum of two tests to confirm the identity of evidence. Most drugs underwent colorimetric testing, followed by extraction and gas chromatography-mass spectrometry, infrared spectroscopy, or microscopic analysis.
- Chemists summarized their methods and the results of their analyses in a final report. These reports were written on a computer either in the controlled substances laboratory or in office areas outside of the laboratory.
- After completing the analysis, the chemists repackaged the evidence and returned it to the central receiving area.
- Evidence inventory employees documented the returned, repackaged evidence and notified the submitting agency that the evidence was ready to be returned to them.
- State police evidence was returned to the central receiving area of Laboratory A for destruction once a case was closed. In these situations, law enforcement officers, evidence inventory employees, and/or other forensic sciences division employees would take the evidence to a nearby facility for incineration.
- According to interviewed evidence inventory employees, the central receiving area received up to 400 cases per week, with as many as 130 of these cases suspected to involve cocaine or opioids.

Section B: Methods, Results, and Discussion

Our objectives were as follows:

- Evaluate the potential for and routes of exposure to cocaine, fentanyl, heroin, and methamphetamine among chemists working in the controlled substances laboratories.
- Evaluate the prevalence of work-related symptoms among employees in the controlled substances laboratories and identify factors that may be contributing to these health effects.

Identify controls to protect employees in the controlled substances laboratories from exposure to controlled substances.

Methods: Health and Safety Program and Document Review

We reviewed the following safety and health program documents:

- Forensic sciences division health and safety manual, dated March 2018
- Central receiving unit and controlled substances laboratory standard operating procedures manuals, dated March 2018
- Controlled substances laboratory training manual, dated March 2018
- Fentanyl safety communications sent to controlled substances laboratory personnel in December 2017
- Naloxone use training, undated
- Written respiratory protection program, dated March 2018
- OSHA Log for the forensic sciences division for the period of January 1, 2013, to December 31, 2017

Facility floor plans, reports of recent maintenance performed on controlled substances laboratory fume hoods, and surface sampling results, performed in each of the three laboratories in 2018 to evaluate for surface contamination in the laboratories

Results: Health and Safety Program and Document Review

The forensic sciences division health and safety manual stated, "there shall be no food or beverages stored, carried through, or eaten within laboratory space or other areas of the laboratory building where hazardous materials are stored or generated." The manual also instructed employees to "avoid touching all clean surfaces with contaminated hands, gloves, or other contaminated personal protective equipment (PPE). This includes general use items (e.g., computers, instrument control panels, etc.) in the laboratory areas." The manual further directed them to "wash hands after removing gloves and before eating, drinking, applying cosmetics or lip balm, applying contact lenses or conducting any activities outside of laboratory space." This manual also said that access to safety showers should not be blocked and "the immediate area beneath the shower kept free from obstructions."

The written respiratory protection program applies to employees who are required to wear air-purifying respirators and atmosphere-supplying respirators and does not apply to contractors.

The program manual also stated that employees shall use respiratory protection in the following cases:

- In areas where known contaminant levels require the use of respiratory protection.
- In areas where contaminant levels may be created without warning (e.g., emergency purposes such as hazardous material spill responses) and pose a respiratory hazard.
- In suspect areas or performing operations suspected of being hazardous but for which adequate sampling data has not been obtained.

Information provided to employees concerning use of filtering facepiece respirators was not consistent. In the health and safety manual, respirator use was noted to be voluntary (i.e., not required) for most employees and involved the use of a filtering facepiece respirator. During our first visit, chemists and evidence inventory employees were not enrolled in the facility's respiratory protection program. However, management representatives regarded respiratory use mandatory in forensic chemistry laboratories per instructions provided to chemists via email: "Chemists must wear a mask (specific for filtering small particles) when working with items that contain dangerous powder substances." Neither the manual nor separate management instructions specified whether laboratory employees would be provided with Appendix D as required by the OSHA respiratory protection standard for voluntary use respiratory protection programs.

Regarding other PPE-related information, the forensic sciences division health and safety manual advised that laboratory employees "wear the appropriate eye protection when there is a reasonable probability of impact, splash, or other potential exposure to the eyes." In addition, email communication from management representatives regarding PPE use in controlled substances laboratories advised that "chemists must wear a lab coat at all times during analysis – lab coats need to be switched out on a weekly basis for cleaning."

The naloxone training we reviewed was a presentation that focused on administration of naloxone by law enforcement officers. It did not appear to include hands-on training on how to properly use the type of naloxone kits available in the controlled substances laboratories or discuss administration of naloxone by chemists or evidence inventory employees.

Review of OSHA 300 Logs for the period of January 1, 2013, to December 31, 2017, showed a total of 18 reports of injuries and illnesses among employees in the forensic sciences division. These included 12 reports of injuries, 1 report of noise exposure, 1 report of heat-related illness, and 1 report of exposure to fiberglass. In 2016, an evidence inventory employee reported symptoms that included dizziness, headaches, nausea, and chest tightness while handling evidence containing suspected PCP on three separate occasions. During one of these incidents, this evidence inventory employee reported wearing "an AVON mask and respirator" when the symptoms began.

Review of the results of surface sampling performed in each of the three controlled substances laboratories in 2018 demonstrated residual levels of laboratory surface contamination with opioids and other controlled substances. The controlled substances present in highest levels on surfaces were cocaine and heroin. We did not explicitly compare our quantitative surface results with the samples taken in 2018 because they were taken using different sampling methods. However, we used these results, along with drugs commonly found in casework, to determine which analytes we measured on surfaces and hands and in air.

Methods: Observations of Work Processes, Practices, and Conditions

We evaluated the following in all three controlled substances laboratories:

- Workplace conditions and work processes and practices
    - Spot carbon dioxide concentrations in the laboratories
- Fume hood face velocity and airflow between laboratory areas and common areas using ventilation smoke
- Employee use of PPE

Results: Observations of Work Processes, Practices, and Conditions

Workplace Conditions and Work Practices

In all laboratories, each chemist was assigned his or her own dedicated workstation in the laboratory. A workstation consisted of laboratory benchtop space, one or more scales, a laptop dock, keyboard, mouse, and monitor. Each chemist had equipment for sampling and sample preparation, colorimetric testing, and microscopy.

As required by laboratory protocols, chemists emptied the container of evidence they were analyzing and weighed the contents to record a net weight. Depending on the amount and type of controlled substance evaluated, the net weight might have been necessary for charging or prosecuting suspected criminals. Not all criminal charges required the measurement of net weights. At the time of our evaluation, when the chemist suspected the evidence contained opioids, chemists were guided to analyze the sample before measuring the net weight of the evidence. Depending on the outcome of the testing, the chemists were allowed to decline to measure the net weight of the evidence if it contained fentanyl or fentanyl analogues. We did not observe chemists forego measuring the net weight of sampled evidence. We also observed several instances of suspected evidence falling onto the workbench and the
balance plate.

Staff cleaned benchtops and equipment using methanol at all three laboratories. At Laboratory A, the benchtops appeared worn and discolored at all chemists' work locations. The laboratory benchtops appeared to be deteriorating. This was not the case at Laboratories B and C where the laboratory benchtops did not appear to be abnormally worn.

Several times during our site visit, the suspected chemical identity—from either the chemists' professional prediction or officers' paperwork— did not match the ultimate outcome of analysis. These incidents demonstrate that using suspected contents to determine which workplace exposure controls to use (PPE, ventilation, declining to take net weights) could lead to insufficient exposure protections.

At the time of our first visit, all three laboratories had at least one naloxone kit available for use in the event of an opioid-related emergency. Several of the naloxone kits were expired at the time of this visit. One laboratory had two types of naloxone kits available, and employees expressed uncertainty about how to use one of the kits. At the time of our second visit in January 2019, expired naloxone kits had been replaced, and only one type of naloxone kit was available in the laboratories.

During both of our visits, the floor under the safety shower in one of the laboratories was blocked by laboratory supplies. This laboratory also did not have a functional, continuous flow eyewash station connected to a water source that was considered safe for emergency eyewash use. Instead, a two-bottle eyewash station was available for use in the event of an emergency. Several replacement eyewash station bottles were also available if needed.

In Laboratory A, local exhaust ventilation (LEV) was installed at each chemist's workstation. The moveable exhaust hoods with semiflexible duct work were not used during our visit, and employees said they did not generally use them.

At Laboratories A and B, we measured spot carbon dioxide concentrations at 512 parts per million (ppm) or lower during our second site visit. According to maintenance staff, these laboratories are ventilated using a single pass system, without recirculation. At Laboratory C, we measured carbon dioxide concentrations that exceeded 1,130 ppm by the end of the workday. ANSI/ASHRAE state that general dilution ventilation cannot be designed to achieve contaminant control. They further recommend that air exchange rates should range from 4 to 10 air changes per hour in laboratories depending on the general and local exhaust ventilation design [ANSI/AIHA 2012]. Although we did not calculate air changes per hour in the laboratories, carbon dioxide concentrations would be lower if Laboratory C had been ventilated at the rates outlined by ANSI/AIHA.

Fume Hood Performance and Use

All three laboratories had at least two fume hoods. Extraction solvents, other chemicals, and liquid chemical waste were stored in bulk in the hoods. Some of the fume hoods contained large amounts of material and waste, preventing their use for evidence handling. Employees used the fume hoods when dispensing solvents. One employee reported sampling suspected carfentanil (a synthetic opioid) in the laboratory fume hood, but we did not observe any employees using the hoods to handle, sample, or weigh evidence.

Laboratory A had four fume hoods, one of which met the ANSI/AIHA laboratory ventilation standards of an average face velocity of 80–120 feet per minute (fpm) [ANSI/AIHA 2012]. Two of the Laboratory A hoods operated at a velocity lower than this range (65 fpm and 63 fpm), and one operated higher than this range (144 fpm). Laboratory B had two ventilation hoods in the laboratory bench area. One of the hoods conformed to the ANSI/AIHA standard, and the average face velocity of the other hood was 140 fpm. In Laboratory C, the average face velocities of each hood were not within the standard range: both were higher (180 fpm and 130 fpm). Lower velocities (60–80 fpm) require ideal laboratory conditions and hoods with excellent containment characteristics to be effective [ANSI/AIHA 2012]. Although hoods with average face velocities between 120 and 150 fpm can be effective at containment, operating costs are very high and not necessary. Velocities above 150 fpm can cause turbulent flow [ANSI/AIHA 2012]. Laboratory C hood face velocities had previously been measured and certified by a contractor but were outdated at the time of site visit. The maintenance staff at Laboratory C maintained the hood fan and belts but did not take face velocity measurements or certify the hood's performance.

When we visually assessed airflow between common areas and laboratory spaces, we expected to see air flowing from hallways and offices into laboratories spaces, with few exceptions. At Laboratory A, air flowed into the laboratory from the antechamber to the laboratory and into the hallway. At Laboratory B, air flowed from both laboratory antechambers into the hallways. At Laboratory C, air flowed from the instrument room into the hallway but flowed into the lab from the hallways at the other two doors.

Employee Use of Personal Protective Equipment

During our first visit to the laboratories, we observed limited use of eye protection (e.g., safety glasses, safety goggles, or side shields on prescription eyeglasses) and frequent use of nitrile gloves. All chemists wore gloves when handling unpackaged evidence. All but one laboratory stocked exclusively nitrile gloves in the laboratory. One laboratory had latex gloves available for employees to use at the time of our first visit but had removed them from their storage area by the time of our second visit.

Employees wore laboratory coats when in the laboratory. Some employees only wore coats when analyzing evidence in the laboratory. Employees reported that correctly sized, clean laboratory coats were sometimes not available. Some employees reported that loose cuffs on the coats caught on laboratory materials. When leaving the laboratory, most employees kept their coats on the back of their chairs in the laboratory. Some hung them up on the coat rack. At one lab, the coats were kept in the office space because they would fall off the coat rack.

Chemists typically changed gloves between cases, and sometimes between items within a case. We observed chemists using workstation keyboards both with and without gloves. This occurred both between and after cases, and without cleaning the keyboard. Additionally, chemists would don and doff their safety glasses with gloved hands. We also observed one employee wash a plate used for eating at the laboratory antechamber sink. Some laboratory sinks in antechambers were not equipped with soap and/or paper towels.

We observed some employees wearing N95 filtering facepiece respirators when analyzing cases and handling unknown powders. We observed that these respirators were generally not worn correctly during the first site visit. Often the straps were not placed correctly. At the time of our first visit, none of the chemists or evidence inventory employees had been fit tested for the provided N95 respirators or included in the respiratory protection program.

Between our two visits, laboratory management made several PPE-related changes:

- Included all chemists in the respiratory protection program.
- Provided additional training on how to correctly don and doff N95 respirators.
- Fit tested all chemists qualitatively for the provided N95 respirators using irritant smoke.
- Enforced the requirement of eye protection in the laboratory spaces.
- Provided laboratory coats with tight-cuffed sleeves to staff.

- Removed all latex gloves from the laboratories.

At the time of our second site visit, we observed the impact of these changes:

- Chemists who wore N95 respirators wore them correctly, and most people working with powders suspected to be opioids chose to wear N95 respirators.
- All chemists always wore eye protection while working on casework in the controlled substances laboratories, but some chemists wearing personal prescription glasses needed side shields.
- Almost all chemists who wanted tight-cuffed laboratory coats used them while working in the controlled substances laboratories. One was awaiting a coat of the correct size and pocket location.
- No latex gloves were available for use in any of the controlled substances laboratories.

In addition to the changes above, chemists had been provided with air-purifying elastomeric half-mask respirators with GME P100 Multigas combination cartridges for organic vapor, acid gases, ammonia, methylamine, formaldehyde, and hydrogen fluoride. During both visits, we observed that respirators, both the N95 filtering facepiece and air-purifying elastomeric half-mask, were not stored correctly. Used N95 filtering facepiece respirators were kept in drawers or on shelves, not in sealed bags. Employees were not sure how often they should discard their N95 filtering facepiece respirator and replace it with a new one. Air-purifying elastomeric half-mask respirators with attached cartridges were generally not kept in sealed bags or cleaned between uses. Employees did not know when they should change the air-purifying cartridges on the air-purifying elastomeric half-mask respirators and had not changed them in the approximately one month since receiving the respirator. We observed one employee use their air-purifying elastomeric half-mask respirator. A chemist used it while handling powder containing suspected opioids on their laboratory bench. In discussion with chemists, they were not aware when each type of respirator (N95 filtering facepiece or air-purifying elastomeric half mask) was required or recommended to be used.

Contracted facility environmental services employees wore N95 filtering facepiece respirators and gloves when entering the laboratory to empty trash cans. During both site visits, some chemists would work with N95 respirators around their necks between cases.

Methods: Exposure Assessment

Air Sampling

Among 12 chemists, we collected full-shift personal air samples for cocaine, fentanyl, heroin, and methamphetamine using 25-millimeter glass fiber filters in conductive cassettes attached to pumps drawing air at two liters per minute. A series of four or five samples were collected on each employee (sample duration ranged from 47 to 127 minutes). We calculated a time weighted average (TWA) concentration using the employee's individual sample data for each of the four target drugs. We used the reporting limit divided by the square root of 2 to impute censored data for individual samples when calculating the geometric mean of the full-shift TWA exposures [Hornung and Reed 1990]. For one employee, pump failure led to loss of two samples, so the remaining two samples were used to calculate a partial-shift exposure.

All samples (air, handwipe, and surface) were stored and shipped cold to the analytical laboratory. At the laboratory, the samples were extracted in the cassette to account for wall losses using a water and methanol mixture. The sample was analyzed via ultrahigh performance liquid chromatography with triple quadrupole mass spectroscopy detection. The reporting limit was 1 nanogram (ng) per sample for each of the four drugs analyzed.

Chemists provided the list of the cases they worked on during our visits, and management provided the list of the confirmed drugs in each of those cases. For each drug, we compared the personal full-shift air concentrations for those who worked with evidence confirmed to contain the drug to the concentrations for those who did not work on cases containing that drug. We compared the air concentrations of the two groups using a one-tailed Mann – Whitney *U* test with significance established at $\alpha = 0.05$.

Handwipe Sampling

We took preshift and postshift handwipe samples of 13 chemists for cocaine, fentanyl, heroin, and methamphetamine. Participants were asked to wash hands thoroughly before preshift handwipe sampling to remove drug contamination from nonoccupational sources. Employees were allowed to wash their hands as they normally would during their work shift. Postshift handwipe samples were taken when the employee ended work in the lab, before they washed their hands for the last time. For each employee, we sampled the palm side of both hands using a swab wetted with methanol. In addition to the handwipe samples, we also sampled the palm side of both gloved hands for three employees at the end of a case. This was in addition to the handwipe samples.

The fraction of the total amount of each analyte that was collected (recovery) during handwipe sampling has not been characterized. The same NIOSH investigator took all handwipe samples.

Surface Sampling

We sampled 22 surfaces across all three laboratories for cocaine, fentanyl, heroin, and methamphetamine using a swab wetted with methanol. The sample area was 100 square centimeters (cm^2) (using a template) on all surfaces, except keyboards and gloved hands. We took a sample of approximately 100 cm^2 on keyboard surfaces.

Average surface recovery for the materials comprising laboratory benchtops, office desktops, and scale plates exceeded 70% using the swabs [Bureau Veritas North America 2018]. For other surfaces, like keyboards and gloved hands, the recovery range for these swabs has not been characterized.

There are no occupational standards regarding limits on surfaces for cocaine, fentanyl, heroin, and methamphetamine set by the federal government or consensus organizations. Some states have developed guidelines for remediation of methamphetamine-contaminated spaces, like clandestine drug labs. The U.S. Environmental Protection Agency (EPA) has developed voluntary methamphetamine laboratory cleanup protocols. According to the EPA, 25 states have developed recommended or required standards for methamphetamine remediation as of 2013. The state standards range from 0.05 to 1.5 micrograms (μg)/100 cm^2, the most common being 0.1 μg/100 cm^2 [EPA 2013].

Additionally, one company that manufactures fentanyl has developed a workplace surface contamination limit of 1 μg fentanyl/100 cm^2 in their facilities [Van Nimmen and Veulemans 2004].

A county health department proposed a limit of 0.1 µg/100 cm^2 for remediation of fentanyl-contaminated properties where the general population might occupy [Rosen 2018]. One state has added fentanyl remediation standards to complement existing methamphetamine contamination remediation legislation: fentanyl should not be detectable in properties post-remediation in this state [California Legislature 2019]. The detection limits expected are not explicitly stated in the legislation [California Legislature 2019].

Results: Exposure Assessment

Air Sampling

Of the 12 chemists who participated in air sampling, 11 had 4–5 consecutive samples included in a full-shift sample (423 to 493 minutes). However, for one chemist, two samples were not analyzed because of pump failure, so the sample time consisted of only about half of the chemist's shift (223 minutes). The four analytes were not detected (reporting limit 1 ng) in the field blank filters.

Minimum, maximum, and geometric mean full-shift TWA exposures are in Table C1. Table C2 contains the TWA full-shift concentrations for all the participating chemists. None of the full-shift fentanyl exposures exceeded an occupational exposure limit established by a fentanyl manufacturing company of 0.1 µg/cubic meter (m^3) [Van Nimmen et al. 2006]. The other analytes, cocaine, heroin, and methamphetamine, do not have established occupational exposure limits. Of the 12 chemists, 10 handled cocaine-containing evidence, 10 handled fentanyl-containing evidence, 8 handled heroin-containing evidence, and 3 handled methamphetamine-containing evidence. We took eight field blank samples across the 3 days of sampling to account for any sample contamination during transport; none were found to contain reportable drugs during analysis.

The average personal air cocaine, fentanyl, and heroin concentrations were higher among employees who handled casework confirmed to contain that respective drug. For cocaine ($P = 0.03$) the air concentrations were statistically significantly higher for employees who worked on casework confirmed to contain the drug compared with the personal air concentrations for those who did not.

We looked at the relationships between confirmed substances in employees' casework and the results of their personal air samples. One employee who did not work on casework containing cocaine still had reportable concentrations of cocaine in their personal air samples. The same is true for three employees who did not work on heroin-containing cases and two employees who did not work on methamphetamine-containing cases. Conversely, five employees who worked on casework containing cocaine did not have reportable cocaine in their personal air samples. Again, the same is true for one person who handled casework containing heroin and three people who handled casework containing methamphetamine.

Handwipe Sampling

Table C3 shows handwipe sampling results for employees at the three lab locations. All 13 postshift handwipe samples had reportable amounts of cocaine (range: 19–2,600 ng/swab) compared to 9 preshift handwipe samples (range: 1.1–19 ng/swab). For fentanyl, 9 of the 13 postshift handwipe samples had reportable amounts, ranging from below the reporting limit of 1 to 11 ng/swab. None of the corresponding preshift handwipe samples had reportable fentanyl levels. For heroin, all 13 postshift handwipe samples had reportable amounts (range: 1.1–160 ng/swab) compared to only four preshift handwipe samples (range: 1.1–3.5 ng/swab). For methamphetamine, nine postshift handwipe samples had reportable amounts (range: 1.1–33 ng/swab), while only one preshift handwipe sample had a reportable amount (5.7 ng/swab). Some employees who did not work on evidence confirmed to contain cocaine, heroin, and methamphetamine had those drugs on their hands at the end of the day, even though most wore gloves:

- 2 of 2 chemists who did not handle cocaine had reportable levels on their hands
- 4 of 4 chemists who did not handle heroin had reportable levels on their hands
- 5 of 9 chemists who did not handle methamphetamine had reportable levels on their hands

Neither of the two chemists who did not handle fentanyl had reportable levels on their hands.

All of the reportable, postshift handwipe samples we collected had higher amounts of a given analyte than their matching, preshift handwipe samples. There are no occupational exposure limits established to use for comparisons with this type of sampling.

Surface Sampling

Table C4 shows surface wipe sampling results at the three laboratory locations. One surface sample was collected at a workstation in which the keyboard had a keyboard cover. The keyboard cover had higher amounts of all analytes as compared to the keyboard underneath. The keyboard cover also had higher amounts of all analytes than the four keyboards without covers (or with nonremovable covers) and some of the highest overall surface concentrations we measured. We did not observe chemists with keyboard covers clean them. At least one keyboard cover was stored in the same drawer as an air-purifying elastomeric half-mask respirator and gloves.

All three surface samples collected on keyboards had reportable concentrations of cocaine (range: 0.027–4.0 μg/100 cm^2), heroin (range: 0.0010–0.68 μg/100 cm^2), and methamphetamine (range: 0.0079–0.046 μg/100 cm^2). Two of the three surface samples collected on keyboards had reportable concentrations of fentanyl (0.021–0.37 μg/100 cm^2).

Of the 13 surface samples collected on lab benches, all had reportable concentrations of cocaine (range: 0.075–5.0 μg/100 cm^2), fentanyl (range: 0.0012–0.37 μg/100 cm^2), and heroin (range: 0.0050–0.23 μg/100 cm^2). Twelve had reportable amounts of methamphetamine (range: 0.0017–0.45 μg/100 cm^2). A surface sample collected from a dusty shelf in the laboratory had reportable concentrations of cocaine (2.9 μg/100 cm^2), fentanyl (0.15 μg/100 cm^2), heroin (4.0 μg/100 cm^2), and methamphetamine (0.11 μg/100 cm^2). This shelf had higher concentrations of analytes compared to most of the other surfaces sampled.

Surface samples collected on the three report desks had lower amounts of analytes as compared to other surfaces. One report desk had no reportable concentrations of all four analytes. Another had a reportable level of cocaine (0.014 μg/100 cm^2) and not reportable concentrations for the remaining analytes. Another report desk had reportable concentrations of cocaine (0.045 μg/100 cm^2), heroin (0.0029 μg/100 cm^2), and methamphetamine (0.0092 μg/100 cm^2), with not reportable concentrations of fentanyl.

None of the report writing area samples or keyboards exceeded the commonly used state or local guideline of 0.1 µg methamphetamine/100 cm² [EPA 2013]. The keyboard cover sample, the lab shelf sample, and 5 of the 13 laboratory bench samples exceeded this guideline. The EPA notes that these standards are thought to be health-protective, despite being developed with feasibility and available technology in mind [Colorado Department of Public Health and Environment 2005; EPA 2013].

Of the surfaces sampled, none of the report writing area samples exceeded the fentanyl contamination limit of 0.1 µg/100 cm², as proposed by the county health department. Two of the laboratory bench samples, the keyboard cover sample, one of the keyboards with no cover, and the lab shelf sample exceeded this proposed limit. The draft guideline developed by the local health department was done with technological feasibility in mind. The limit was established based on the common limit of detection for surface samples, making site clearance contingent upon nondetectable fentanyl concentrations for all samples taken [Rosen 2018]. None of the surface samples exceeded an internal fentanyl contamination limit of 1 µg/100 cm² as set by a manufacturer for their facilities.

One of the seven swab field blanks had a reportable level of 1.3 ng/swab (0.0013 µg/swab) of cocaine in the sample. No other analytes were reportable in this sample (reporting limit 1 ng). None of the other field blank samples contained reportable levels of the four analytes. We blank-corrected the hand and surface wipe samples taken on the day this field blank was taken.

Methods: Employee Health Assessment

Confidential Medical Interviews

During our first visit in June 2018, we invited all 24 chemists, evidence inventory employees, and contracted facility environmental services and maintenance staff working across the three laboratories to participate in confidential medical interviews. Interviews covered basic demographics, work history and practices, training, health and safety concerns, and possible work-related health effects. We asked questions specifically about work practices related to handling cases suspected to contain cocaine or opioids. We focused on these substances because the results of the 2018 surface sampling demonstrated higher levels of cocaine and heroin on surfaces than other controlled substances, and the request included concerns about exposures to fentanyl or fentanyl analogues. We asked interviewed employees whether they had experienced any symptoms or health effects that they felt were related to handling cocaine, methamphetamine, or opioids at work. Known health effects of severe cocaine, fentanyl, heroin, and methamphetamine toxicity are shown in Table C5.

Results: Employee Health Assessment

Confidential Medical Interviews

All 24 employees working across the three laboratories at the time of our first visit participated in confidential medical interviews. This included 13 chemists, 7 evidence inventory employees, and 4 contracted facility environmental services and maintenance employees. Table C6 shows the locations within the facilities where these employees reported working. Among 13 interviewed chemists, the median reported time spent in the controlled substances laboratory was 5.5 hours (range: 1–7.5 hours). Five of seven evidence inventory employees reported spending no work time in the controlled substance laboratories; the other two reported spending 10 minutes–1 hour each day. Three of four contracted environmental services and maintenance employees reported spending 10–30 minutes of their daily work hours in the controlled substance laboratories.

The median number of cases analyzed by interviewed chemists in the controlled substances laboratory was reported to be 17.5 cases per week (range: 0–30). Of these cases, the median number suspected to be cocaine or opioids was 10.5 cases per week (range: 0–24). Of note, three interviewed chemists were in training at the time of our visit. As a result, they reported analyzing primarily training cases under the supervision of another more experienced chemist. Most interviewed chemists reported only rarely processing cases under a fume hood, but one reported using a hood up to four times a week for casework. Reported reasons for choosing to use a hood for casework included cases that require the use of volatile reagents for analysis, handling cases with a strong odor or those containing PCP, unknown liquids, large quantities of unknown powder, cases that could contain carfentanil, and when processing pill presses.

We asked about PPE use among the 13 chemists and 7 evidence inventory employees when they handled cases involving known or suspected cocaine or opioids in the controlled substances laboratory and central receiving area (displayed in Table C7). All 13 interviewed chemists and none of the 7 evidence inventory employees reported always wearing a laboratory coat. All 13 interviewed chemists and 6 evidence inventory employees reported always wearing long pants. All 13 chemists reported always wearing nitrile gloves while 6 evidence inventory employees reported sometimes wearing nitrile gloves. Use of N95 filtering facepiece respirators was also variable across the two groups, with 10 chemists reporting sometimes wearing one and 6 evidence inventory employees reporting never wearing one. Most chemists (n = 9) and most evidence inventory employees (n = 6) reported never wearing safety glasses or goggles.

During interviews, we also asked laboratory employees about other personal work practices. Among the 13 interviewed chemists, 6 reported laundering their laboratory coats weekly or every 2–3 weeks, 3 reported laundering monthly, and 4 reported never laundering or only on a seldom basis. Of the seven evidence inventory employees, three reported eating, drinking, or storing food or drink in the central receiving area daily, and two chemists reported seldomly eating, drinking, or storing food or drink in the controlled substances laboratory. The remaining 19 of 24 interviewed employees reported never eating, drinking, or storing food or drink in the controlled substances laboratory or central receiving area.

When asked about handwashing, 19 interviewed employees, including 8 chemists, all 7 evidence inventory employees, and all 4 contracted facility environmental services and maintenance staff, reported always washing their hands before eating or drinking at work. Of the 13 chemists, 5 reported only sometimes washing their hands before eating or drinking at work. In addition, 15 interviewed employees, including 8 chemists, 3 evidence inventory employees, and all 4 contracted facility environmental services and maintenance staff reported always washing their hands before leaving the laboratory.

Table C8 shows the training that interviewed employees reported receiving in certain health and safety topics. Most (16–18) of the 20 laboratory employees reported that they had received training on the following topics: safe handling of cases involving known or suspected cocaine or opioids, recognition of symptoms/signs of opioid intoxication, proper administration of naloxone, safe handling of sharps, and what to do in the event of a sharps injury. None of the four contracted facility environmental services and maintenance staff we interviewed reported receiving any training in these topics. All 13 chemists reported receiving training on how to properly administer naloxone.

None of the 24 interviewed employees reported any incidents of direct skin, respiratory, or mucous membrane exposure to suspected cocaine or opioids at work in the three months prior to our visit. Regarding symptoms, one chemist reported being unsure whether dizziness or lightheadedness experienced on two or three occasions while working in the laboratory was related to casework or something else. None of the other 23 interviewed employees reported experiencing any symptoms that they felt were related to handling cocaine or opioids at work. Another chemist reported feeling lightheaded or dizzy when PCP was handled in the controlled substances laboratory. Walking outside of the facility for 15–20 minutes typically resulted in resolution of these symptoms. Health effects of severe cocaine, fentanyl, heroin, and methamphetamine toxicity are shown in Table C5. None of the interviewed employees reported a sharps injury at work in the three months prior to our visit.

All 24 interviewed employees reported participating in facility cleaning. One evidence inventory employee reported regularly dry sweeping the central receiving area. Four chemists and two contracted facility environmental services and maintenance staff reported regularly dry sweeping the controlled substances laboratory. In addition, three contracted facility environmental services and maintenance staff reported always wearing nitrile gloves when cleaning in the controlled substances laboratory and always using an N95 respirator when removing trash from the controlled substances laboratory.

At the end of our interviews, we asked employees to share additional work-related health and safety concerns they had. Seventeen interviewed employees reported no additional concerns. Among the remaining seven interviewed employees, additional issues identified included concerns about poorly functioning fume hoods and other facility-related indoor environmental quality issues. A few employees also expressed concerns about certain drug handling procedures including the requirement to open drug packaging in the central receiving area to count contents, perform net weights, use enclosed analytical balances, and handle sharps such as needles and razor blades. One employee expressed a desire to have cuffed laboratory coats while two employees expressed a desire to improve availability of PPE.

Three interviewed employees also complained about poor communication in general between employees, employees and management, and the facility and law enforcement agencies that submit evidence for analysis. These included a lack of communication about casework performed by nearby chemists in controlled substances laboratories and reports that new safety and health policies and procedures were sometimes released and implemented with little or no notice given to employees. Another concern expressed was about inconsistent packaging of controlled substances submitted for analysis.

Lastly, three employees reported concerns related to the naloxone kits kept in the controlled substances laboratory for emergencies. Complaints included inadequate naloxone use training, insufficient numbers of available naloxone kits, and failure to replace expired naloxone kits in a timely manner.

Discussion

Although employees at the three controlled substance laboratories reported no symptoms associated with acute exposures to cocaine, methamphetamine, and opioids, we identified the potential for unintentional exposures in the air and on contaminated surfaces and hands.

Work Practices

Because of the unpredictable form, amount, and contents of incoming evidence, the policy of measuring net weights poses a potential risk of hazardous substances exposure to forensic chemists. Taking net weights requires extra handling of uncontained evidence: removing substances completely from packaging, transferring substances to disposable weighing paper or a weigh dish, and placing this into and removing it from a balance. Measuring net weights increases the time the substance spends outside of packaging and requires chemists to handle larger amounts of these substances compared to the amount needed for analysis. Therefore, measuring net weights creates the opportunity for spills and aerosolization that could potentially lead to significant exposure to these drugs. These exposures are less likely to occur when measuring gross weights.

The practice of laying a piece of paper between the laboratory bench and the evidence was common at all the laboratories. This may be effective at preventing surface contamination but poses a greater risk of aerosolizing the evidence being handled, based on our observations. Our observations of employees shaking barrier paper after analysis and the barrier paper being emptied from small trash containers into the larger waste bin daily may be contributing to employees' airborne drug exposures.

Most of the employees who had detectable air samples for a specific drug had handled evidence containing that drug. Therefore, working on casework containing a drug appeared to contribute to air exposures of that drug. However, this was not universal. For cocaine, heroin, and methamphetamine, we found the drugs in the air sample of at least one employee who did not work with casework that contained those drugs. We were not able to attribute this to a specific activity or activities. This indicates that exposure can potentially occur as a result of adjacent employees' work or the aerosolization of small amounts of environmental contamination during work in the drug labs. Overall, the personal air concentrations for those who handled evidence containing specific drugs were higher than those that did not personally analyze that drug.

We found all employees with fentanyl in their postshift handwipe sample had worked with fentanyl-containing evidence. A minority of employees with cocaine and heroin in their handwipe samples had not handled casework containing the drug. However, for methamphetamine, 75% of the employees whose handwipe sample contained methamphetamine had not handled casework containing methamphetamine. These handwipe and surface sample results demonstrate that handling evidence is not the only source of potential dermal exposure.

Exposures in Air

Several studies have demonstrated the potential for aerosolization of cocaine and exposures to workers. In one evaluation of cocaine exposure among narcotics criminalists processing packages of cocaine, researchers found that employees who made small incisions in the packages to take small samples and who wore masks (3M Model 9970, discontinued) had lower urinary concentrations of cocaine and cocaine metabolites than those who opened and repackaged evidence or who did not wear respiratory protection [Le et al. 1992].

In an evaluation measuring airborne levels of cocaine in forensic laboratories in Spain, cocaine was present in all air samples, even on days when there was no cocaine being handled during the sampling period. The concentration of cocaine in the air increased considerably (100 times higher) on days when cocaine was handled [Armenta et al. 2014]. Cocaine handling consisted of opening, transferring, sampling, and resealing evidence packages.

Personal air exposures to cocaine measured among the chemists in our evaluation (NR–0.72 $\mu g/m^3$, with NR meaning not reportable or less than 1 ng per sample) were lower than some previous studies of law enforcement and chemists. In simulated cocaine evidence processing, the researchers measured concentrations 68–6,400 $\mu g/m^3$, which is much higher than exposures we measured [Le et al. 1992]. In an evaluation of cocaine exposure among crime laboratory employees preparing training aids for military working dogs, personal air exposures to cocaine were measured at 29.20–69.94 $\mu g/m^3$ [Gehlhausen et al. 2003]. These personal air exposures decreased to 11.00–18.09 $\mu g/m^3$ following interventions that included changing procedures, using a laboratory hood during all manufacturing functions, fit testing for respirators, and providing more rigorous training on PPE use [Gehlhausen et al. 2003]. These employees' exposures, before and after intervention, were also much higher than exposures we measured.

In a previous health hazard evaluation (HHE) evaluating police officers' exposures to chemicals while working inside a drug vault, personal air exposures to cocaine ranged from not detected (minimum detection concentration = 0.03 $\mu g/m^3$) to 12 $\mu g/m^3$ [NIOSH 2011]. Some of these personal air sampling results may have overestimated the actual exposures because of the sampling method. The personal air exposures from that HHE were among the lowest published for exposure to cocaine and are similar or greater than exposures we measured. In the same HHE, personal air exposures to methamphetamine ranged from not detected (minimum detection concentration = 0.003 $\mu g/m^3$) to 0.028 $\mu g/m^3$ [NIOSH 2011]. These exposure concentrations were similar to those we measured.

In one study of employees who manufactured fentanyl, full-shift TWA personal air exposures to fentanyl were 0.5–7,310 ng/m^3 (0.0005–7.31 $\mu g/m^3$), with a geometric mean of 40 ng/m^3 (0.04 $\mu g/m^3$) [Van Nimmen et al. 2006]. The majority of these pharmaceutical employee exposures were much higher than full-shift personal exposures we measured on chemists by several orders of magnitude. The geometric mean exposure we measured (0.007 $\mu g/m^3$) was also much lower than the geometric mean in this study of pharmaceutical employees. None of the full-shift fentanyl exposures exceeded an occupational exposure limit established by a fentanyl manufacturing company of 0.1 $\mu g/m^3$ [Van Nimmen et al. 2006].

In general, personal fentanyl and cocaine air exposures in this evaluation were much lower than those measured in similar studies or evaluations [Le et al. 1992; Gehlhausen et al. 2003; Van Nimmen et al. 2006]. None of the interviewed employees reported any symptoms related to handling cocaine or opioids at work, and OSHA 300 Logs revealed only one employee with reported symptoms possibly associated with PCP. The potential health effects and symptoms from exposures to low levels of these drugs are not well characterized or understood. Table C5 details the health effects from higher levels of exposures to cocaine, fentanyl, heroin, and methamphetamine as found in scientific literature.

Air exposures to the four drugs measured on sampling days were low relative to those found in other studies and to one applicable occupational exposure limit. However, due to the unpredictable nature and origin of the evidence being handled, prudent occupational health practices call for minimizing the handling of evidence as much as possible, implementing engineering controls, and developing emergency response policies that would reduce the likelihood of exposure and subsequent health effects in the event of an acute spill or exposure. In this evaluation, employees who worked with evidence containing confirmed cocaine, fentanyl, and heroin had higher air exposures to the respective drugs they worked with than those who did not work with evidence containing those drugs and for cocaine, this difference was statistically significant. One assumption of Mann – Whitney *U* test is independence between the observations, in this case air measurements. When comparing air exposures of employees who worked with various drugs, versus those who did not work with those drugs, the impact of adjacent employees working with those same drugs is unknown. We assumed these air exposure measurements to be independent, with this assumption of independence being a limitation of this study. Laboratory management can reference the practices of industries where employees work with biologically potent ingredients, like the pharmaceutical industry, as a model for exposure control.

Surface Contamination and Handwipes

The surface sampling data showed that laboratory surfaces that were not cleaned as frequently as bench tops (keyboard covers and shelving) were contaminated with higher concentrations of drugs. We observed that cleaning practices varied by laboratory, and oftentimes depended on the chemist(s) using the workstation. Some chemists cleaned their benchtops and/or keyboards between every case using methanol, others less often, and still others relied on using a disposable barrier paper to prevent surface contamination. Laboratory benches were also among the surfaces that were most contaminated with drugs, with almost all wipe samples having reportable concentrations of cocaine, fentanyl, heroin, and methamphetamine.

We measured methamphetamine and cocaine concentrations that were much lower than the maximum concentrations found on police station surfaces. In one study, which measured amounts of drugs on surfaces in police stations, methamphetamine and cocaine were among the most frequently detected drugs on surfaces and were also the drugs found in the highest concentrations [Doran et al. 2017]. The heroin metabolite 6-monoacetylmorphine (6-MAM) was also found on surfaces in the police stations. That study found no correlation between the amount of drugs on surfaces and the number of drug-based arrests at the police station, concluding that the amount of drugs on surfaces is more influenced by factors like the amount of drug seized, the surface types at each police station, and cleaning practices [Doran et al. 2017].

In an HHE from 2011, surface concentrations of drugs in a police department drug vault were similar to surface concentrations we measured for methamphetamine (maximum 0.079 $\mu g/100\ cm^2$) and cocaine (maximum 7.3 $\mu g/100\ cm^2$) [NIOSH 2011].

All of the surface samples we collected at the three laboratories were below a fentanyl surface contamination limit developed internally by a fentanyl manufacturer (1 $\mu g/100\ cm^2$) [Van Nimmen and

Veulemans 2004]. Two laboratory bench surfaces, two keyboards, and a shelf in the laboratory met or exceeded the surface remediation limit proposed by a county health department for fentanyl-contaminated properties (0.1 μg/100 cm^2) [Rosen 2018]. Dry sweeping and dry cleaning practices reported by some chemists and maintenance staff could potentially aerosolize these substances in the laboratories.

The EPA has published protocols for methamphetamine cleaning and decontamination focused on cleaning methamphetamine laboratories [EPA 2013]. Although the EPA has not established quantitative post-cleanup standards for methamphetamine and associated chemicals, many state and local agencies have done so. These post-cleanup standards for methamphetamine range from 0.05 to 1.5 μg/100 cm^2, with the most common standard being 0.1 μg/100 cm^2 [EPA 2013]. Most of these remediation standards are based on analytical detection limits and feasibility and are not based on health. However, these standards are believed to be conservative enough to be protective of health and environment [Colorado Department of Public Health and Environment 2005]. Seven methamphetamine surface wipe samples in our evaluation exceeded the most common methamphetamine cleanup standard of 0.1 μg/100 cm^2. One of these wipe samples, taken on the keyboard with removable cover, exceeded the highest cleanup standard. We did not identify any cleanup or occupational standards for heroin or cocaine on surfaces.

All the postshift handwipe samples collected had higher amounts of a given analyte compared to preshift handwipe samples, unless both samples did not have reportable levels (> 1 ng/wipe). Cocaine was present in 9 of 13 preshift handwipes, reflecting the relative pervasiveness of cocaine on surfaces and items that normally would not be in contact with illicit drugs. Preshift handwipes were mostly not reportable for fentanyl, heroin, and methamphetamine with a few exceptions. These exceptions could indicate contact with surfaces contaminated with these drugs at work but outside of the laboratory, contact with surfaces contaminated with these drugs prior to work, or drugs remaining on hands from the previous work shift. While hand hygiene was self-reported to be good by interviewed employees, quality hand hygiene should be encouraged for all laboratory employees.

Cleaning and Decontamination

Research is underway on the cleaning and decontamination of illicit drugs, particularly fentanyl. Fentanyl degrades when exposed to oxidant solutions [Qi et al. 2011]. Products that contain or generate peracetic acid may also be effective in the decontamination of fentanyl and carfentanil, but guidelines on amounts and durations have not been established [EPA 2018]. UV radiation and temperature may also be effective in degrading fentanyl [Reitstetter and Losser 2018]. The EPA Fact Sheet for On-Scene Coordinators on Fentanyl and Fentanyl Analogs describes strategies for decontamination and cleanup in various forms and on different surfaces [EPA 2018]. Cleaning and decontamination methods for fentanyl may be effective for heroin and other illicit opioids. The staff at the laboratories we visited used a methanol solution to clean laboratory surfaces. One study demonstrated several cleaning protocols that had greater than 97% removal efficiencies, including methanol, soap and water, OxiClean™, adhesive and methanol, and Dahlgren Decon solution [Sisco et al. 2019]. We found mention of methanol as a cleaning agent in remediation settings for some drugs [Owens et al. 2018].

Exposure Controls

Due to the impact of the opioid crisis, many federal agencies and professional organizations have provided guidelines on keeping workers safe from fentanyl, its analogues, and other opioids through engineering controls, work practice changes, and PPE. The American Academy of Forensic Science (AAFS) published a position statement recommending control methods that follow the hierarchy of controls approach when handling and analyzing suspected synthetic opioids. These controls include implementing strict evidence acceptance protocols; using engineering controls such as evidence packaging, fume hoods, and balance enclosures; and using work practices including good lab technique and housekeeping [AAFS 2017]. Additionally, the AAFS recommends implementing an emergency response plan that includes spill control, decontamination, first aid, naloxone use, and appropriate training on these safety protocols [AAFS 2017]. The American Society of Crime Laboratory Directors provides more specific recommendations that include changes to packaging/storage, updates on laboratory practices, use of alternative sampling devices (to test evidence without removing it from packaging), adopting a naloxone policy, as well as training and education [American Society of Crime Laboratory Directors 2018].

Ideally, all evidence should be handled and analyzed in a fume hood, and there should be one fume hood for each chemist. However, the current lab configurations and the number of fume hoods at each lab we evaluated does not allow this to occur. We did not observe fume hoods being used for casework. Further inspection of the fume hoods showed that none were certified to have acceptable face velocity. Some fume hoods had face velocities outside of the standard range, either below or above the recommended average face velocity of 100 fpm (range 80–120 fpm). Face velocities lower than recommendations may be inadequate to capture contaminants. Face velocities higher than recommendations may cause airflow turbulence, which reduces the ability of the fume hood to capture contaminants and may even cause contaminants to escape the hood. Higher than recommended airflow also results in higher electricity use and expenses while not improving capture efficiency. In this evaluation, the high face velocities we measured also make it difficult to work with or weigh powders inside the hood. Furthermore, when sampling powders and when balance sensitivity is important, a ventilation hood enclosure designed for this activity, such as a powder hood, should be used.

In Laboratory A, LEV with an adjustable snorkel hood was available at each workstation, but was not used during our visit or otherwise routinely, according to staff. ASHRAE laboratory design guidance calls these "snorkel-type" moveable hoods appropriate for removing heat and no- or low-hazard airborne contaminants [ASHRAE 2015]. This type of LEV is not ideal in forensic drug laboratories because employees routinely handle hazardous materials. When asked, several chemists were unclear on the function and proper use of ventilation controls in protecting them from drugs in evidence. User-adjustable LEV is not routinely used in similar workplaces where biologically active materials are handled and sampled, like pharmaceutical manufacturing facilities. When employees can be exposed to high-hazard materials in air (like potent opioids and other powdered controlled substances), laboratory ventilation guidance and pharmaceutical industry resources prioritizes product containment and isolation through exposure control devices, such as variable air volume fume hoods, laminar flow ventilated hoods or cabinets, and ventilated gloved boxes [ASHRAE 2015, 2018; Wood 2010].

NIOSH does not have specific PPE guidance for chemists but does provide guidance on recommended PPE during investigations and evidence collection. Different levels of PPE are recommended depending on the amount of fentanyl present. At minimal exposure levels, defined by a response where suspected fentanyl may be present but none is visible, nitrile gloves are recommended. At moderate exposure levels, defined by a response where small amounts of fentanyl products are visible, a disposable 100-series filtering facepiece respirator (e.g., P100 filtering facepiece respirator), safety goggles/glasses, and wrist/arm protection are recommended in addition to nitrile gloves [NIOSH 2017]. These two exposure levels are most similar to chemists' exposures during the course of their work. Published guidance from the AAFS and The InterAgency Board provides similar PPE recommendations [AAFS 2017; The InterAgency Board 2017].

Because of the variability in incoming evidence, scenario-based protocols would be an effective approach to writing guidelines. This means that guidance on what engineering controls and PPE should be used for a specific type of evidence would be useful. Guidelines should include clear policies for how and where chemists can process evidence. For example, the testing of small amounts of evidence may be done on the desktop, but non-trace evidence or evidence from suspected traffickers should be sampled in a fume hood or other ventilated enclosure.

Respiratory protection guidelines and requirements in the respiratory protection program in our evaluation were not specific to forensic laboratory work but rather applied to all police department staff enrolled in the plan. These gaps left employees unsure when they were required to wear respiratory protection and when it was optional. When we spoke to employees, the determining factors varied and included the form of the evidence (powder or not) and/or the suspected identity of the substance. However, we observed that the suspected identity of the evidence frequently differed from the actual identity of the evidence.

An additional type of respirator, the air-purifying elastomeric half-mask respirator, was provided to employees in the last several months before our visit. However, most employees did not wear this respirator, reporting to us that they did not know when or if it was required and that it caused headaches or pain when worn. Review of the health and safety documentation, including the respiratory protection program and communications with employees, did not appear to provide specific guidance about which activities require respirator use and how to select which respirator to use. NIOSH recommends respirators with P100 particle filtration for first responders with possible fentanyl exposures in air, which the air-purifying half-face elastomeric respirator provides in this workplace [NIOSH 2017]. In dedicated laboratory space, engineering controls, rather than frequent respiratory protection use, is the preferred method of exposure control. Respiratory protection should be limited to emergencies, such as spills, or nontypical sampling or processing that cannot occur within a ventilated workspace.

Contracted facility environmental services employees wore N95 respirators when emptying trash containing discarded barrier papers and small amounts of evidence. Based on the respiratory protection program and conversations with management, it was unclear who was responsible for the respirator protection program in which environmental staff should be enrolled.

We observed all employees wearing nitrile gloves when they handled suspected illicit drug evidence. Therefore, the hand contamination we measured is likely from contacting bare hands with contaminated surfaces like laboratory benches, keyboards (and keyboard covers), door handles, sink handles, or from removing gloves in such a way that contaminates the hands. Some chemists typed on their workstation keyboard without removing contaminated gloves and then typed with bare hands, which could be a source of contamination. We observed most employees wearing safety glasses and laboratory coats while in the laboratory on the second site visit. However, interviewed employees' self-reported use was variable.

Limitations

This evaluation was subject to several limitations. First, industrial hygiene sampling can only document exposures on the day of sampling in the locations sampled. These results may not be representative of conditions during other days as the casework varies day to day. Second, because the interviews asked employees about past workplace processes, practices, and conditions; exposures; and health effects, these results are subject to recall bias.

Conclusions

Employees at three controlled substances laboratories reported no symptoms associated with acute exposure to cocaine, fentanyl, heroin, or methamphetamine. However, we identified the potential for unintentional exposures in the air and on contaminated surfaces and hands for all four drugs sampled. We provided recommendations to assist the laboratories in minimizing exposures to these substances. These recommendations included changing workplace practices that potentially increase exposure risks, creating a more effective respiratory protection program, and training employees on protocols to improve employee safety.

Section C: Tables

Table C1. Summary full-shift personal air sample concentrations (µg/m^3)*

	Cocaine	Fentanyl	Heroin	Methamphetamine
Geometric Mean	0.065	0.007	0.018	0.005
Max	0.72	0.04	0.31	0.03
Min	NR	NR	NR	NR

NR = concentration is below the minimum reportable concentration

* The minimum reportable concentrations range from 0.004 to 0.005 µg/m^3.

Table C2. Individual full-shift personal air sample concentrations (µg/m^3)

Participant	Sample duration (minutes)	Cocaine	Fentanyl	Heroin	Methamphetamine	MRC
1	223	0.066	0.018	0.049	NR	0.005
2	396	0.021	0.030	0.15	0.028	0.005
3	441	NR	NR	0.011	NR	0.005
4	460	0.006	NR	0.061	NR	0.004
5	400	0.005	0.041	0.31	0.012	0.004
6	415	0.20	NR	0.009	NR	0.005
7	408	0.72	0.028	0.044	NR	0.004
8	385	0.55	NR	0.006	NR	0.005
9	478	0.12	NR	NR	NR	0.004
10	428	0.099	NR	NR	NR	0.005
11	492	0.072	NR	0.012	0.005	0.005
12	424	0.65	NR	NR	NR	0.004

MRC = Minimum reportable concentration

NR = concentration is below the minimum reportable concentration

Table C3. Individual preshift and postshift handwipe samples (ng/swab)*

Participant	Cocaine		Fentanyl		Heroin		Methamphetamine	
	Preshift	Postshift	Preshift	Postshift	Preshift	Postshift	Preshift	Postshift
1	16	830	NR	11	1.1	53	NR	7.5
2	2.3	25	NR	4.0	2.1	30	NR	32
3	NR	77	NR	2.7	NR	17	NR	NR
4	1.4	93	NR	5.3	NR	66	NR	3.7
5	19	140	NR	8.9	3.5	160	5.7	33
6	NR	18	NR	NR	NR	1.0	NR	NR
7	4.2	310	NR	11	NR	20	NR	5.2
8	8.8	2600	NR	5.0	NR	36	NR	100
9	NR	550	NR	3.0	NR	6.7	NR	NR
10	1.5	100	NR	NR	NR	1.1	NR	NR
11	1.1	120	NR	NR	NR	4.2	NR	4.2
12	1.1	350	NR	NR	NR	2.2	NR	1.1
13	NR	46	NR	5.9	3.0	17	NR	1.1

* Reporting limit was 1 ng/swab.

Table C4. Surface sample results (µg/100 cm^2)*

Location	Cocaine	Fentanyl	Heroin	Methamphetamine
Keyboard cover	5.8	0.21	2.6	1.6
Keyboard under cover	0.49	0.0022	0.010	NR
Keyboard, no cover	4.0	0.021	0.68	0.046
Keyboard, no cover	1.7	0.13	0.078	0.0079
Keyboard, no cover	0.026	NR	0.0010	0.010
Laboratory bench surface	5.0	0.0012	0.0050	0.0084
Laboratory bench surface	4.2	0.37	0.16	0.13
Laboratory bench surface	2.9	0.023	0.046	0.035
Laboratory bench surface	1.9	0.0015	0.011	0.0018
Laboratory bench surface	1.8	0.0081	0.058	NR
Laboratory bench surface	1.8	0.054	0.11	0.060
Laboratory bench surface	1.4	0.052	0.032	0.25
Laboratory bench surface	1.0	0.037	0.083	0.048
Laboratory bench surface	0.81	0.10	0.048	0.17
Laboratory bench surface	0.78	0.060	0.11	0.0043
Laboratory bench surface	0.74	0.037	0.094	0.10
Laboratory bench surface	0.39	0.0068	0.0071	0.0017
Laboratory bench surface	0.075	0.078	0.23	0.45
Report desk	NR	NR	NR	NR
Report desk	0.044	NR	0.0029	0.0092
Report desk	0.014	NR	NR	NR
Shelf in laboratory	2.9	0.15	4.0	0.11

* The reporting limit was 1 ng (0.001 µg) per sample.

Table C5. Health effects of severe cocaine, fentanyl, heroin, and methamphetamine toxicity*

Controlled substance	Health effects
Cocaine	Dilated pupils, sweating, agitation, anxiety, elevated heart rate and blood pressure, heart arrhythmias, stroke, seizures, and high body temperature
Fentanyl	Lethargy or other indications of central nervous system depression, shallow or slow breathing, miosis or pinpoint pupils, slow heart rate, low blood pressure, low body temperature
Heroin	Lethargy or other indications of central nervous system depression, shallow or slow breathing, miosis or pinpoint pupils, slow heart rate, low blood pressure, low body temperature
Methamphetamine	Dilated pupils, sweating, agitation, anxiety, hallucinations, elevated heart rate and blood pressure, heart arrhythmias, stroke, seizures, high body temperatures, and electrolyte abnormalities such as low potassium or sodium or elevated blood glucose

* [Bateman et al. 2014]

Table C6. Selected laboratory locations where interviewed employees reported working

Location	No. of employees (n = 24)
Central receiving area	21
Controlled substances laboratory	20
Controlled substances laboratory instrument room	16
Report writing area	13

Table C7. Personal protective equipment reported to be worn by interviewed laboratory employees (n = 20)

Personal protective equipment	No. forensic laboratory chemists (n = 13)	No. evidence inventory employees (n = 7)
Nitrile gloves		
Always	13	0
Sometimes	0	6
Never	0	1
N95 respirator		
Always	3	0
Sometimes	10	1
Never	0	6
Safety glasses/goggles		
Always	0	0
Sometimes	4	1
Never	9	6

Table C8. Description of training received as reported by interviewed employees

Training	No. of employees (n = 24)
What to do in the event of a sharps injury	18
Safely handling sharps	17
Safely handling evidence containing suspected cocaine/opioids	17
Recognizing signs or symptoms of opioid intoxication	16
Proper administration of naloxone	16

Section D: References

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