HealthHazard® Evaluation Program

Evaluation of Occupational Exposures to Illicit Drugs in Forensic Laboratories

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The Health Hazard Evaluation Program investigates possible health hazards in the workplace under the authority of the Occupational Safety and Health Act of 1970 [29 USC 669a(6)]. The Health Hazard Evaluation Program also provides, upon request, technical assistance to federal, state, and local agencies to investigate occupational health hazards and to prevent occupational disease or injury. Regulations guiding the Program can be found in Title 42, Code of Federal Regulations, Part 85; Requests for Health Hazard Evaluations [42 CFR Part 85].

Availability of Report

Copies of this report have been sent to the employer, employees, and union at the workplace. The state and local health departments and the Occupational Safety and Health Administration Regional Office have also received a copy.

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Introduction

Request

Management at a state police agency was concerned about potential occupational exposure to illicit drugs, including methamphetamine, among employees working in the toxicology lab.

Workplace

The state toxicology laboratory (also toxicology lab) served the entire state, performing toxicology testing for law enforcement agencies and other submitting agencies and parties throughout the state. Toxicology laboratory division employees performed forensic analyses on a variety of biological materials, such as urine and blood, for the presence and amount of illicit and licit drugs. The request focused on occupational exposures to illicit drugs, specifically methamphetamine and cocaine. No work-related health effects related to potential exposure to drugs were noted in the request. The toxicology laboratory division, including the toxicology laboratory evidence vault, occupied one side of the third floor. At the time of our visit, 23 forensic scientists and one laboratory manager worked in the state toxicology laboratory.

Regional crime laboratory management agreed to include the regional crime laboratory in this health hazard evaluation because it was located near the state toxicology laboratory, separated by a shared hallway. The regional crime laboratory (also crime lab) analyzes suspected drug evidence for controlled substances and drugs of forensic interest, genetic material, firearms, and other items related to criminal offenses. It was one of five regional crime laboratories in the state, serving the needs of that geographic region. The regional crime laboratory was located on the second and third floors of the same building. The crime laboratory evidence storage vault was located on the second floor. Employees of the crime laboratory material analysis section, located on the third floor, performed forensic analyses on a variety of seized drug evidence. Two forensic scientists and one supervisor worked in the materials analysis section of the regional crime laboratory at the time of our visit.

Prior to the health hazard evaluation request, the toxicology laboratory division occupied and then vacated laboratory and office space that previously belonged to the regional crime laboratory, called the annex space. Shared common areas, including restrooms and a break room, were also located on the third floor along the shared hallway.

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

Our Approach

We conducted a virtual site visit of the facility in March and April 2022 to gather preliminary information. During this virtual site visit, we completed the following activities:

- Conducted a virtual walkthrough of the facility, focusing on the second and third floors.

- Evaluated building ventilation virtually with assistance from the law enforcement agency industrial hygienist.
- Held confidential medical interviews with 34 employees by video conferencing.

We visited the facility in June 2022. During the site visit, we completed the following activities:

- Observed work process, work practices, and workplace conditions.
- Tested 13 toxicology laboratory forensic scientists' hands for exposures to methamphetamine, cocaine, fentanyl, and heroin.
- Collected surface samples for methamphetamine, cocaine, fentanyl, and heroin on surfaces in the state toxicology laboratory, the materials analysis areas of the regional crime laboratory, annex laboratory areas, and common areas.
- Administered a written questionnaire to 23 toxicology laboratory employees.
- Reviewed relevant records and documents on the safety and health program, past cleaning activities in the former and current toxicology laboratory areas, and laboratory surface sampling results completed prior to the visit.
- Spoke with facilities maintenance staff and continued the ventilation evaluation, focusing on areas that were not evaluated during the virtual evaluation.
- Visually inspected building ventilation systems.

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

Our Key Findings

Detectable levels of methamphetamine, cocaine, fentanyl, and heroin were found on surfaces

- In the toxicology laboratory, detectable levels of methamphetamine were found on a supply vent cover (1/1), return vent cover (1/1), centrifuges (2/4), and laboratory bench surfaces (3/11). Detectable levels of cocaine were found on the supply vent cover (1/1), return vent cover (1/1), and door handle (1/4).
- In the crime laboratory, detectable levels of methamphetamine were found on hood sashes (2/2), laboratory bench surfaces (2/2), keyboards (2/2), door handles (2/3), and at the bottom of a vestibule door leading to the shared hallway. Laboratory bench surfaces (2/2) and keyboards (2/2) had detectable amounts of methamphetamine, cocaine, fentanyl, and heroin.
- In the annex laboratory, we found detectable levels of methamphetamine and cocaine on a fume hood surface (1/1), a supply vent cover (1/1), a centrifuge (1/1), and on fume hood sashes

(2/2). Methamphetamine was detected on a door handle in the annex laboratory (1/1). Cocaine was detected on a door handle in the annex office (1/1).

- None of the surface samples collected in the toxicology lab exceeded the state remediation level for methamphetamine contamination of 1.5 micrograms per 100 square centimeters. This level is the same as a health-based remediation level for methamphetamine contamination calculated by the state of California. One sample collected from the fume hood sash of the crime laboratory exceeded this state limit for methamphetamine contamination in remediated spaces. There are no relevant remediation levels for surfaces for cocaine, fentanyl, and heroin.
- On the hands of the 13 toxicology lab forensic scientists tested, we did not find detectable levels of methamphetamine, cocaine, fentanyl, or heroin. Scientists' hands were tested before entering the laboratory at the beginning of the day and when leaving the laboratory at the end of the day.

Employees did not report any symptoms related to handling methamphetamine, cocaine, fentanyl, or heroin at work

- Most employees reported no work-related health symptoms.
- Of those who did report a work-related health concern, none were from potential exposure to handling licit or illicit drugs.

Observed air flow between laboratories and surrounding areas may have affected the movement of drugs

- Pressurization between the state toxicology laboratory and the shared hallway indicated that air mostly flowed from the toxicology laboratory into the shared hallway. One doorway between the toxicology laboratory and the hallway was observed to be neutrally pressured, meaning that air was likely to flow both into and out of the toxicology laboratory.
- One of the crime laboratory vestibule doorways was positively pressured compared with the shared hallway, meaning that air mostly flowed from the crime laboratory into the shared hallway at that door. The remainder of the doorways between the crime laboratory and the shared hallway were negatively pressured, meaning that air mostly flowed from the shared hallway into the crime laboratory from those doorways.
- Laboratory ventilation guidelines state that, in general, air should flow from low hazard areas to higher hazard areas. Keeping the desired airflow direction can slow the movement of air contaminants but does not completely stop it.
- Laboratory management provided records of fume hood velocity certified by a contractor for the years 2020 and 2021. Most fume hoods had a display that showed the hood's face velocity. For a few fume hoods, we verified that the display value aligned with our measurements.

Personal protective equipment (PPE) access, use, and training can be improved

- Lab coats were stored in the vestibule connecting offices to the toxicology laboratory. Employees may enter and exit the lab from vestibules that did not provide access to lab coats.
- New PPE was stored in the toxicology laboratory. Employees and visitors had to enter the lab to don new or change out PPE.
- Lab coats and eye protection were observed being inconsistently worn by toxicology laboratory employees when in the laboratory for short periods of time or while not processing biological samples. This was consistent with medical interview and questionnaire findings.
- More training was both needed and desired:
    - Most toxicology laboratory employees did not know if trainings or written policies on PPE use existed.
    - More than half of the toxicology laboratory employees surveyed felt that trainings need to be improved.

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.

Potential Benefits of Improving Workplace Health and Safety:

↑ Improved worker health and well-being	↑ Enhanced image and reputation
↑ Better workplace morale	↑ Superior products, processes, and services
↑ Easier employee recruiting and retention	↑ 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 followed by using 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 PPE might be needed. Read more about the hierarchy of controls at https://www.cdc.gov/niosh/topics/hierarchy/.

We encourage the laboratory 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 methamphetamine, cocaine, fentanyl, and heroin on surfaces

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

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

Establish and encourage employees to follow a consistent policy for using fume hoods when handling evidence biological and bulk drug samples.

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

- Continue or increase the frequency of routine deep cleaning of laboratory surfaces.
- Use wet cleaning methods or a vacuum equipped with a high efficiency particulate air filter for cleaning laboratory surfaces.
- Remove cleaning equipment that could aerosolize particles, such as vacuum cleaners without high efficiency particulate air filters and compressed air canisters. This will help to prevent employees dry sweeping and using other dry-cleaning methods when cleaning laboratory surfaces.
- Provide, at a minimum, annual training to ensure compliance with approved cleaning practices.
- Consider using a detergent and water solution, as recommended by the Environmental Protection Agency, when deep cleaning or cleaning large areas. The Environmental Protection Agency discourages the use of methanol for remediation activities due to flammability and other hazards.
- Change cleaning protocols as needed to reflect the most up-to-date research on surface cleaning and contaminant removal for drugs commonly found in submitted evidence.

Update laboratory protocols to reduce employees' exposure to controlled substances.

- Eliminate measuring net weights of evidence whenever it is not needed for law enforcement purposes or legal proceedings. Changing this practice will reduce the risk of drugs becoming airborne during transfer from packaging to scales.
- Educate all employees, including contracted janitorial staff, on work practices to minimize possible aerosolization of and surface contamination with evidence materials. For example, instruct employees to refrain from transporting loose evidence materials without an enclosed container.

Improve health and safety training in the toxicology laboratory.

- Many toxicology laboratory employees stated they wanted more or better training. Current training can be improved by using formalized and varied methods including visual or interactive training.
- Consider testing employees' knowledge before and after training to evaluate their understanding of the training objective.

Remind employees handling biological samples to practice principles of bloodborne pathogen exposure prevention.

- Educate employees about the importance of practicing universal precautions for bloodborne pathogens when handling samples and other solutions, such as capping tubes before vortex-mixing. These principles will help employees prevent exposure to illicit drugs from biological evidence and drug standards.

Provide space and encourage employees to store personal items outside of laboratory areas and vestibules.

Encourage employees with any work-related health concerns to talk to their healthcare providers about their potential workplace exposures to illicit drugs.

Review and update PPE practices and storage policies.

- Increase the availability and locations for laboratory coat storage in vestibules in the toxicology laboratory.
- Store new PPE in vestibules or in office areas outside of the toxicology laboratory. This prevents potential contamination of unused PPE, provides better access, and makes it easier to change into new PPE.

- Consider establishing a set of required PPE when employees enter the toxicology laboratory or when they perform specific tasks or work with specific evidence in the crime laboratory. Display PPE requirements clearly at all entrances to the toxicology laboratory.
- Create schedules for replacing PPE items. Train employees on any changes to this policy.
- Tell employees not to hang used laboratory coats inside the toxicology laboratory, on the backs of their laboratory bench chairs, or on other laboratory equipment.
- Encourage toxicology laboratory employees to only enter and exit the laboratory through vestibules where required PPE is stored and available for use.
- Establish glove-use policy for workstation and analytical instrument keyboards in the toxicology and crime laboratories to determine if gloves should or should not be used on keyboards.
- Provide training on the correct use of PPE, including when to use, store, and replace it.

Determine if forensic scientists who handle drug evidence should be enrolled in the respiratory protection program

- Past health hazard evaluations done in forensic labs found respiratory protection to be another effective control for preventing unnecessary exposure to illicit drugs in the air.
- Where voluntary use of N95 respirators is allowed for protection against illicit drug particles, provide employees with Appendix D of the Occupational Safety and Health Administration's Respiratory Protection Standard or the state's equivalent standard.

Recommendation 2: Consult the building facilities manager or a ventilation engineer to modify ventilation systems to maintain differential pressures to prevent the spread of hazardous substances in the building

Why? Maintaining building ventilation and differential pressure are important strategies to reduce the potential spread of infectious diseases and the movement of hazardous materials in laboratories.

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

Determine desired directional airflow between rooms in the building.

- Laboratory ventilation guidelines specify that "airflow shall be from areas of low hazard to higher hazard." Maintaining directional airflow opposes the migration of air contaminants.

- Redesign or adjust existing controls on ventilation systems for desired directional airflow between laboratories and other spaces, such as offices and shared common areas.

Provide dedicated ventilation to the evidence storage vault.

- Past HHEs evaluating occupational exposures in evidence rooms and storage areas may provide additional information:
    - HHE Report No. HETA-2018-0150-3340, Evaluation of Potential Occupational Exposures to Narcotics in a County Evidence Room (cdc.gov)
    - HHE Report No. HETA-2010-0017-3133, Evaluation of Police Officers' Exposures to Chemicals While Working Inside a Drug Vault – Kentucky (cdc.gov)

Continue maintaining fume hoods with quarterly inspections conducted by laboratory staff and annual inspections conducted by a contractor.

- Continue ensuring that fume hood face velocities are within ANSI/ASSP recommendations of 80–120 feet per minute.
- Consider asking the fume hood contractor to conduct tracer gas containment tests according to ANSI/ASSP guidance if concerns exist about the effectiveness of fume hood containment.

Recommendation 3: Address other potential health and safety issues at your workplace

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 possibly increased costs to your agency. We saw the following potential issues at your workplace:

- Hazard communication
- Training effectiveness

Although they were not the focus of our evaluation, these issues could impact your workers' health and safety and should be addressed.

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

Increase hazard communication and conduct job hazard analyses to identify potential hazards and ways to control for them.

- Find more information on job hazard analysis here: https://www.osha.gov/sites/default/files/publications/osha3071.pdf.
- Place signs at each laboratory entrance displaying required PPE and other important health and safety messages.
- Create health and safety policies and procedures that are efficient and specific to a forensic scientist's tasks.

Evaluate the effectiveness of existing training programs and make improvements based on employee feedback and training posttests.

Recommend forensic scientists leave laboratory areas when they are not doing lab work.

Encourage employee involvement in the health and safety committee to address other workplace concerns and solicit feedback on existing practices.

- Openly discuss plans to make changes that affect employees' work and allow for time for feedback.
- Committee actions could include working to address concerns brought up during medical interviews and questionnaires such as:
  - Exposure to solvents
  - Musculoskeletal disease and ergonomic concerns: encourage employees to request an ergonomic assessment through the law enforcement ergonomics program or report any concerns to their supervisors
  - Mental health and workplace stress
  - Safety issues outside of the building

Provide opportunities for employees to submit anonymous feedback or concerns regarding laboratory health and safety.

Supporting Technical Information

Evaluation of Occupational Exposures to Illicit Drugs in Forensic Laboratories

HHE Report No. 2021-0115-3388

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Section A: Workplace Information

Building

The state toxicology laboratory (toxicology lab) is the only laboratory in the state analyzing biological evidence for drug content. The regional crime laboratory (crime lab) is one of the regional laboratories within the crime lab division. Laboratories within the crime lab division evaluate any items associated with a criminal trial. The state toxicology lab and the part of the regional crime lab evaluating drug evidence are located on the third floor of a four-story building, separated by a shared hallway. The evidence storage vault for the toxicology lab was located within the toxicology lab, and the crime lab evidence storage vault storing drug evidence was located on the second floor.

Built in the early 1900s, and renovated in the 1980s, the 100,000-square foot building was owned by the city and leased to the state police agency at the time of our in-person visit. The building was renovated as dedicated laboratory space with office space before the state toxicology lab and the regional crime lab moved in, which was in the early 2000s.

Employee Information

Number of employees at the time of our in-person evaluation: 28 toxicology lab employees and 30 crime lab employees (2 crime lab employees analyzed seized drug evidence).

Length of shift: 8 hours, Monday through Friday.

Union: Yes.

History of Issue at Workplace

Previous Issues

Because of space constraints and increased demand, the toxicology lab had recently expanded into a laboratory and office space formerly used by the crime lab (annex space). This annex space was across the hallway from the toxicology labs and offices. Following this expansion, the toxicology lab division discovered that biological evidence extracts analyzed in the toxicology lab by employees occupying the annex offices contained methamphetamine. However, repeat confirmation testing done on these samples was negative for methamphetamine. An investigation to find the cause of these discrepant test results found that all samples were handled by forensic scientists occupying the office areas of the annex space. Toxicology lab management then removed all toxicology lab personnel from the annex space.

During further investigation to find the origin of the discrepant result, management learned that methamphetamine synthesis was used as a training tool in the annex space in the early 2000s. The agency hired a remediation contractor to clean the annex office areas, vestibules, and hallway. Although toxicology lab personnel no longer occupied the annex offices or labs, discrepant results for methamphetamine were still identified, with confirmation testing confirming no methamphetamine in samples that had initially tested positive for methamphetamine.

Request Basis

Past surface sampling found detectable levels of methamphetamine, cocaine, and other drugs on surfaces in the toxicology lab and the annex space. The annex office, vestibules, and hallway were cleaned by a remediation contractor; the annex office was subsequently renovated. The toxicology lab was cleaned by a remediation contractor and by lab management. Toxicology lab management was concerned about the potential for adverse health effects from unintentional employee exposure to illicit drugs that could result from these detectable levels on surfaces.

Process Description

Toxicology Lab

- State and local law enforcement agencies, medical examiners, coroners, and other governmental entities submitted biological evidence to the state toxicology lab to analyze for the presence of drugs or alcohol. These results could help determine if drugs or alcohol contributed to a crime or a death.
- Submitted biological evidence was most commonly blood or urine. Blood samples went into blood collection tubes and urine samples into cups, and then they were properly packaged and labeled. Tissues and other body fluids might also be submitted for analysis. Rarely, nonbiological evidence might also be submitted for testing.
- Biological evidence samples were shipped or hand-delivered to the property and evidence custodian at the facility. The custodian recorded received evidence into the laboratory database, secured the evidence in the toxicology lab evidence vault, and managed evidence release into and out of the evidence vault.
- Forensic scientists analyzed received evidence for the presence of drugs or alcohol. Forensic scientists analyzed a set (approximately 30) of evidence samples in vials at one time for analytes based on written lab protocols. Depending on the analyte(s) of interest, the forensic scientist prepared samples in laboratory fume hoods and ran extracts of the sample on analytical instruments in the instrument room. Generally, scientists used analytical techniques including immunoassays, gas chromatography-mass spectrometry, and liquid chromatography with tandem mass spectrometry or time of flight mass spectrometry to identify drugs in evidence samples. Evidence analyzed for alcohol and volatiles used headspace gas chromatography.
- Samples that were being processed were stored in a secure, locked refrigerator in the toxicology lab when not in use.
- When completed, forensic scientists returned evidence to the evidence room. In most cases, evidence was returned to the submitting entity after the required retention period. If permission was given by the submitting entity, the evidence was disposed of.
- Scientists concluded a case by writing results into a report, which was then issued to the submitting entity.

- Depending on analysis progress, forensic scientists might only work in the lab for part of their shift or not at all. Scientists wrote reports on personally assigned computers located in designated cubicle spaces in the toxicology division offices.

In 2020 and 2021, the state toxicology lab received approximately 16,000 cases per year. About two thirds of cases pertained to impaired driving, and one third were coroner and medical examiner cases.

Crime Lab

Analyzing suspected seized drugs in the crime lab typically involved the qualitative examination of suspected drug evidence to see if the material contained a controlled substance, designer drug, or other drugs of known forensic interest. The analysis combined techniques such as recording weights, performing chemical extractions, and using instruments. At least two uncorrelated analytical techniques were used to conclusively identify a seized drug. Other forensic scientists in the crime lab system analyzed genetic material, firearms, and other evidence items related to criminal offenses.

Section B: Methods, Results, and Discussion

Our objectives were as follows:

- Evaluate the extent of work-related exposure to methamphetamine, cocaine, fentanyl, and heroin among forensic scientists.
- Evaluate the prevalence of work-related symptoms among employees in the toxicology lab and the crime lab.
- Identify and evaluate controls to protect forensic scientists and laboratory managers from exposure to controlled substances.

Methods: Health and Safety Program and Document Review

We reviewed the following documents from the toxicology lab division:

- Safety and Wellness Manual (dated Jan 2018)
- Safety Plan (dated Oct 2021)
- Operations Manual (dated Oct 2020)
- Amines Test Method Standard Operating Procedure (SOP) (dated Apr 2020)
- Basic Drugs Testing Method SOP (dated Aug 2018)
- Cocaine Test Method SOP (dated Sep 2018)
- Fentanyl Test Method SOP (dated Apr 2021)
- Fentanyl Screening SOP (dated Apr 2021)
- Testing Quality Assurance Manual (dated Oct 2021)

We reviewed the following documents from the crime lab division:

- Safety and Wellness Manual (dated Jan 2018)
- Safety Orientation Checklist (dated Apr 2020)
- Quality Operations Manual (dated Aug 2020)
- Safety Manual (dated Apr 2017)
- Laboratory Response Technical Procedures (dated Nov 2017)
- Covid Cleaning Protocols (no date)

Results: Health and Safety Program and Document Review

Both Labs

The *safety and wellness manual* applied to both the toxicology lab and the crime lab. This manual discussed broad safety and health topics such as respiratory protection program elements and general PPE usage. The manual also outlined the roles and responsibilities of health and safety personnel. It dictated that supervisors should ensure employees have proper training, receive appropriate PPE, and use and maintain PPE as required. The manual also specified disinfecting work surfaces after completing procedures. In addition, the manual stated that reusable items should undergo scheduled decontamination as well as immediate cleaning when visibly contaminated.

Toxicology Lab

The toxicology lab division's *operations manual* detailed the operational responsibilities of the testing laboratory. It listed personnel responsibilities and mentioned that "supervisors will ensure that employee training meets or maintains competency requirements," however, it did not list specific training requirements. The testing quality manual detailed equipment maintenance requirements but did not mention cleaning or decontaminating equipment.

We reviewed the SOPs for the testing of amines, basic drugs, cocaine metabolites, and fentanyl. While the cocaine metabolites testing procedures mentioned that using a fume hood was required, no other controls or PPE were listed as requirements in the other SOPs.

The *safety plan* outlined the safety and health program for the toxicology lab division. This document listed which personnel and processes had the potential to be exposed to infectious, toxic, or hazardous materials. The document further detailed the potential routes of exposures and the events (such as broken glassware) that could lead to such exposures; these were separated into biological and chemical hazards.

In the biological laboratory safety section, protective measures included "general attention to laboratory cleanliness and hygiene" but did not list strategies on how to achieve this goal. Scientists were instructed to handle tubes with biological specimens under vacuum. They were also told to conduct procedures with high potential for generating droplets (blending, sonicating, vigorous mixing, vortex-mixing) and procedures involving hazardous substances (including biological specimens, derivatizing agents, acids, bases, and solvents) in fume hoods with the sash down. The required PPE listed included lab coats, impermeable gloves, and "some type of eye/face protection." Employees were instructed to change gloves "as needed, to prevent cross contamination," but the plan offered no specific guidance on how to prevent cross contamination.

This section also discussed universal precautions such as not eating, drinking, or handling cosmetics or contact lenses in the lab area. It also required employees to wash hands after working with biological specimens and before leaving the lab. In the plan, scientists were prohibited from wearing soiled lab coats in public areas. The plan did not include guidance on when to discard and replace disposable lab coats.

Work surfaces and utensils used for biological materials were required to be decontaminated with bleach solution daily or after completion of a procedure. All spills were to be cleaned promptly and with impermeable gloves and other appropriate protective clothing, although the exact PPE is not mentioned. Later in the section, it mentioned that gloves should be changed and hands washed after completing each specimen.

Medical waste, defined as "blood, human tissue, or any gloves, wipes, absorbent pads, disposable tubes or pipettes, rags or disposable glassware, or other items contaminated with blood" was to be disposed in appropriate medical waste containers.

The chemical laboratory safety section offered information on elements of safety operation, along with storage and spill instructions. This section built upon the biological hazard section and provided broad information on wearing PPE but did not elaborate on PPE for specific chemical hazards. For example, this section specified that "protective glasses should be worn to guard against ultraviolet and infrared exposure" but did not specify which protective glasses and where this exposure may occur.

Crime Lab

The *safety manual* was designed to protect employees from potential health hazards in the laboratory. This document designated safety personnel, discussed control measures and detailed the chemical hygiene program. To avoid potential contamination from chemicals or evidence, the personal hygiene section of this document restricted eating, drinking, smoking, or applying cosmetics in any lab area unless designated by the lab manager. Hand washing was recommended after contact with evidence, chemicals, or any other hazardous materials, as well as after working at any hood. Hand washing was also recommended before exiting the lab to common areas.

The *safety manual* specified that fume hoods were the primary engineering control in the lab and should be used for operations that might result in the release of toxic or hazardous chemical vapors or dust. Examples of chemicals of moderate and high chronic or high acute toxicity listed included diisopropylfluorophosphate, hydrofluoric acid, and hydrogen cyanide. The manual emphasized the use of fume hoods when handling chemicals but did not specify if or what types of drug evidence should be handled in fume hoods. The manual instructed scientists to clean hoods after each use. In addition, the manual stated that fume hoods should be evaluated quarterly to ensure a face velocity of 60 to 100 feet per minute (fpm), and that a contractor should inspect fume hoods annually to ensure performance.

The PPE section of the *safety manual* required removing rings and dangling jewelry and tucking away loose hair during laboratory operations. In general, scientists should "wear eye and hand protection and a laboratory coat." This section also dictated that lab coats and shoes be worn while using hazardous chemicals and that lab coats be removed before entering common areas. This section recommended appropriate eyewear when handling potentially hazardous materials. The eye protection required for these operations was to be determined by the lab manager. Gloves were similarly recommended as necessary. The guidelines for gloves included properly selecting and inspecting gloves based on the permeability of common chemicals. Gloves were to be replaced periodically depending on the frequency of use and permeability of the substance being used. Scientists were instructed to "avoid touching doorknobs, draw handles, or other common-use items that may later be touched by ungloved individuals" and to remove gloves before eating or leaving the laboratory. Respirator use was voluntary only, but information about the types of respirators available was detailed in the manual.

The lab housekeeping section of the *safety manual* recommended cleaning and disinfecting countertops as appropriate. It further stated that cleaning "should be done at the end of an operation or the end of each day," and equipment should be returned clean and ready for use. However, the manual did not mention cleaning in between testing or when there is visible contamination.

Methods: Employee Health Assessment

Confidential Medical Interviews

During our virtual visit, we invited 17 toxicology and 17 crime lab employees to participate in confidential semi-structured medical interviews by randomly selecting a representative sample based on job titles. Interviews covered basic demographics, work history and practices, health and safety concerns, PPE use, training, and possible work-related health effects or direct exposure to controlled substances during the 3 months preceding our virtual visit.

Written Questionnaires

We used the results of the virtual interviews to design a written questionnaire that we administered during our in-person visit. We invited all forensic scientists, laboratory technicians, laboratory aides, and property and evidence custodians from the toxicology lab to participate. We also invited crime division employees who handle bulk drugs (two employees total) working on the third floor to complete a written questionnaire. Questionnaires covered basic demographics, work history and practices, training history, PPE use, cleaning practices, possible work-related health effects, controlled substance direct exposure incidents, and health and safety concerns. In total, 23 employees participated in the written questionnaire; all were from the toxicology lab division.

Findings from interviews and written questionnaires on training, PPE use, and cleaning are reported separately as contributions to the assessment of work processes, practice, and conditions.

Results: Employee Health Assessment

Confidential Medical Interviews

As part of our virtual site visit, 34 employees working across the toxicology and crime lab divisions participated in confidential medical interviews. This included 20 scientists, 5 supervisors, 6 laboratory technicians or property and evidence custodians, and 3 administrative assistants. Of the 34 employees, 26 (76%) were female and 8 (24%) were male, and the median age was 41 years (range: 32–45 years). Demographic information and data on job characteristics for both toxicology and crime lab employees interviewed are in Table C1.

Of 17 toxicology division employees interviewed, median job tenure was 5 years (range: 6 months–21 years), and the median number of work hours per week was 40 (range: 40–62 hours per week). Of 17 crime division employees interviewed, median job tenure was 17 years (range: 1–26 years), and the median number of work hours per week was 40 (range: 30–50 hours per week).

Of 17 crime division employees, 2 (12%) reported a direct skin, respiratory, or mucous membrane exposure to suspected illicit drugs at work. One of the two could not recall the specifics of the exposure incident. The other employee reported exposure to methamphetamine from synthesizing methamphetamine for training purposes in the early 2000s. Neither employee reported any health symptoms or concerns from these exposures.

Although health symptoms from direct exposure to suspected illicit drugs were absent, across the toxicology and crime lab divisions, 11 of 34 (32%) employees reported one or more work-related health symptoms (4 toxicology division employees and 7 crime division employees). Health concerns from work included headache (1), eczema (1), allergies (1), musculoskeletal issues (5), and mental health issues (3). Most musculoskeletal issues were reported to be from poor ergonomics.

Written Questionnaire

During our in-person visit, 23 forensic scientists, laboratory technicians, laboratory aides, and property and evidence custodians working in the toxicology lab division completed a questionnaire (Table C2). Of the respondents, 19 (83%) were female and 4 (17%) were male. The median age of the respondents was 42 years (range: 25–58 years), and median job tenure was 4 years (range: 3 months–21 years). For the 2 weeks prior to our visit, the respondents worked a median of 40 hours per week (range: 16–45 hours per week).

None of the 23 employees who participated in the written questionnaire reported any health symptoms from direct exposure to suspected illicit drugs.

Methods: Work Processes, Practices, and Conditions

We observed the following in the toxicology lab and regional crime lab:

- Work processes, work practices, and workplace conditions
- Employee use of PPE

Self-reported use of PPE, cleaning, and hygiene practices were collected from interviews with toxicology and crime lab employees and from written questionnaires with toxicology lab employees as described in the previous section.

Results: Work Processes, Practices, and Conditions

Work Processes and Practices

Both Labs

Reported cleaning practices were gathered from both interviews and the written questionnaire. Most interviewed employees reported cleaning at work (n = 29 of 34, 85%). Areas cleaned included laboratory benchtops, fume hoods, tools, equipment, and other work areas in the laboratory. All employees who reported cleaning reported wearing some form of PPE such as gloves, lab coats, and/or gowns. Solutions used for cleaning varied and included water, diluted bleach, detergent, diluted ethanol, and methanol.

Toxicology Lab

Work descriptions included laboratory and office work with employees spending 5% to 100% of their time in the laboratory areas. Laboratory employees' reported work activities included extraction of drugs and alcohol from biological specimens (blood, urine, serum), accepting and inventorying samples, making reagents, and performing proficiency testing on samples from external agencies. Office work included data review, data analysis, report write-up, and training. Of the 17 toxicology division employees who participated in interviews, 4 (24%) reported a direct skin, respiratory, or mucous membrane exposure to suspected illicit drugs at work. In two of those four exposures, a sample spilled or splashed onto the employee. The remaining two reported exposures were from general handling of samples in the toxicology lab vault and in the annex area. None of the employees reported health symptoms from the exposures.

In the toxicology lab, employees shared 11 laboratory workstations, each containing a laboratory benchtop, a fume hood, and equipment for sample and reagent preparation. Although each scientist did not have a dedicated workstation, they did have preferred areas and generally used the same one or two workstations. Shared lab equipment included evaporators, centrifuges, vacuum manifolds, incubators, and analytical instrument workstations. Analytical instrument workstations were in the instrument room in the toxicology lab and consisted of an analytical instrument (e.g., gas chromatograph-mass spectrometer) connected to a computer with a monitor, keyboard, and mouse. Two laboratory workstations were dedicated to analyzing alcohols and other volatile substances. These were separated from the other 11 laboratory workstations and were shared among toxicology lab forensic scientists.

Scientists might spend only part of the working day in the lab or might conduct lab work on one day and write reports another day at their desk in the toxicology division offices. Of the 23 respondents who completed a written questionnaire, all worked with biological samples either in the laboratory or the toxicology lab storage vault room. Median hours worked in the lab or vault were 10 hours per week (range: 10 minutes–35 hours). The flow of work was determined by the individual scientist. Scientists prepared reagents, control solutions, and biological sample extractions in batches in the fume hood of laboratory workstations. Biological evidence requiring the same analyses were batched together.

Scientists prepared reagents by dissolving compounds into a solution. They used these reagents to prepare samples for analysis on various analytical instruments. We observed instances of dry reagent spilling out of its large container while a scientist prepared reagent solution. Reagents, controls, and biological samples in tubes were often vortex-mixed to ensure samples and solutions were fully mixed. We observed instances of scientists vortex-mixing solutions using gloved thumbs instead of caps to cover the tops of tubes. After samples were extracted, this extract was placed into autosampler vials for analysis using analytical instrument workstations.

The median number of samples handled over the 2 weeks preceding our visit was 90 (range: 0–10,000). Employees reported samples contained methamphetamine, cocaine, tetrahydrocannabinol (THC), heroin, and other drugs (e.g., fentanyl, benzodiazepine, morphine, oxycodone, opioids, amphetamine, and other amines) (Table C3). The median number of samples processed under a fume hood was 74 (range: 0–300) with most employees (n = 18 of 23, 78%) reporting using the hood to process all their samples. Use of a fume hood to process samples was reported to be the default procedure, especially for samples containing possible bloodborne pathogens or biohazards.

We observed waste that potentially contained bloodborne pathogens being placed in biohazard waste bins located at each workstation and throughout the laboratory. Waste not containing bloodborne pathogens was discarded in the regular trash stream. Most toxicology lab employees reported receiving training on proper handling and disposal of biological samples on the written questionnaires (n = 20 of 23, 87%). Fewer employees reported receiving training on cleaning and decontamination procedure for handling samples with suspected illicit drugs (n = 15 of 23, 65%). More than half of toxicology lab employees felt that training needs to be improved (n = 13 of 23, 57%).

In the toxicology laboratory, methanol was reported as the cleaning solution chosen most often for cleaning surfaces before and after lab work and after fume hood use. We observed scientists frequently wiping down surfaces with 50% methanol and deionized water. Because of the batched nature of lab work, it was unclear when scientists wiped down bench and hood surfaces during analysis. We observed scientists cleaning surfaces at the beginning and end of the day. We also observed a variety of cleaning solutions available in the lab, some specifically for removing infectious agents. According to management in April 2021, the staff deep cleaned the fume hoods but the method and cleaning agent used for this deep cleaning were unclear. After this deep cleaning, the lab implemented cleaning logs to document daily hood cleaning. We observed that these logs were not filled out every day and did not indicate when or if a fume hood was used on a particular day.

From the written questionnaires, 14 of 23 (61%) toxicology lab employees reported cleaning in the 2 weeks prior to our visit (Table C4). The areas cleaned included lab benches (n = 13), hoods (n = 11), common lab areas (n = 7), and shared equipment (n = 4). Most respondents who cleaned reported cleaning more than one area (n = 11 of 23, 48%) and reported cleaning several times a day (n = 9 of 23, 39%). Types of cleaning included using a wet cloth or paper to wipe surfaces (n = 13), removing biohazards or other waste (n = 8), using a dry cloth to wipe surfaces (n = 2), and other types of cleaning (n = 2). Cleaning solutions used were methanol (n = 12), disinfectant wipes (n = 11), bleach (n = 10), and water (n = 4). Almost all employees who reported cleaning (n=14) also reported receiving guidance on using methanol or bleach for cleaning fume hood surfaces (n = 13 of 14, 93%).

Employee hygiene practices were analyzed based on written questionnaire responses. Of 23 toxicology lab employees, 14 (61%) reported that they always washed their hands upon entering or leaving the laboratory, 8 (35%) reported sometimes washing their hands upon entering or leaving the laboratory, and 1 (4%) did not answer this question (Table C4). Hand washing after glove removal was reported by 21 of the 23 (91%) employees: 11 of 23 (48%) reported always washing their hands after glove removal, and 10 of 23 (43%) reported sometimes washing their hands after glove removal. Most toxicology lab employees (n = 16 of 23, 70%) reported always washing their hands before eating or drinking and 7 of 23 (30%) reported sometimes washing their hands before eating or drinking. None of the respondents reported ever eating in the laboratory area.

Scientists shared concerns about dirt and unknown debris falling out of the vent covers in the toxicology lab and potential exposures to solvents in the instrument room.

Crime Lab

Work descriptions included laboratory, office, and field work. Laboratory employees' reported work activities included creating and making reagents, cannabis quantification testing, examining and testing evidence (bullets, firearms, cartridges, etc.), and DNA extraction and testing.

In the crime lab material analysis section, forensic scientists analyzing seized drug evidence each had their own laboratory workstation. A laboratory workstation consisted of a laboratory benchtop, fume hood, computer with monitor, keyboard, and mouse. Scientists shared analytical instrument workstations consisting of an analytical instrument connected to a computer with a monitor, keyboard, and mouse. For some analytical instrument workstations, each of the two scientists had their own workstations due to the low number of scientists analyzing seized drug evidence.

Forensic scientists collected submitted drug evidence from evidence storage on the second floor of the building and transported it into the lab on the third floor. Unlike in the toxicology lab division, crime lab forensic scientists work on one case at a time. We observed scientists placing barrier paper on the laboratory bench and opening packaged evidence on this paper to prevent substances from contaminating the bench. Scientists emptied containers of powdered and crystalline drug evidence onto weighing paper and weighed the contents to record a net weight. According to laboratory protocols, scientists were able to forego collecting net weights. Instead, they could record the weight with the packaging if the scientist suspected that contents could be a safety risk and note how the amount of drug evidence was assessed. We only observed scientists weighing evidence after removal from packaging.

For pills and tablets, scientists counted the number of pills or tablets. Scientists took a sample from the evidence for analysis and repackaged the remainder of the evidence. The sample taken depended on the form of the evidence, a small amount of powder or crystal from powdered or crystalline drugs, or a single pill or tablet from a number of pills or tablets. We observed scientists working in fume hoods when adding reagents to drug evidence or handling solvents. We observed scientists changing nitrile gloves frequently throughout casework.

For certain types of analyses involving compounds in solid form (e.g., infrared spectroscopy), scientists transported the sample to the analytical instrument workstation on pieces of weighing paper. After analyses, the barrier paper and the remaining sample was disposed of in the trash. Gloves were also disposed of in the trash. Scientists cleaned surfaces and equipment with a methanol solution after each discrete case. Contracted janitorial staff emptied the trash and removed it from the crime lab. We observed naloxone kits available for use in the event of an opioid-related emergency.

In the crime lab, we noted the presence of vacuums without high efficiency particulate air (HEPA) filtration. We also noted the presence of a can of compressed air near a scientist's workstation.

Employee Use of Personal Protective Equipment

Self-reported use of PPE reported in confidential interviews included responses from both toxicology and crime lab employees. Responses from written questionnaires only included toxicology laboratory employees.

Both labs

From interview responses, PPE used most frequently in the toxicology and crime labs were gloves, gowns or laboratory coats, safety goggles, and respirators (including masks or filtering facepiece respirators). Other types of PPE were worn with less frequency. Only crime lab employees reported wearing Tyvek suits, hair nets, disposable sleeves, face shields, and full facepiece respirators.

Most interviewed employees reported wearing lab coats or gowns at work (n = 30 of 34, 88%). A majority wore disposable gowns (n = 20 of 30, 67%) but some wore lab coats (n = 8 of 30, 27%) and some wore both (n = 2 of 30, 7%). Of the 30 employees who wore lab coats or gowns, 12 (40%) reported always wearing them for specific tasks such as performing DNA extractions, handling messy crime evidence, cleaning, or opening samples. The rest wore them occasionally and not with every task.

Safety glasses were worn with varying degrees of frequency. From confidential interviews, 25 employees (13 toxicology lab and 12 crime lab) reported wearing safety glasses at work; 10 of the 25 reported wearing glasses for specific tasks, such as waste disposal, opening biological samples, testing firearms, performing DNA extractions, and filling liquid nitrogen.

In response to questions on mask use, 22 employees (7 of 17 toxicology lab and 15 of 17 crime lab) reported wearing masks at work. Toxicology lab employees reported wearing either surgical/disposable masks (n = 1) or cloth masks (n = 2) while crime lab employees reported wearing surgical/disposable masks (n = 5), KN95 or unfitted N95 respirators (n = 4), and full-face respirators with dual filters (n = 1). Of 22 toxicology and crime lab employees who reported wearing masks at work, 9 (41%) did not specify what type of masks they wore. Most toxicology employees reported wearing masks as a COVID-19 precaution (6 of 7, 86%) while most crime lab employees reported wearing masks for specific tasks (12 of 15, 80%).

Toxicology Lab

Among 23 questionnaire respondents in the toxicology lab, 10 (43%) reported being without any PPE while in the lab 3–5 times a day during the 2 weeks prior, 6 (26%) reported being without PPE more than 5 times a day during the 2 weeks prior, 4 (17%) reported never being without PPE during the 2 weeks prior, and 3 (13%) reported being without PPE 1–2 times a day during the 2 weeks prior (Figure B1). The most frequent reason for why an employee chose not to wear any PPE was because they were not handling any samples, but five employees said they did not wear PPE because they were doing something quickly in the lab.

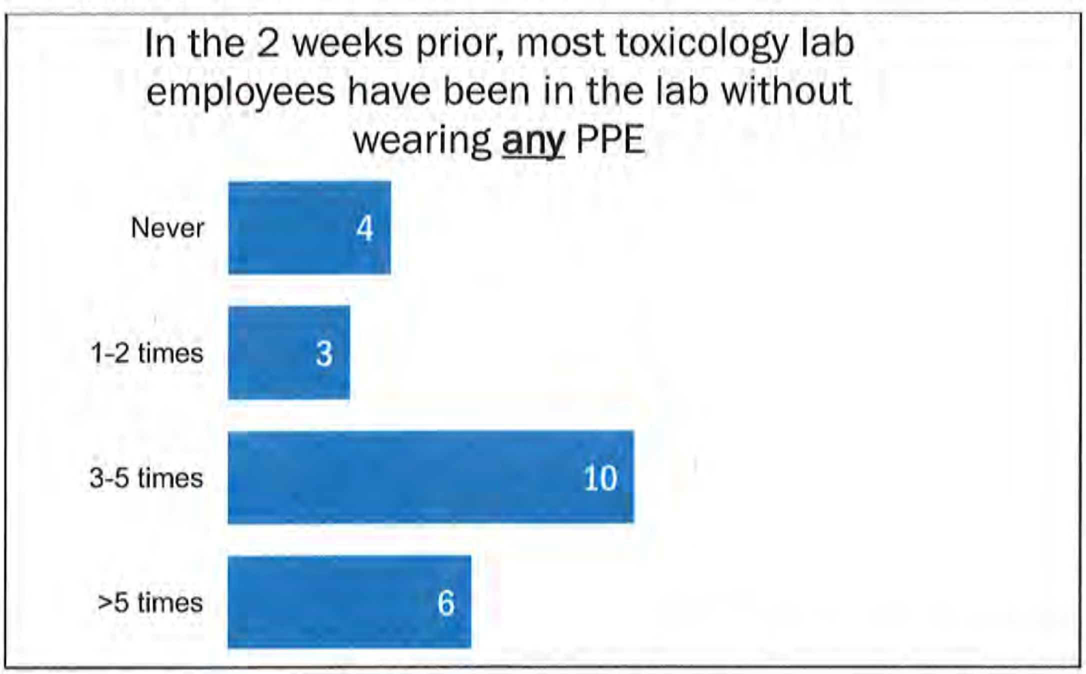

Figure B1: Frequency of employees being in the toxicology lab without wearing any PPE in the 2 weeks preceding our evaluation (n = 23).

Toxicology lab forensic scientists wore disposable lab coats. We observed inconsistent lab coat use. We observed scientists not wearing lab coats when entering the lab for tasks that did not involve working with samples or at the hood. These tasks included obtaining samples and preparing for analysis. From written questionnaires, 14 of 23 (61%) toxicology lab employees reported wearing a lab coat or gowns with all tasks in the 2 weeks prior and 8 of 23 (35%) reported sometimes wearing lab coats or gowns in the 2 weeks prior.

There was a sign posted on the door between the toxicology offices and the vestibule with biosafety information. This sign stated that PPE was available for use but did not specify which PPE was required to enter the toxicology lab. Clean lab coats and eye protection were stored inside the lab near the vestibule door. Most lab coats were stored hanging in this vestibule connecting the toxicology offices with the toxicology lab. When hanging in the vestibule, lab coats were often touching one another. We observed some lab coats hung up at workstations near fume hoods and on the backs of chairs.

From 23 written questionnaires, 22 toxicology lab employees reported wearing lab coats or gowns at work. Of the 22 toxicology lab employees who reported wearing lab coats or gowns at work, 9 (41%) changed their lab coat/gown less than once a day or once a day, 5 (23%) changed their coat only when it got dirty, and 8 (36%) did not change their lab coat or gown at all in the 2 weeks prior to our visit or reported changing their lab coat once a week. Management and scientists noted the inability to source lab coats and nitriles gloves in correct sizes due to supply chain issues, which may have impacted the frequency of replacing or changing these PPE. About half (n = 12 of 22, 54%) of the toxicology lab employees who reported wearing lab coats or gowns at work reported receiving training or written guidance on when to wear lab coats or gowns or how frequently to change them; 3 of 22 (14%) reported no training or communication on lab coat or gown use, and 7 of 22 (32%) said they did not know of any training or written policies and procedures on use of lab coats or gowns (Figure B2).

We observed eye protection (safety glasses) being worn inconsistently while employees conducted lab work. While in the lab but not conducting lab work, few scientists wore eye protection. We also observed scientists handling eye protection with gloved hands. Of 23 employees who completed written questionnaires, 12 (52%) toxicology lab employees reported always wearing eye protection in the lab, 7 (30%) reported sometimes wearing eye protection in the lab, and 4 (17%) reported never wearing eye protection in the lab. Of 19 employees who reported always or sometimes wearing eye protection in the lab, 2 (11%) reported wearing it because of personal preference, 12 (63%) reported wearing for specific job duties, and 5 (26%) reported wearing for both specific job duties and because of personal preference. Figure B2 summarizes written questionnaire information. Most employees who reported wearing eye protection said they received training or written policies and procedures on when to wear eye protection (n = 14 of 19, 74%); 1 of 19 (5%) reported no training or communication on use of eye protection, and 4 of 19 (21%) reported that they did not know of any training or written policies and procedures on use of eye protection.

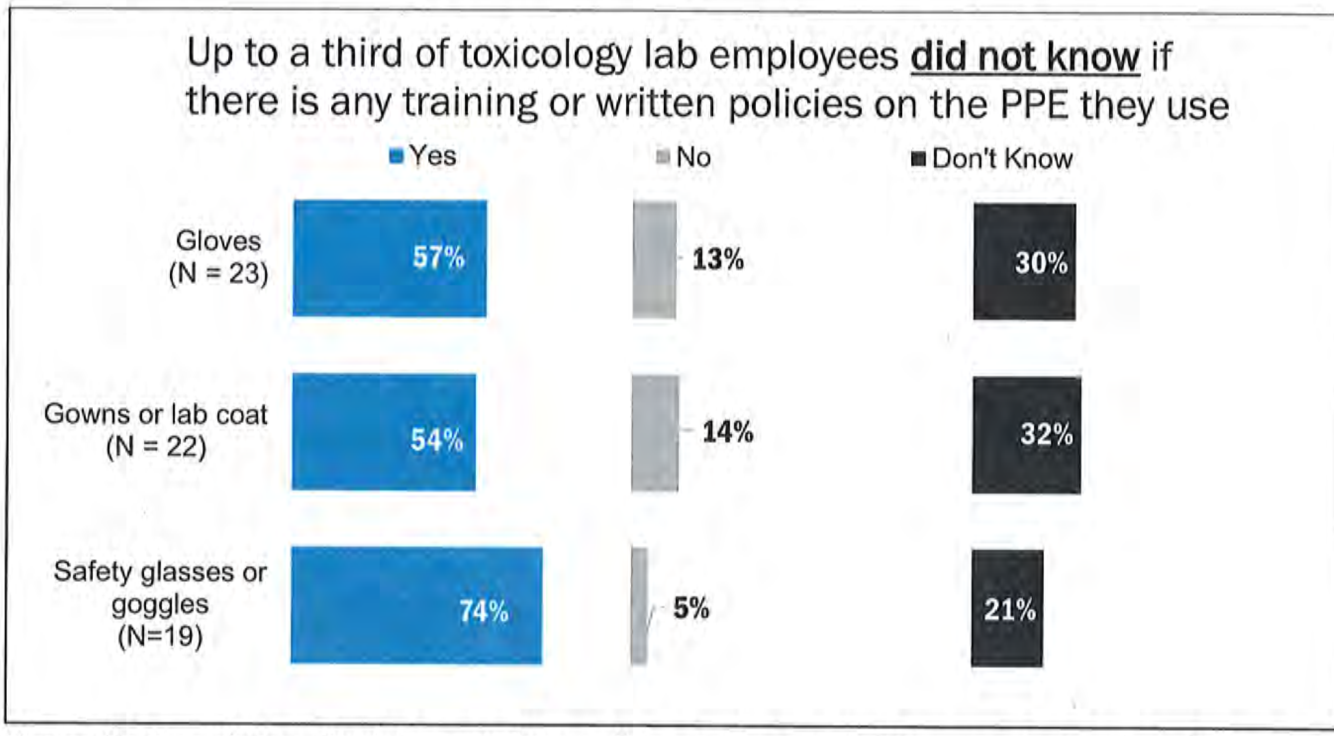

Figure B2: Knowledge of training or written policies on the use of gloves, gowns, or safety glasses as reported by toxicology lab employees.

All toxicology lab employees reported glove use. Written questionnaire responses were similar to findings from the confidential interviews with 21 of 23 (91%) toxicology lab employees reporting that they always wore gloves and 2 of 23 (9%) employees reporting that they sometimes wore gloves in the laboratory. Most employees (n = 19 of 23, 83%) changed gloves several times a day. Three employees reported changing gloves depending on the level of self-assessed contamination on their gloves. We observed most scientists changing nitrile gloves frequently, but this varied by scientist. We observed scientists using gloved hands to type on transaction and analytical instrument keyboards.

Of 23 toxicology lab employees, 13 (57%) received training or written policies and procedures on when to wear gloves and how often to change their gloves; 3 (13%) reported no training or communication on glove use, and 7 (30%) stated that they did not know of any training or written policies and procedures (Figure B2).

We did not observe any scientists using respirators during our visit and did not observe respirators being available in the lab. Scientists in the toxicology lab were not enrolled in a respiratory protection program. Written questionnaire responses from toxicology lab employees were similar to findings from confidential interviews with 9 out of 23 toxicology lab employees (39%) stating they wore masks at work, and 4 out of 9 employees (44%) reporting that they wore surgical or disposable masks. Eight of the nine employees (89%) who wore masks at work reported not having received any training or written guidance on when and where to wear a mask.

Work Conditions

At the end of our virtual interviews, we asked employees to share additional work-related health and safety concerns they had. Most (29 of 34) interviewed employees reported no additional concerns.

Among the remaining five employees, concerns included exposure to noise and carcinogenic chemicals, lack of airflow in the vault room, and general workflow disruption because of drug contamination concerns and legal proceedings.

Methods: Exposure Assessment

We assessed exposure based on past sampling reports, surface sampling, and handwipe sampling.

Past Sampling Reports

We reviewed past surface sampling results completed by a contractor before and after remediation events in the annex office area, vestibules, and hallway, and one of the fume hoods in the toxicology lab. We also reviewed past surface sampling results collected by toxicology management staff and analyzed by a federal agency.

Surface Sampling

We sampled 60 surfaces throughout the third floor for methamphetamine, cocaine, fentanyl, and heroin using a swab wetted with methanol. We focused surface sampling on commonly touched surfaces and surfaces that may indicate if substance migration could have occurred. The sample area was 100 square centimeters (cm^2) using a template on all surfaces except keyboards and door handles (including refrigerator and freezer door handles). On keyboard surfaces, we took a sample of approximately 100 cm^2. On door handles, we took a sample of the whole handle. Most surface samples were taken by the same NIOSH investigator, with a few exceptions including the vent covers in the toxicology lab.

Neither the federal government nor consensus organizations have set occupational standards limits on surfaces for methamphetamine, cocaine, fentanyl, or heroin. The U.S. Environmental Protection Agency (EPA) has developed voluntary laboratory cleanup protocols for methamphetamine and fentanyl [EPA 2021]. Some states have developed guidelines for remediation of spaces contaminated with methamphetamine. According to the EPA as of August 2021, 21 states require or recommend that methamphetamine labs be cleaned to meet a quantitative remediation standard. These state remediation standards range from 0.05 micrograms (μg) to 1.5 μg per 100 cm^2 for methamphetamine, with the most common standard set at 0.1 μg per 100 cm^2 [EPA 2021].

A company that manufactures fentanyl has developed a tentative workplace surface contamination limit of 1 μg fentanyl per 100 cm^2 [Van Nimmen and Veulemans 2004]. The province of Alberta, Canada, established a remediation benchmark on surfaces for fentanyl of less than 1.0 nanogram (ng) per 100 cm^2 for wipe samples, a value based on the lowest feasible limit of detection for fentanyl of 1 ng, not health considerations [EPA 2021]. Alberta has also established a remediation benchmark in air. According to the EPA as of August 2021, there are no state or federal standards in the United States for determining the successful remediation of fentanyl.

Handwipe Sampling

We took handwipe samples of 13 toxicology lab forensic chemists' hands for methamphetamine, cocaine, fentanyl, and heroin before (prelab) and after (postlab) working in the lab. Participants were asked to wash hands thoroughly before the prelab handwipe sampling to remove potential drug contamination from nonlaboratory sources. Employees were allowed to wash their hands as they normally would during their work in the lab. Postlab handwipe samples were taken when the employee ended work in the lab and 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. The same NIOSH investigator took all handwipe samples.

Results: Exposure Assessment

Past Sampling Reports

Remediation Contractor

After discovering biological sample extracts that were incorrectly identified as containing methamphetamine, toxicology lab management hired a contractor, certified by the state health department for drug lab decontamination, to provide remediation and decontamination services to some areas suspected of having elevated levels of methamphetamine on surfaces. The contractor collected surface samples before and after remediation activities. Surface samples were collected using disposable templates of 100 cm^2 for discrete samples and 25 cm^2 for composite samples on cotton gauze pads wetted with methanol. Most of the collected surface samples were discrete samples. The detection limit for surface samples was 0.030 µg per sample.

Pre-remediation surface sampling occurred on two separate occasions: June 2019 and November 2019. Pre-remediation surface sampling found multiple samples with detectable amounts of methamphetamine on surfaces in the annex space labs and office area, including in the vestibules and hallway. One pre-remediation sample with detectable amounts of methamphetamine was collected on the bypass grille of a fume hood in the toxicology lab. This same hood had been used to process some of the sample extracts that had been incorrectly identified as containing methamphetamine. Surface samples with levels that exceeded the state remediation standard for surfaces were collected from the floor of the annex lab, a vent cover (return grille) in the annex lab, and floors in the vestibules (2) and hallway (1) surrounding the annex labs and office area. Three surface samples collected in the annex office area also had detectable levels of cocaine. Carpet vacuum samples collected in February 2020 also found detectable levels of methamphetamine in the carpet near a vestibule door and in the annex office area.

In April 2020, the contractor performed decontamination and cleanup activities in the toxicology lab and annex office area, vestibules, and hallway. Details of how this cleaning was performed were not included in the documentation. The first set of post-remediation surface samples collected by the contractor found detectable amounts of methamphetamine on surfaces in the annex office area, vestibules, and hallways. One sample, from the floor of the hallway, exceeded the state remediation standard for methamphetamine on surfaces of 1.5 µg per 100 cm^2. The areas that were decontaminated before this first set of post-remediation surface samples was unclear from the contractor documentation provided by the toxicology lab management.

In May 2020, the contractor performed decontamination and cleanup activities in the annex office area, the vestibules, and hallways, and the hood in the toxicology lab. Decontamination activities for most surfaces were washing and rinsing of surfaces three times. The hood was also vacuumed with a HEPA vacuum before washing and again 48 hours after washing. For the annex office area, all remaining personal items and a metal bookshelf that had methamphetamine on a collected surface sample was disposed of. All drop ceiling tiles, vent covers, and light bulbs were removed and disposed of. The ceiling tracks were washed and rinsed three times. The ductwork serving the area was cleaned with compressed air or powered soft bristled brushes.

The second set of post-remediation surface samples collected by the contractor found detectable amounts of methamphetamine on surfaces in the annex office area, vestibules, and hallway. All these results were under the state remediation standard for methamphetamine.

The final set of surface samples by the remediation contractor were taken March 2021 in the toxicology lab and labeled as "pre-remediation surface sampling" and identified one surface sample with detectable levels of methamphetamine. This sample was taken on the back wall of a fume hood, on a baffle near a slot where air would exhaust out of the hood. No other decontamination or remediation services were provided by the contractor.

Federal Agency

Toxicology lab management contacted the National Institute of Standards and Technology (NIST) to measure background levels of drugs on surfaces throughout the lab. In May 2021, toxicology lab management staff collected surface samples from 100 surfaces throughout the toxicology labs and offices. The materials and methods for this surface sampling differed from those used by the contractor and for this evaluation. The samples were collected on dry meta-aramid wipes from a surface area of approximately 5 inches by 5 inches using a template. Management staff were instructed to collect samples using one directional sweeping motion. The limit of detection for each surface wipe sample was 10 ng per wipe.

Although not directly comparable to other results or to state remediation standards, these results provided information on surfaces that have had drugs particles on them. During this sampling event, surfaces sampled included door bench surfaces, hood surfaces, door handles, floors, and vent covers. There were detectable levels of methamphetamine on 3 of 4 instrument room supply vent covers and a main lab return vent cover. Cocaine was also identified on each of these surfaces; additionally, one other sample taken from a return vent cover in the toxicology lab detected cocaine but not methamphetamine in the sample.

Each quarter (3 months) since this initial sample collection, toxicology lab management staff or the agency industrial hygienist collected 25 surface samples throughout the toxicology lab for analysis by NIST. Subsequent quarterly surface sampling events did not find detectable levels of drugs. The locations of these samples were not listed in provided documents.

NIOSH Surface Sampling

Table C5 shows surface wipe sampling results collected in the toxicology lab, crime lab, annex lab and office area, and common areas on the third floor of the building for this evaluation. The reportable limit for each surface wipe sample is 1 ng or 0.001 μg per wipe.

Toxicology Lab

In the toxicology lab, the highest drug concentrations were found on surface wipe samples collected on vent covers (one supply and one return) containing methamphetamine (0.021 μg/100 cm^2 and 0.044 μg/100 cm^2, respectively) and cocaine (0.0042 μg/100 cm^2 and 0.0059 μg/100 cm^2, respectively).

Of the four surface wipe samples collected on lab centrifuges, two had reportable concentrations of methamphetamine. Of 11 surface wipe samples collected on laboratory benches, 3 had reportable concentrations of methamphetamine. Of four surface wipe samples collected on door handles, one had a reportable concentration of cocaine.

The remaining surface wipe samples collected in the toxicology lab did not have reportable amounts of any of the four drugs. None of the surface wipe samples collected in the toxicology lab exceeded the state remediation guideline of 1.5 µg per 100 cm^2 or the lower, more commonly used state or local remediation guideline for methamphetamine of 0.1 µg per 100 cm^2 [EPA 2021]. No toxicology lab surfaces had reportable concentrations of fentanyl or heroin.

Crime Lab

In the crime lab, we collected surface samples to determine drug levels on surfaces used by forensic scientists analyzing bulk drug evidence. The highest levels of drugs were collected on surface wipe samples from hood sashes. Of the two samples collected on hood sashes, two had reportable concentrations of methamphetamine, cocaine, and heroin, and one contained fentanyl. Both laboratory bench surface samples had reportable concentrations of methamphetamine, cocaine, fentanyl, and heroin. Both surface samples collected from computer workstation keyboards had reportable concentrations of methamphetamine, cocaine, fentanyl, and heroin.

We collected surface samples to determine drug levels on commonly touched surfaces. Of three surface samples collected on door handles in the crime lab, two had reportable concentrations of methamphetamine, cocaine, and heroin.

We collected a surface sample at the bottom of the door between a crime lab vestibule and the shared hallway to determine if drugs were present. This surface sample had reportable concentrations of methamphetamine and cocaine.

Annex Lab and Office

In the annex lab, we collected surface samples to determine drug levels on surfaces that are commonly touched by laboratorians or could indicate a history of drug particle movement. A sample collected on a hood surface had reportable concentrations of methamphetamine and cocaine. Of two samples collected on hood sashes, both had reportable concentrations of methamphetamine and cocaine, and one had reportable concentrations of heroin. A sample collected on a centrifuge also had reportable concentrations of methamphetamine and cocaine. A sample collected on a supply vent cover had reportable concentrations of methamphetamine and cocaine. A door handle had reportable concentrations of methamphetamine.

In the annex office area, a door handle between the office and the shared hallway had reportable concentrations of cocaine.

Common Areas

Two surface wipe samples were taken from the shared break room. A surface sample collected using a template placed on exhaust vents on the side of a free-standing microwave had a reportable concentration of methamphetamine.

Handwipe Sampling

Of 13 toxicology lab forensic scientists who participated in prelab and postlab handwipe sampling, none had reportable amounts of methamphetamine, cocaine, fentanyl, or heroin on their hands before entering the lab to conduct work or after leaving the lab for the day. The reporting limit was 1 ng or 0.001 μg per sample for each of the four drugs.

Methods: Ventilation Evaluations

Virtual Ventilation Evaluation

Prior to the virtual ventilation evaluation, the following NIOSH equipment was shipped to laboratory management: TSI® Alnor Balometer Capture Hood EBT73, a fog generator to visualize the airflow at doorways, and a laser tape measure. With video conferencing, a NIOSH ventilation engineer guided the law enforcement agency industrial hygienist to measure airflow at all accessible ventilation duct grilles and covers in the toxicology and crime labs. Toxicology lab management had requested the evaluation of the annex lab only occur during the on-site evaluation to reduce the potential for migration of drugs from the annex lab into other areas. At doorways, the law enforcement agency industrial hygienist was instructed to determine the movement of air (into or out of the room) with the door open and closed. The volume of each room or area was also recorded.

On-site Ventilation Evaluation

We met with city facilities staff to review building ventilation specifications. A NIOSH ventilation engineer visually inspected and measured separation distances for rooftop air handlers and visually inspected above the drop ceiling in toxicology and crime labs for leaky or misconnected ducting and signs of concern.

We verified pressurization measurements collected during the virtual evaluation using a fog generator for toxicology and crime labs on the third floor. We selected fume hoods at random to confirm that instantaneous face velocity measurements displayed by the fume hood were correct by confirming face velocities with a TSI® VelociCalc Multi-Function Ventilation Meter 9565. We collected airflow measurements using a TSI® Alnor Balometer Capture Hood and visualized pressurization and airflow at doorways using a fog generator in the annex lab and office areas.

We reviewed photographs taken by the law enforcement agency's industrial hygienist of a drug evidence storage vault on the second floor. This evidence storage vault was not served by building ventilation.

Results: Ventilation Evaluations

Some ventilation components and equipment were managed by the city, the owner of the building, and some components and equipment were managed by the law enforcement agency. The air handling units serving office and administration areas were on the east side of the building while the air handling units serving the laboratory areas were on the southwest side of the building. The laboratories were ventilated with a single pass system without recirculation. The exhaust systems were located on the northwest portion of the building. The separation distance between the laboratory exhaust and laboratory intake was 30.5 feet; the lab exhaust systems were directed upwards.

Facilities staff reported that regular maintenance was performed quarterly or semiannually depending on the unit, prefilter, or filter. Filtration had been increased as much as feasible, up to minimum efficiency reporting value (MERV) 13, for occupied areas of the building, to better protect against infectious disease spread. The visual inspection of ventilation systems and connections above the drop ceiling in the toxicology and crime labs found no obvious irregularities. All the observed exhaust ducting from the fume hoods were weld sealed and caulked where necessary. The fume hood exhausts were controlled by Phoenix Control valves that appeared to be functioning. There were no misconnected or leaking ducts or signs of animals.

On the toxicology side of the floor, air flowed into the toxicology lab at two doorways: the vestibule between the northern toxicology lab offices and the toxicology lab and the northern vestibule between the hallway and the toxicology lab. The northern door between the toxicology lab and the instrument room remained open during our visit. At this door and another door between the toxicology lab and the instrument room, air flowed from the instrument room into the toxicology lab. The instrument room also had a door leading directly into the shared hallway without a vestibule. At this door, we observed that pressurization was neutral, and air flowed both into and out of the instrument room from the shared hallway. These observations align with the volumetric airflow measurements in these rooms.

At the southern vestibule of the crime lab, air flowed from the lab into the hallway. The door between the crime lab and the vestibule remained open during our site visit. At this door, the airflow direction was inconsistent, flowing into the crime lab closer to the floor and neutral to flowing out of the crime lab at chest height. At the middle vestibule of the crime lab, air flowed from the crime lab into the vestibule and air flowed from the hallway into the vestibule. These observations aligned with the volumetric airflow measurements we collected.

At the annex lab vestibule, air flowed from the shared hallway into the vestibule. Air flowed from the annex office area into the vestibule between the annex office area and annex hallway. Air also flowed from the annex hallway into the crime lab.

Employees had reported ventilation and indoor environmental quality concerns in the crime lab evidence storage vault. With assistance from the agency industrial hygienist, we observed that air flowed out of the two side rooms in the evidence storage vault into the main evidence storage area, and from the main evidence storage area into the evidence technician office area. Air flow between the crime lab main evidence storage area and other areas were not evaluated.

We did not measure fume hood face velocities as part of our ventilation evaluation because lab management provided documentation of fume hood certifications performed by a contractor in 2020 and 2021. When the contractor identified fume hoods that had face velocities outside of the laboratory ventilation standard of an average face velocity of 80–120 fpm [ANSI/ASSP 2022], they conducted the required maintenance or repairs and retested the fume hood to ensure compliance with the standard.

Discussion

Although employees at this state police agency's toxicology and crime labs reported no symptoms associated with acute exposure to illicit drugs, we identified the potential for unintentional exposure on contaminated surfaces.

Work Processes, Practices, and Conditions

Exposure to illicit drugs can cause health effects. Known health effects of methamphetamine toxicity include activation of the sympathetic nervous system (dilated pupils, sweating, agitation, anxiety, elevated heart rate and blood pressure, heart arrhythmias, stroke, seizures, and high body temperature). Severe heroin and tetrahydrocannabinol exposure leads to activation of the parasympathetic nervous system (lethargy, slow breathing, slow heart rate, low blood pressure, and low body temperature) [Becker 2012; Enevoldson 2004].

While the health effects associated with high levels of exposure to drugs are known, less is known about effects at low levels of exposure.

Occupational health best practice calls for minimizing exposure to these and other substances because of the known hazards at higher levels of exposure and the unpredictable nature and origin of the evidence. During our site visit, work practices that were inconsistent with the health and safety manual or incongruent with workflow processes created opportunities for potential drug exposure. For example, in the toxicology lab, we observed instances of scientists vortex-mixing solutions (including biological samples) without capping tubes, creating a potential for dermal exposure to illicit substances and bloodborne pathogens in biological samples. This practice also does not align with the practice of universal precautions.

The handling of drug evidence can lead to transfer of trace particulate onto various laboratory surfaces [Sisco et al. 2020a]. In the crime lab, we observed scientists placing barrier paper on the laboratory bench. While using barrier papers to prevent surface contamination is often standard practice in forensic laboratories, this may pose a greater risk for aerosolization of evidence being handled since transfer and disposal of barrier paper over the trash containers can create airborne drug exposure. We also observed crime lab employees collecting net weights. Because of the unpredictable form, amount, and contents of incoming evidence, measuring net weights poses a potential risk of hazardous substances exposure to forensic scientists, and may contribute to drug background levels and be a potential source of inhalation exposure [Sisco et al. 2020b]. Measuring net weight requires extra handling of uncontained evidence without the use of controls: removing substances from packaging, transferring substances to disposable weighing paper or a weigh dish, and placing this into and removing it from a balance. These steps create opportunities for spills and aerosolization that could lead to potential drug exposure. Although protocols allowed a scientist to forego collecting net weights and record the weight with the packaging if the scientist suspected the contents to contain a safety risk, this places the burden on scientists to perform a risk assessment every time they handle evidence. Additionally, past HHEs have observed that the suspected identity of evidence contents by law enforcement or forensic scientists may not align with its actual identity [NIOSH 2020a]. These exposures can be minimized if standard policy is to measure gross weights or encourage law enforcement agencies to consider not requiring measuring net weight as part of evidence analysis if it may not change the outcome of a criminal trial.

Scientists in both labs used a methanol solution to clean laboratory surfaces and hoods. A study by Sisco et al. [2019] found that cleaning with methanol removed nearly all (over 97%) drug residue or particulate from a phenolic resin surface, however, it is unclear if diluting methanol with water decreases efficacy. More research is needed to evaluate this and other factors that impact cleaning efficiency, including the force, direction, and frequency of cleaning. Sisco et al. [2019] emphasizes the importance of establishing appropriate cleaning procedures and protocols, stating that remaining surface background is likely the result of gradual residue buildup or from infrequent cleaning. For cleaning of large surface areas or surfaces expected to contain higher amounts of methamphetamine and fentanyl and potentially heroin and other illicit opioids, the EPA recommends a detergent-water solution [EPA 2021].

Training is another key element to an effective health and safety program. We found that more than half of toxicology lab employees felt that training needed to be improved. Suggestions by employees included making training more visual and interactive rather than reading manuals. This is in line with a study that found behavioral modeling as being more effective than other types of training [Burke et al. 2006]. Behavioral modeling is a hands-on training method where the trainee observes a role model performing a task in a safe manner, practices the task, and then receives and incorporates feedback designed to improve safety when performing the task. Having clear guidelines and integrating training methods like behavioral modeling can prevent work-related unintentional exposure to illicit drugs among laboratory workers.

Strengthening training on PPE use can also minimize risk to potential drug exposure. Employees from both labs reported wearing gloves, gowns, and/or safety glasses most of the time. However, we observed inconsistent PPE use, unclear policies on PPE use and replacement, and improper storage of PPE, such as hanging lab coats side by side where they are touching each other. We also observed that employees can enter and exit the lab from vestibules that did not provide access to lab coats and other PPE, suggesting employees can enter the laboratory without any PPE. This is consistent with self-reports from toxicology lab employees as most reported having been in the lab without wearing any form of PPE in the 2 weeks prior to our visit.

When updating PPE guidelines, employers can take two approaches: a geographical approach or a task-based approach. In a geographical approach, PPE standards are recommended and enforced by area. This can work well for the toxicology lab division where overall tasks are similar regardless of the sample contents and where we would expect trace amounts of drugs in the samples. About half of toxicology lab employees described wearing PPE for certain tasks while the rest cited a physical location (i.e., lab) as the reason for wearing their PPE. A clear policy of where and what PPE is required can help with adherence to PPE standards and minimize confusion surrounding why PPE is required.

Because of the variability in incoming evidence, task-based protocols may be more effective for the crime lab division. Guidance on what PPE should be used for a specific type and amount of evidence and associated handling practices can reduce exposure. Policies on how scientists should process evidence and should notify scientists working nearby when they are processing evidence items that could result in unintended exposure can also help with risk assessment and risk management in the laboratory. PPE should always be used in the context of an overall health and safety program that provides adequate training, retraining, and periodic testing of the workers' knowledge of the proper use of PPE.

Exposure Assessment

Few surfaces in the toxicology lab had reportable amounts of drugs. Methamphetamine was identified on laboratory surfaces, with the highest amount found on a supply vent cover in the instrument room and a return vent cover in the main lab. The presence of methamphetamine and cocaine found on the supply vent cover does not determine that drugs have been in or have been transported by the building HVAC systems but could also be from particles adhering to the surface of the vent cover. Methamphetamine and cocaine were found on the supply and return air vents indicating that these substances were in the lab air in the past. Although the amounts of methamphetamine were highest on the vent covers in the toxicology lab, the amount was low relative to other surfaces where drugs were detected. No surfaces in the toxicology lab had levels exceeding the state remediation guideline for methamphetamine.

A study evaluating background drug levels in forensics labs found that in toxicology labs, methamphetamine was present on less than 20% of surfaces sampled (average concentration of between 0.0 and 0.1 ng per cm^2). Cocaine was found on just over 20% of surfaces sampled (average concentration under 0.1 ng per cm^2) [Sisco and Najarro 2019]. In this evaluation, the highest amounts of drugs identified in the toxicology lab were found on surfaces related to drug standards preparation. Lower levels were found on or near analytical instrumentation, another area where drug standards might be used.

In the crime lab, we found reportable levels of drugs on most surfaces where drugs are handled. This is expected due to the nature of the work [NIOSH 2020a,b; Sisco and Najarro 2019; Sisco et al. 2018]. Areas commonly used for analyzing drugs had the highest levels of drugs, including hood sashes, laboratory bench surfaces, and keyboards. A sample taken of the bottom of the door where we observed that air flowed from the crime lab into the shared hallway found detectable levels of methamphetamine and cocaine, supporting that pressurization is important to preventing the migration of substances out of the crime lab. One sample, collected on the surface of a hood sash, exceeded the state remediation level and the health-based remediation standard established by California for methamphetamine of 1.5 μg per 100 cm^2. No other samples collected exceeded this state limit.

In a study sampling areas inside and outside of a crime lab, sampling from areas outside of the crime lab, where lower levels of drugs were found on surfaces, showed that 48% of all samples contained methamphetamine (range: 0.004–1387.45 ng per cm^2), and 82% of samples contained cocaine (range: 0.002–412.4 ng per cm^2) [Sisco and Najarro 2019]. Two past health hazard evaluations (HHEs) conducted in forensic labs evaluating drug evidence found methamphetamine in 89% (17/19, range: 0.0017–1.6 μg per 100 cm^2) and 100% (39/39, range: 0.0088–59 μg per 100 cm^2) and cocaine in 100% (19/19, range: 0.026–5.8 μg per 100 cm^2) and 100% (39/39, range: 0.004–6.6 μg per 100 cm^2) of surface wipe samples collected in the crime lab [NIOSH 2020a,b]. The levels of methamphetamine and cocaine found in the crime lab were within the ranges found in the prior evaluations. In the toxicology lab in this HHE, methamphetamine was found in 18% (7/40) samples and cocaine was found in 8% (3/40) samples. The reportable limit (also the detection limit) for the sampling wipes used in this HHE was 1 ng per wipe, lower than those used by Sisco and Najarro [2019].

The amount of fentanyl found in the crime lab on a hood sash, two laboratory bench surfaces, and two keyboards exceeded the benchmark for fentanyl remediation of under 1 ng per 100 cm^2 (or 0.001 μg per 100 cm^2) established by Alberta, Canada [EPA 2021]. This established limit is not health-based. The EPA notes that health-based limits may be lower than this limit depending on the fentanyl analog. We found no detectable amounts of fentanyl on any other surface samples. Occupational limits currently do not exist for illicit drugs on surfaces. However, prudent occupational health practice would be to implement and improve strategies to minimize levels on surfaces to reduce potential exposures.

In the annex lab, levels of methamphetamine were below the state remediation guideline of 1.5 μg per 100 cm^2. A surface sample collected from the hood surface and hood sash exceeded the most commonly adopted state remediation guideline of 0.1 μg per 100 cm^2 [EPA 2021]. These results align with the post-remediation surface samples collected by the remediation contractor. Cocaine was detected in most samples where methamphetamine was detected, and heroin was detected in a sample collected on the hood sash.

We collected two samples in the break room to see if drugs had migrated to common areas where they were not handled. A sample collected at the microwave exhaust found levels just about the reportable limit, suggesting that low amounts of methamphetamine had been present in the air.

None of the wipes collected from toxicology lab scientists' hands before and after they conducted work in the lab had reportable amounts of methamphetamine, cocaine, fentanyl, or heroin. This suggests that despite reportable levels of these drugs found on surfaces throughout the floor, scientists have minimal to no exposure from touching surfaces and are not likely to have much or any take-home exposure.

Ventilation

Airflow can facilitate or reduce the movement of particles between spaces. We observed that at some toxicology lab doorways, air flowed into the lab from surrounding areas, and at one crime lab vestibule door, air flowed from the lab into the shared hallway. Maintaining pressurization can be an important part of any facility's plan for controlling the movement of contaminants and infectious particles. The ANSI/ASSP Z9.5-2022 laboratory ventilation standard recommends that "airflow shall be from areas of low hazard to higher hazard." This standard further explains that " 'Space pressurization' or 'directional airflow' between spaces is one of many tools available to limit exposure to laboratory hazards. Effectively applied, it opposes migration of air contaminants; it does not eliminate it" [ANSI/ASSP 2022]. Air movement can be impacted by many factors, which effective pressurization can overcome. Therefore, pressurization should be used with other engineering and administrative controls to help prevent worker exposure to laboratory hazards.

An effective engineering control is local exhaust ventilation (LEV), which is designed to capture harmful substances where they are generated. In both laboratories, the main type of LEV installed were laboratory fume hoods. Ideally, all evidence should be handled and analyzed in a fume hood. We observed that in general, scientists in both labs used fume hoods when they were handling solvents and other reagents but might not use fume hoods when handling biological or bulk drug evidence. When employees can be exposed to high-hazard materials in air (like powdered opioids and other controlled substances), laboratory ventilation guidance and pharmaceutical industry resources prioritize product containment and isolation through exposure control devices, such as variable air volume fume hoods, laminar flow ventilated hoods or cabinets, and ventilated glove boxes [ASHRAE 2015, 2018; Wood 2010]. All fume hoods in the toxicology and crime labs were certified annually by an outside contractor to ensure velocities within the ANSI/ASSP recommended face velocity of 80–120 fpm, with the crime lab manual specifying a range of 60–100 fpm [ANSI/ASSP 2022].

Limitations

This evaluation was subject to several limitations. First, industrial hygiene sampling can only document exposures and levels at the time of sampling in the locations sampled. These results may not be representative of conditions during other days. Second, surface sampling was based on professional judgment and results may not be representative of all surfaces in the location. Third, 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 reported no symptoms associated with acute exposure to methamphetamine, cocaine, fentanyl, or heroin. However, we identified the potential for unintentional exposures to these and other substances on contaminated surfaces. We provided recommendations to assist both laboratories in minimizing exposure to these substances. These recommendations included changing workplace practices to reduce exposure risk, modifying building ventilation, and training employees on protocols to improve employee safety.

Section C: Tables

Table C1. Participant demographic information and job characteristics from virtual interviews (n = 34)

Demographic characteristics	Toxicology laboratory employees (n = 17)	Crime laboratory employees (n = 17)
Male, No. (%)	2 (12)	6 (35)
Age in years, Median (Range)	39 (26–48)	42 (26–65)
Job characteristics		
Years with this state agency, Median (Range)	5 (0.5–21)	17 (1–26)
Hours worked per week, Median (Range)	40 (40–62)	40 (30–50)
Job title, No. (%)		
Scientist or technician	9 (53)	15 (88)
Lab manager, property & evidence custodian, or other	8 (47)	2 (12)

Table C2. Participant demographic information and job characteristics from written questionnaires (n = 23)

Demographic characteristics	Median (Range)
Male, No. (%)	4 (17)
Age in years	42 (25–58)
Job characteristics	
Years with toxicology laboratory	4 (0.25–21)
Hours worked in the past 2 weeks	80 (32–90)
Hours worked in the laboratory or vault room in the past 2 weeks	20 (1–60)
Job titles, No. (%)	
Scientist or technician	15 (65)
Property & evidence custodian or other	8 (35)

Table C3. Frequency, location, and potential exposure from work with biological samples from written questionnaires administered to toxicology laboratory employees (n = 23)

Number of samples handled in the past 2 weeks, Median (Range)	90 (0–1000)
Number of samples processed under a fume hood, Median (Range)	74 (0–300)
Number of employees processing samples under a fume hood, No. (%)	
Yes	18 (78)
No	5 (22)
Number of employees reporting potential exposure to the following drugs, No. (%)	
Methamphetamine	10 (43)
Cocaine	7 (30)
Heroin	6 (26)
Tetrahydrocannabinol	7 (30)
Other drugs	8 (35)
Unknown	11 (48)

Table C4. Description of self-reported cleaning and hygiene practices as abstracted from written questionnaires administered to toxicology laboratory employees (n = 23)

Cleaning Practices	No. (%)
Participated in cleaning	
Yes	14 (61)
No	9 (39)
Areas of cleaning*	
Lab bench	13 (57)
Common areas in the lab	7 (30)
Shared equipment	4 (17)
Hood	11 (48)
Vault room	0 (–)
Types of cleaning*	
Clean surfaces with dry cloth	2 (9)
Clean surfaces with wet cloth/paper	13 (57)
Remove biohazard or other waste	8 (35)
Other types of cleaning	2 (9)
Types of cleaning solution used*	
Water	4 (17)
Disinfectant wipes	11 (48)
Bleach	10 (43)
Methanol	12 (52)
Hygiene Practices	
Washing hands upon entering/leaving the lab	
Always	14 (61)
Sometimes	8 (35)
Never	0 (–)
Missing	1 (4)
Washing hands before eating/drinking	
Always	16 (70)
Sometimes	7 (30)
Never	0 (–)
Washing hands after glove removal	
Every time	11 (48)
Sometimes	10 (43)
Never	0 (–)
Missing	2 (9)

*Participants could choose more than one option

Table C5. Surface sample results (µg/100 cm^2)

Area	Location	Methamphetamine	Cocaine	Fentanyl	Heroin
Tox Lab	Supply vent cover	0.044	0.0042	NR	NR
Tox Lab	Return vent cover	0.021	0.0059	NR	NR
Tox Lab	Centrifuge	0.0025	NR	NR	NR
Tox Lab	Centrifuge	0.0011	NR	NR	NR
Tox Lab	Centrifuge	NR	NR	NR	NR
Tox Lab	Centrifuge	NR	NR	NR	NR
Tox Lab	Laboratory bench surface	0.0019	NR	NR	NR
Tox Lab	Laboratory bench surface	0.0014	NR	NR	NR
Tox Lab	Laboratory bench surface	0.0013	NR	NR	NR
Tox Lab	Laboratory bench surface	NR	NR	NR	NR
Tox Lab	Laboratory bench surface	NR	NR	NR	NR
Tox Lab	Laboratory bench surface	NR	NR	NR	NR
Tox Lab	Laboratory bench surface	NR	NR	NR	NR
Tox Lab	Laboratory bench surface	NR	NR	NR	NR
Tox Lab	Laboratory bench surface	NR	NR	NR	NR
Tox Lab	Laboratory bench surface	NR	NR	NR	NR
Tox Lab	Laboratory bench surface	NR	NR	NR	NR
Tox Lab	Door handle	NR	0.0021	NR	NR
Tox Lab	Door handle	NR	NR	NR	NR
Tox Lab	Door handle	NR	NR	NR	NR
Tox Lab	Door handle	NR	NR	NR	NR
Tox Lab	Hood surface	NR	NR	NR	NR
Tox Lab	Hood surface	NR	NR	NR	NR
Tox Lab	Hood surface	NR	NR	NR	NR
Tox Lab	Hood surface	NR	NR	NR	NR
Tox Lab	Hood surface	NR	NR	NR	NR
Tox Lab	Hood surface	NR	NR	NR	NR
Tox Lab	Hood surface	NR	NR	NR	NR
Tox Lab	Hood surface	NR	NR	NR	NR
Tox Lab	Hood surface	NR	NR	NR	NR
Tox Lab	Hood surface	NR	NR	NR	NR
Tox Lab	Hood surface	NR	NR	NR	NR
Tox Lab	Hood surface	NR	NR	NR	NR
Tox Lab	Instrument keyboard	NR	NR	NR	NR
Tox Lab	Instrument keyboard	NR	NR	NR	NR
Tox Lab	Instrument keyboard	NR	NR	NR	NR
Tox Lab	Transaction keyboard	NR	NR	NR	NR

Table C5 continued. Surface sample results (µg/100 cm²)

Area	Location	Methamphetamine	Cocaine	Fentanyl	Heroin
Tox Lab	Transaction scanner	NR	NR	NR	NR
Tox Lab	Freezer door handle	NR	NR	NR	NR
Tox Lab	Freezer lock surface	NR	NR	NR	NR
Tox Lab	Refrigerator door handle	NR	NR	NR	NR
Crime Lab	Hood sash	2.1	0.12	NR	0.0046
Crime Lab	Hood sash	0.53	1.6	0.059	0.059
Crime Lab	Laboratory bench surface	0.43	0.086	0.055	0.053
Crime Lab	Laboratory bench surface	0.089	0.062	0.0027	0.0037
Crime Lab	Bottom of door	0.080	0.017	NR	NR
Crime Lab	Keyboard	0.078	0.21	0.056	0.015
Crime Lab	Keyboard	0.0068	0.019	0.0039	0.0029
Crime Lab	Door handle	0.048	0.058	NR	0.0037
Crime Lab	Door handle	0.0077	0.035	NR	0.0013
Crime Lab	Door handle	NR	NR	NR	NR
Annex Lab	Hood surface	0.29	0.052	NR	NR
Annex Lab	Hood sash	0.15	0.11	NR	NR
Annex Lab	Hood sash	0.038	0.043	NR	0.0016
Annex Lab	Supply vent cover	0.066	0.016	NR	NR
Annex Lab	Centrifuge	0.030	0.0022	NR	NR
Annex Lab	Door handle	0.0038	NR	NR	NR
Annex Office	Door handle	NR	0.0023	NR	NR
Break Room	Microwave exhaust	0.0015	NR	NR	NR
Break Room	Table	NR	NR	NR	NR

NR = not reportable, meaning the result was under the reporting limit of 1 ng (0.001 µg) per sample
Tox Lab = toxicology lab

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