Fundamentals of Fentanyl Safety in Public Health Laboratory Settings

SEPTEMBER 2020

Public health laboratories (PHLs) are important stakeholders in the fight to end the opioid epidemic in jurisdictions nationwide. Through opioids biosurveillance, the sampling and clinical testing of non–fatal opioid overdose patients for public health surveillance purposes, PHLs inform and guide a myriad of stakeholders and public health interventions.

As the laboratory role in opioids biosurveillance expands, PHLs will be using occupational health and safety and risk minimization principles to guide the development of safe clinical sample accessioning, processing and handling procedures, while preventing exposure to fentanyl and related analogues. This document provides fundamental occupational health and safety considerations for PHLs active in this area, as well as a list of additional resources.

The guidance document may be used in concert with laboratory risk assessment templates. Due to the scope of and inter–laboratory variations in public health laboratory activities regarding handling of samples, reference standards and instrumentation, this document is not intended to be comprehensive. It is however, designed to provide a general overview of the types of potential hazards and appropriate controls to help eliminate or minimize safety risk to public health laboratory personnel.

CONTENTS

FENTANYLS OVERVIEW

Fentanyl is a highly–addictive, rapid–acting and potent synthetic opiate that is both pharmaceutically and illicitly–produced. It is 50–100 times more potent than morphine and is prone to misuse and abuse. Synthetic opioids, predominantly fentanyl analogues, have been associated with a significant increase in national opioid poisoning deaths since 2013.

ASSESSING EXPOSURE RISK

Laboratory scientists who work with analytical standards, certified reference materials Traceable Opioid Materials (TOM) Kits,[1] and neat drug standards and containing these potent compounds may be at risk of exposure to fentanyl if proper precautions are not taken. Thorough exposure assessment, adherence to universal precautions and enforcement of control solutions significantly reduce exposure risk to fentanyl compounds and bloodborne pathogens. For more information regarding bloodborne pathogen control, please see Biosafety in Microbiological and Biomedical Laboratories, 5th Edition.[2]

POTENTIAL ROUTES OF EXPOSURE

Without proper safety controls, scientists may come into contact with fentanyls in powder, pill or liquid forms, and may be subject to accidental exposure via inhalation, ingestion, dermal, ocular and percutaneous routes. Care must be taken when handling reference materials and analytical standards to avoid incidental inhalation and ingestion exposures, as could occur if liquid material is splashed onto face or hands.

Fentanyl and fentanyl analogues have low dermal absorptive capacity. Still, care should be taken to avoid dermal contact. Small quantities of fentanyls on the skin for a short time are not sufficient to cause death or other severe adverse outcomes. Fatal doses are usually associated with exposure to potent drug product over an extended period of time.[3] Note that the nature of clinical opioids biosurveillance testing does not involve the handling of large quantities of seized drug product.

While poisoning associated with dermal absorption is unlikely, estimates of biological availability are as follows:

- Onset of systemic absorption: 1–12 hours[3]
- Peak concentrations within 16–48 hours[3]
- >2/3 of the drug is absorbed[2]

It is not known if fentanyl can be absorbed systemically through the eye.[4] Appropriate eye protection required for working in chemical laboratories (safety goggles or glasses) and working in a chemical fume hood with the sash at the designated height should provide sufficient protection from ocular exposure.

Handling, sampling and testing the contents of drug paraphernalia such as needles and syringes elevates risk of percutaneous exposure to both biological and chemical hazards such as bloodborne pathogen (HIV, Hepatitis B and C) infection and drug intoxication. Given the magnitude of potential adverse health outcomes associated with these risks, these practices should be discouraged.

Laboratory scientists and occupational health and safety specialists are encouraged to develop and exercise chemical safety plans to mitigate and manage all potential exposures introduced during clinical opioids biosurveillance testing procedures. Consider consulting laboratory safety officers and Laboratory Response Network for Biological (LRN–B) and Chemical Threats (LRN–C) partners and colleagues to learn more about additional safety resources, practices and equipment that may be available.

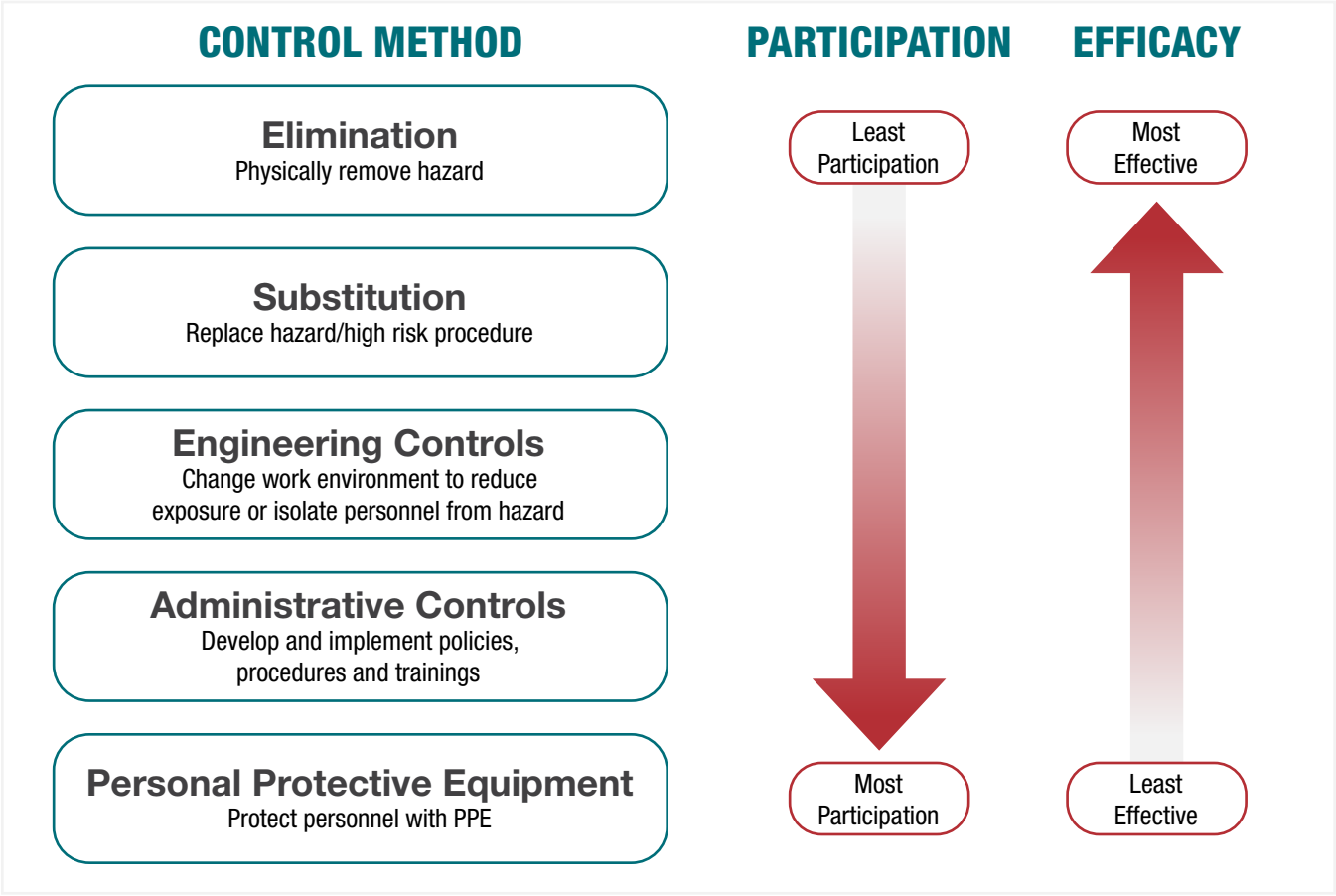
CONTROLLING FENTANYL EXPOSURE RISK: APPLYING THE HIERARCHY OF CONTROLS FRAMEWORK

PHLs engaged in opioids biosurveillance and/or forensic drug testing should thoroughly evaluate their pre–analytical, analytical and post–analytical procedures, assessing potential risks and implementing controls in accordance with the National Institutes of Occupational Safety and Health (NIOSH) Hierarchy of Controls (**Figure 1**). The NIOSH Hierarchy of Controls is an occupational health and safety framework used to group and prioritize exposure control practices by effectiveness, reliability and sustainability. Elimination, or total removal of the hazard, is ranked highest on the hierarchy, while personal protective equipment (PPE) is ranked lowest, given no other potential exposure control solution is feasible. Additional exposure control strategies include substitution, engineering and administrative control solutions. Effective implementation of the Hierarchy of Controls substantially reduces risk of illness or injury when used appropriately.[5]

Elimination and Substitution

Elimination or substitution of exposure risk to fentanyl and other opioids is not possible as these are the target analytes in clinical opioids biosurveillance testing. Laboratories can consider opportunities to substitute particular solvents used in the analytical process with less toxic alternatives, however this methodological change will need to be assessed for efficacy and fully validated to ensure quality test results.

Figure 1: National Institutes of Occupational Safety and Health (NIOSH) Hierarchy of Controls [5]



Engineering Controls

The proper use of chemical fume hoods (CFHs), biological safety cabinets (BSCs) or combined CFH/BSCs is crucial to engineering safe testing environments. Although these pieces of equipment may look similar, they each have a wide range of functionality and purpose. Therefore, PHLs should weigh all factors to select the appropriate control for your application and facility.[6] Fentanyl compounds should always be handled in a CFH or a combined CFH/BSC cabinet to prevent exposure to laboratory scientists.

Chemical Fume Hoods: CFHs evacuate chemical vapors, fumes and aerosols from the work area, protecting the laboratory scientist working in the hood. To accomplish this, air flows from outside the CFH and is removed to the outdoor environment through ducts. A well–designed chemical fume hood, when properly installed and maintained, offers a substantial degree of protection to the user, provided it is used appropriately and its limitations are understood. Analysts should keep the hood free of extraneous materials and position the hood sash to the appropriate level to provide a physical barrier and ensure adequate face velocity and exhaust.[5]

Biological Safety Cabinets: BSCs utilize high–efficiency particulate air (HEPA) filters to trap infectious agents and release microbe–free exhaust air back to the laboratory through vents above the cabinet. BSCs afford protection from infectious agents but not chemical hazards, and therefore are not recommended for the handling of chemical standards or certified reference materials. Powders should never be handled in a BSC as there is significant potential for BSC airflow to spread light substances and contaminate the cabinet. BSCs may be used to prepare and process clinical specimens.

Combined CFH/BSC: This dual option affords the greatest level of protection from both chemical hazards and infectious agents. These hoods, which are hard ducted to the exterior environment, have considerable air intake requirements and may not be feasible in all laboratory facilities.

Additionally, laboratories should assess other opportunities for engineering controls to minimize potential exposures

such as: disposable glove boxes, automated dispensing systems, enclosures for auto samplers and balances, and physical barriers (such as shields) for bench–top procedures.

Laboratories should asses their engineering needs and determine the best solutions for their specific requirements.

Administrative Controls

PHLs are encouraged to review laboratory procedures periodically to assess exposure risk and find opportunities to implement new or strengthen existing administrative controls. Examples of control solutions include but are not limited to:

- **Implement a Laboratory 'Buddy System.'** Laboratory scientists should never work alone in the laboratory. Supervisors should routinely check on the wellbeing of staff in person and via telephone. Always ensure telephones are available and operational within the laboratory.
- **Promote a culture of safety in the laboratory.** Develop written policies that prohibit eating, drinking, vaping and smoking in the laboratory. Raise awareness of the risks associated with touching your eyes, nose or mouth after touching standards or reference materials, potentially contaminated surfaces in fume hoods or within the laboratory, and handling clinical samples. Encourage staff input into the development of policies.
- **Train staff on safety policies annually**.
- **Encourage reporting of accidents and incidents** as an opportunity to review and revise policies and procedures to improve laboratory safety.
- **Rotate job assignments** to minimize potential exposure, if feasible.
- **Post exposure control practices in the laboratory.** Immediately wash fentanyl-exposed skin thoroughly with cool water and soap. Avoid breaking the skin during hand washing and ensure all open wounds are covered. **Do not use hand sanitizers, bleach, or any alcohol–based cleaner as alcohol increases absorption potential**.[3]

PERSONAL PROTECTIVE EQUIPMENT

While implementing the Hierarchy of Controls greatly minimizes exposure risks, it is essential that appropriate PPE be made available to all laboratory scientists involved in clinical opioids biosurveillance testing. Below is a list of PPE that should be considered, at a minimum:

- Laboratory coats
- Eye protection (safety glasses, goggles, face shields)
- Disposable nitrile gloves
- Sleeve protectors

It is important to note that the use of NIOSH–Approved N95 Particulate Filtering Facepiece Respirators[6] is not required for laboratory scientists involved in clinical opioids biosurveillance testing. However, laboratory decisions about required PPE should be informed by risk assessments of the opioids biosurveillance testing program. Forensic laboratory scientists testing seized drugs should assess the inhalation risks and determine appropriate PPE requirements.

Laboratory scientists who wear respirators must be medically evaluated and fit–tested prior to using this personal protective option. It is important to note that individuals with facial hair will be unable to achieve an adequate seal for the respirator to function properly.

SAFE MANAGEMENT OF CHEMICAL AND BIOHAZARDOUS WASTE

Proper waste disposal is crucial to reducing potentially harmful exposures in the laboratory. Prior to the initiation of biosurveillance testing, laboratory scientists should work with occupational health and safety specialists to develop procedures that are in compliance with local, state and federal regulations.

Fentanyl compounds are neutralized by a 10% hydrogen peroxide solution. It is advisable to have this solution available to mitigate any fentanyl spills in the laboratory.

DECONTAMINATION

Instrumentation, equipment and surfaces should be decontaminated both prior to service as well as immediately after regular use with 10% hydrogen peroxide solution over a 10-minute period.[2] Benches and surfaces should then be decontaminated with a 5% bleach solution to minimize infectious hazards.

OPIOID EXPOSURE EMERGENCY PREPAREDNESS AND RESPONSE PLANNING

Development and exercise of an opioid exposure response plan is crucial to ensuring laboratory scientists are aware of the correct steps to take during an exposure incident. Staff should be able to recognize opioid poisonings, implement first aid action and communication plans, and be adequately trained in the administration of Naloxone.

Signs and Symptoms of Opioid Poisoning/Overdose

Opioids, including fentanyls, depress central nervous system and respiratory function and may be associated with adverse health outcomes, including death.

Opioid poisoning symptoms include:

- Unconsciousness or unresponsiveness
- Drowsiness
- Slow or erratic pulse
- Slow, shallow or absent breathing
- Slow heartbeat
- Snoring, falling asleep or gurgling sounds
- Small, constricted pinpoint pupils
- Choking or gurgling
- Limp body
- Pale blue and/or cold skin

Opioid Exposure First Aid Measures

Individuals experiencing symptoms of opioid poisoning should receive immediate medical attention. Call 911 to alert emergency medical services (EMS), then attempt to rouse and stimulate the individual while waiting for EMS professionals to arrive. The National Poison Center Hotline (1.800.222.1222) can provide specialized medical advice to staff and/or medical professionals.

Consider **Figure 2** when developing first aid plans.

Figure 2: Opioid Exposure First Aid Measures

Exposure Pathway	First Aid Measures
Dermal	• Seek medical attention, Call 911 • Wash area with plenty of soap and water for 15 minutes • Remove contaminated clothing
Ingestion	• Seek medical attention, Call 911 • Rinse mouth with water only if the individual is conscious **Note:** Do not induce vomiting unless directed to do so by medical personnel.
Inhalation	• Seek medical attention, Call 911 • Move the individual to fresh air • Keep the individual in a comfortable breathing position
Ocular	• Seek medical attention, Call 911 • Immediately flush eyes with plenty of water for 15 minutes
Percutaneous	Seek medical attention, Call 911

Responding to and Reporting Opioid Exposure Incidents

If a laboratory scientist has been potentially exposed to fentanyl or other opioids, the laboratory should implement their exposure control plan including appropriate notifications and first aid procedures.

Naloxone Supply, Administration and Safety Training

Naloxone (Narcan, Evzio) should be made easily accessible to laboratory scientists and staff involved in clinical opioids biosurveillance testing in the public health laboratory. Kits must be properly stored and routinely inspected to ensure that they meet manufacturer requirements for use. Expired Naloxone kits should be safely and appropriately disposed of and promptly replaced.

Naloxone administration and safety training should be made widely available and required for all laboratory scientists potentially coming into contact with fentanyl and other opioids. It is recommended that laboratories conduct Naloxone administration and safety trainings at least annually. Laboratories are encouraged to contact local or state health and emergency response departments to arrange for staff training.

UPDATE DOCUMENTATION AND TRAIN STAFF

After implementing safety measures, routinely re-evaluate and exercise plans to ensure that these measures are sufficient. PHLs are strongly encouraged to incorporate this guidance into existing analytical standard operating procedures as well as any pre-existing facility exposure management plans.

Prominently display the telephone number for the Poison Control Center (1.800.222.1222) and the steps involved in responding to an exposed individual.

ADDITIONAL SAFETY RESOURCES FOR LABORATORIES AND FIRST RESPONDERS

Laboratories

- US Centers for Disease Control and Prevention (CDC):
  - Biosafety in Microbiological and Biomedical Laboratories, 5th Edition
  - Fentanyl Resource Page
  - Fundamentals of Chemical Fume Hood Safety
  - Fundamentals of Working Safely in a Biological Safety Cabinet
  - Respirators
- National Institutes of Health (NIH): Chemical Safety
- US Occupational Safety and Health Administration:
  - Laboratory Safety Guidance
  - Bloodborne Pathogens and Needlestick Prevention

First Responders

- American College of Medical Toxicology/American Academy of Clinical Toxicology: Position Statement: Preventing Occupational Fentanyl and Fentanyl Analog Exposure to Emergency Responders
- CDC: Illicit Drugs, Including Fentanyl: Preventing Occupational Exposure to Emergency Responders

All Occupations

- American Association of Poison Control Centers: Poison Help Line
- American Medical Association: How to Administer Naloxone
- NIH: Prevention of Occupational Exposure to Fentanyl and Other Opioids
- US Substance Abuse and Mental Health Administration: Naloxone

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This publication was supported by Grant or Cooperative Agreement number #5 NU60OE000103, funded by the US Centers for Disease Control and Prevention. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the US Centers for Disease Control and Prevention or the Department of Health and Human Services.