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THE EMERGENCE OF CARFENTANIL IN KENSINGTON: ETHICAL AND CLINICAL CHALLENGES FOR HARM REDUCTION IN THE ERA OF ULTRA-POTENT SYNTHETIC OPIOIDS

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Abstract: *The emergence of carfentanil as a highly potent synthetic opioid circulating in illicit drug markets represents a significant escalation in the ongoing opioid epidemic. Addressing this crisis requires an interdisciplinary approach that synthesizes existing literature while recommending community-based strategies and further methods. Carfentanil has recently been detected in Kensington, Philadelphia and continues to affect communities burdened by poverty, housing instability, and disparities in healthcare, which increase overdose risks. The extreme potency of carfentanil creates unique clinical hazards and complicates overdose response and treatment efforts. Existing toxicology and surveillance methods face limitations in detection and monitoring of this drug effectively. The presence of carfentanil highlights the need for comprehensive harm reduction strategies, including access to naloxone, supervised consumption sites, and drug checking. Ethical considerations related to the responsibilities of the pharmaceutical industry, health equity, and social justice are critical to developing effective solutions. An integrated response aims to reduce the devastating effects of ultra potent synthetic opioids, raise awareness of their risks, and decrease their circulation within communities.*

Keywords: *carfentanil, synthetic opioids, harm reduction, naloxone, overdose, potency, polysubstance use, testing strips, Philadelphia.*

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INTRODUCTION

Carfentanil, a synthetic opioid originally developed as a veterinary tranquilizer for large animals, has increasingly infiltrated the illicit drug supply, contributing to a new and particularly dangerous phase of the opioid crisis. The opioid epidemic remains one of the most significant health crises in the United States, having claimed more than half a million lives since its designation as a public health emergency in 2017 (Saunders et al., 2026). Although the Centers for Disease Control and Prevention (CDC, 2025) reported a nearly 24% decline in overdose deaths in 2024, the proliferation of fentanyl analogues has continued to accelerate since 2013. Over the past decade, the illicit drug supply has undergone a profound transformation, with synthetic opioids largely displacing heroin and other previously dominant substances. In 2023, nearly 70% of all drug poisoning and overdose deaths involved synthetic opioids (Tanz et al., 2024). While fentanyl has already reshaped the epidemiology of overdose mortality, an even more potent class of compounds—fentanyl analogues—has emerged within the drug supply. Among these, carfentanil is particularly concerning due to its extraordinary potency and increasing detection in overdose toxicology reports across the United States. Estimated to be approximately 100 times more potent than fentanyl and 10,000 times more potent than morphine, carfentanil represents a substantial escalation in overdose risk (Drug Enforcement Administration, 2025). Recent data underscore this threat: deaths involving carfentanil increased approximately sevenfold within a single year, rising from 29 to 238 cases over comparable six-month periods between 2023 and 2024 (Tanz et al., 2024). The Drug Enforcement Administration (DEA) has also reported the seizure of approximately 100 kilograms of carfentanil mixed with fentanyl and its identification in at least 37 states, further illustrating its expanding geographic reach (DEA, 2025). These trends highlight the urgent need for improved surveillance, education, and intervention strategies to address the growing impact of ultra-potent synthetic opioids.

Unlike many opioids used in clinical medicine, carfentanil has no approved therapeutic use in humans. It was first synthesized in 1974 by a team of chemists at Janssen Pharmaceutica, including Paul Janssen, for exclusive use in veterinary medicine (PubChem, 2026). Marketed under the trade name “Wildnil” in 1986, it was approved as a general anesthetic for large animals. Its extreme potency made it particularly suitable for immobilizing species such as rhinoceroses, hippopotamuses, and elephants, where only minute quantities are required due to their substantial body mass (PubChem, 2026). In 1988, the DEA classified carfentanil as a Schedule II controlled substance under the Federal Controlled Substances Act, recognizing both its accepted veterinary use and its high potential for abuse and severe psychological or physical dependence (Commonwealth of Pennsylvania, 2016). Despite its clinical utility in veterinary contexts, commercial production of Wildnil was discontinued in 2003, largely due to concerns regarding diversion, misuse, and shifts in pharmaceutical demand (EMCDDA, 2018). Structurally and pharmacologically related to fentanyl, carfentanil exerts profound effects at extremely low doses. Even microscopic quantities—approximately one-sixth the weight of a poppy seed—may induce severe respiratory depression, central nervous system suppression, and death (Bloom, 2017). This extreme potency is corroborated by autopsy and toxicological reports in which carfentanil has been identified as the primary cause of death even at trace concentrations. Consequently, the drug has never been approved for human use and remains subject to strict regulatory control.

Despite the cessation of commercial production, carfentanil persists in limited legitimate contexts and, more prominently, within the illicit drug market. Evidence suggests that it remains available in highly restricted forms, including compounded veterinary preparations and as a radiotracer in positron emission tomography (PET) research. In research settings, carfentanil is used experimentally to study μ-opioid receptor activity and its role in neurobiological pathways such as addiction (Dubroff et al., 2025). However, the overwhelming majority of contemporary carfentanil use occurs outside legitimate medical or scientific applications. According to DEA intelligence reports, many synthetic opioids circulating in the United States originate from international sources,

particularly China, where chemical modifications have historically been used to circumvent regulatory controls (O'Neill Institute, 2017). Carfentanil itself was not widely consumed domestically in these regions but was instead synthesized for export into illicit markets. Evidence suggests distribution networks involving transnational criminal organizations, including Chinese suppliers, Mexican drug trafficking organizations, and online vendors have facilitated its introduction into the United States (DEA, 2025).

Due to its extreme potency, carfentanil is rarely encountered in pure form; rather, it is commonly mixed with fentanyl, heroin, or other powder-based substances, or pressed into counterfeit pills designed to resemble prescription medications (DEA, 2025). From an economic standpoint, its high potency allows for the production of a large number of doses from minimal quantities, making it an attractive substance for illicit manufacturers seeking to maximize profit while minimizing transportation and detection risks. Importantly, individuals who consume carfentanil are often unaware of its presence, resulting in a high likelihood of unintentional exposure among users who believe they are consuming other opioids (EMCDDA, 2018).

The presence of carfentanil in the drug supply poses significant challenges not only for individuals who use drugs but also for healthcare systems, first responders, and law enforcement. Clinically, the extreme potency of carfentanil presents substantial challenges for overdose recognition and treatment. Carfentanil intoxication presents with features characteristic of opioid toxicity, including profound sedation, pinpoint pupils, and respiratory depression, leaving a narrow window for effective intervention. Overdose reversal often requires repeated or higher doses of naloxone compared with less potent opioids, complicating standard treatment protocols (Virginia Department of Health, 2016). These factors place substantial strain on emergency medical services, emergency departments, and community-based harm reduction programs, all of which must adapt to an increasingly unpredictable and potent drug supply. In response to these risks, the U.S. Department of Justice has issued safety guidance for first responders, emphasizing the importance of protective measures to mitigate potential exposure (DOJ, 2018).

The emergence of carfentanil must be understood within the broader historical trajectory of the opioid epidemic. Public health frameworks commonly describe the crisis as evolving through multiple waves. The first wave, beginning in the 1990s, was driven by the widespread prescribing of opioid analgesics for chronic pain management, followed by a second wave characterized by increased heroin use beginning around 2010 (CDC, 2025). The third wave, emerging around 2013, involved the rapid proliferation of illicitly manufactured synthetic opioids, particularly fentanyl. More recently, a fourth wave has been described, marked by the co-use of synthetic opioids with psychostimulants, further complicating overdose risk and treatment (Volkow & Blanco, 2020). The opioid epidemic is thus the product of complex and intersecting clinical, economic, and social factors. Within this evolving context, carfentanil represents not a fundamentally new phenomenon, but a significant escalation in the potency and unpredictability of the drug supply. Its pharmacological properties, combined with its increasing prevalence, introduce unique clinical, public health, and ethical challenges. A comprehensive understanding of carfentanil—including its origins, pharmacology, patterns of distribution, and clinical implications—is essential for informing effective interventions and policies aimed at reducing the harms associated with contemporary synthetic opioid use. At the same time, substantial gaps in knowledge remain, underscoring the need for continued research into its long-term impacts and future trajectory within the opioid crisis.

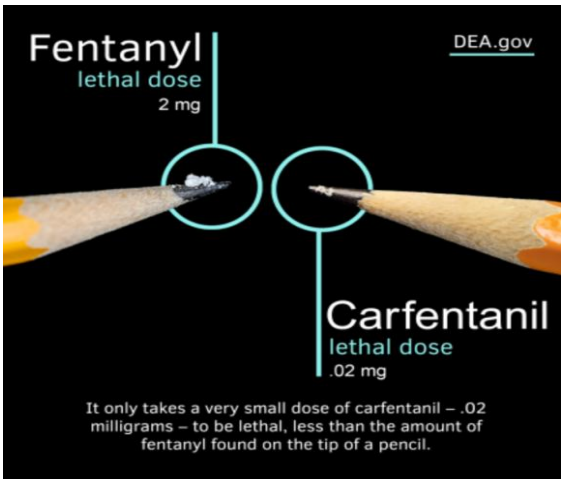

Figure 1. Relative potency of fentanyl and carfentanil (Drug Enforcement Administration, 2025)

PUBLIC HEALTH CONTEXT

Carfentanil-related overdose patterns are reflective of national trends regarding the developing synthetic opioid crisis in the United States. Over the past decade, overdose deaths involving synthetic opioids have risen dramatically, with fentanyl and its analogs emerging as the primary drivers of fatalities associated with both heroin and prescription opioids (Spencer et al., 2024). Carfentanil has been implicated in multiple regional overdose clusters amid the broader nationwide opioid epidemic.Federal surveillance data show that fentanyl analogs appear sporadically in the illicit drug supply, frequently coinciding with sudden spikes in overdose mortality in affected regions. While consistent with national trends, these localized outbreaks demonstrate the erratic and region specific emergence of synthetic opioids.

Across the United States, carfentanil has been prevalent and reappeared in the drug supply after a decline seen in the late 2010s, demonstrating a recent indication of overdose deaths in areas such as Ohio, West Virginia, and Pennsylvania. The resurgence reflects the shifts within the opioid market, particularly the incorporation of potent synthetic analogs into fentanyl products. In November, 2025, the Philadelphia Department of Public Health issued a health alert noting carfentanil had been increasingly detected in city drug samples and involved in unintentional overdose deaths (PDH, 2025). Between July and September of 2025, carfentanil was identified in 77 of 364 suspected dope samples submitted for analysis, which showcases approximately one in five samples testing positive for the carfentanil analog. All samples containing carfentanil also included fentanyl and its precursor 4-ANPP, which underscores the drug's ability to integrate into an existing fentanyl dominated supply (Substance Use Philly, 2025).

Local drug checking and monitoring data from the Philadelphia Department of Public Health corroborate these findings, characterizing a volatile drug supply in which opioids remain the primary class of drugs associated with fatal overdoses (PDH, 2025). To better understand the significance of carfentanil's presence in Philadelphia, it is important to consider broader overdose trends within the city. Philadelphia has experienced persistent changes in overdose trends over the past decade, which is largely due to the increasing dominance of synthetic opioids such as fentanyl. Local reporting indicates that fentanyl and its analogs continue to be involved in the majority of overdose deaths in Philadelphia, accounting for more than 70% of cases even as deaths involving other substances such as heroin and xylazine have declined (U.S. Drug Enforcement Administration, n.d.). At the beginning of the mid-2010s, fentanyl rapidly replaced heroin in the illicit opioid supply, leading towards an increase of record levels of overdose

mortality. Although recent analyses suggest a decline in overall overdose deaths from 2021-2022, synthetic opioids remain overwhelmingly implicated in fatal outcomes (Tanz et al., 2024).

Within this evolving drug supply, carfentanil demonstrates a more episodic pattern. Despite carfentanil being less prevalent than fentanyl, periods in which carfentanil becomes more widely available have been associated with sudden increases in overdose severity and mortality.

Populations Most Affected (PWUD, Unhoused Individuals, and Urban Communities)

The synthetic opioid crisis, mainly caused by fentanyl and its derivatives, is disproportionately affecting vulnerable populations such as people who use drugs (PWUD), individuals experiencing homelessness, and residents of urban communities. As individuals from these groups experience greater structural inequalities; unstable housing; and restricted access to medical care, they are at a greater risk for overdose. In addition, factors such as age, race, and environment further influence overdose risk among PWUD. Specifically, people between 25 and 54 are the ages with the most deaths from fentanyl combined with stimulants, and in some places, Black and African American individuals are dying at a particularly high rate. This demonstrates inequities in drug exposure, healthcare access, and the broader social determinants of health (Friedman & Shover, 2023). PWUD face increased risks due to the variable composition of the illicit drug supply, the contents of illicit opioids are often unknown to users and may be combined with a variety of substances. Consequently, individuals using other illicit substances may be inadvertently exposed to opioids such as carfentanil. Friedman and Shover (2023) have described the current stage of the overdose crisis as the "fourth wave" and is defined by the wide-spread use of synthetic opioids and stimulants among polydrug users (Friedman & Shover, 2023).

Cuyahoga County, Ohio studies on overdose deaths attributed to fentanyl analogs have shown a high prevalence of deaths involving complex drug mixtures, with many cases including three or more substances and common combinations of fentanyl analogs (such as carfentanil) with cocaine or heroin (Bhullar et al., 2022). Therefore, these mixtures demonstrate how synthetic opioids can infiltrate all aspects of the illicit drug marketplace. Individuals experiencing homelessness have also experienced disproportionate levels of overdose death. Looking at a group of people without homes in Boston, researchers found that most deaths were from overdose – about one in four. Individuals experiencing homelessness experience substantially higher mortality rates than the general population (Fine et al., 2022). Lack of housing stability, limited access to substance use treatment, continued use of illicit drugs from unregulated sources all increase the risk of overdose. Additionally, co-occurring medical and mental health conditions, including mental illness and substance use disorders, further heighten vulnerability among this population (Fine et al., 2022). Therefore, these results illustrate that populations experiencing the greatest impacts from the synthetic opioid crisis share structural disadvantages, such as poverty, housing instability, and barriers to healthcare that increase the likelihood of overdose.

Overdose mortality and drug-related harm in Philadelphia are not evenly distributed across the city (Hansen et al., 2021). Instead, they exhibit distinct geographic clustering associated with neighborhood level socioeconomic conditions (Johnson & Shreve, 2020). Socioeconomic conditions, such as housing instability and poverty, are closely linked to substance use and overdose risk in Philadelphia. Reports indicate that neighborhoods experiencing high levels of housing insecurity, unemployment, and economic deprivation also bear a disproportionate burden of drug related morbidity and mortality (Kriston, 2024). Neighborhoods such as Kenstington, North Philadelphia, and West Philadelphia experience higher poverty rates, lower median incomes, and greater housing instability than more affluent areas, making them particularly vulnerable to the impacts of the city's open-air drug market and drug trafficking activity (Kriston, 2024). Both neighborhoods of which experience a 40-60% poverty rate (Association for Health Education Philadelphia, n.d.).

These structural barriers influence access to effective treatment. Individuals experiencing homelessness or economic hardship often face challenges in initiating and completing substance use treatment and maintaining

recovery over time. Constraints limit the effectiveness of evidence based interventions and contribute to persistent disparities in treatment outcomes across the city (AU Media, 2020).

Detailed analyses of Philadelphia neighborhoods further demonstrate the spatial concentration of overdose risk. Fatal opioid overdoses are disproportionately concentrated in North and West Philadelphia, where overdose mortality rates are substantially higher than the citywide averages. Complementing these findings, emergency medical services data have been used to identify overdose hotspots throughout the city. These analyses reveal recurrent clusters of EMS overdose calls that frequently coincide with neighborhoods such as North and West Philadelphia (Reyes, 2021).

Polysubstance Use Patterns (Carfentanil, Fentanyl, Xylazine, and Benzodiazepines)

The synthetic opioid crisis is marked by the growing prevalence of polysubstance use (i.e., the consumption of fentanyl and/or carfentanil along with other drugs). The consumption of multiple drugs during an overdose event is now a major contributor to overdose death in the U.S. (Park et al., 2022). Maryland-based research examining overdose deaths involving fentanyl reported that almost 75 percent of the fentanyl-related overdose deaths examined were due to the consumption of fentanyl in combination with multiple other substances (Park et al., 2022). Commonly encountered combinations of drugs included fentanyl used in conjunction with heroin, cocaine, alcohol, and benzodiazepines. It's no coincidence these drugs are used together. People involved in the illicit drug trade may add fentanyl to other substances because it is inexpensive to produce and increases drug potency, making the product more addictive and financially profitable while allowing smaller quantities to be distributed (Bhullar et al., 2022).

The increasing prevalence of potent synthetic opioids has also placed substantial strain on Philadelphia's emergency medical services and hospital systems. Although overdose deaths have slightly declined in recent years, EMS teams and emergency departments continue to respond to a high volume of opioid related emergencies (Reyes, 2021). National surveillance data further underscore the clinical challenges associated with ultrapotent opioids such as carfentanil. Although relatively rare compared with fentanyl, carfentanil related overdoses require rapid recognition and intervention due to the drug's extreme potency. Standard doses of naloxone remain effective for reversing these overdoses; however, multiple administrations are often required, and delayed recognition can result in rapid clinical deterioration.

Challenges in Surveillance and Toxicology Detection

Tracking the spread of carfentanil and other synthetic opioids through public health surveillance and forensic toxicology labs presents significant difficulties. Because carfentanil is often found in very small amounts, detecting it in biological samples requires very sensitive analytical methods.

Many earlier toxicology screening methodologies were insufficiently sensitive to reliably detect carfentanil in biological specimens. Improvements in lab tech, particularly liquid chromatography-tandem mass spectrometry (LC-MS/MS), have made it much easier for labs to find even tiny amounts of man-made opioids (Solbeck et al., 2021). Yet, interpreting toxicology results remains complicated. Among deaths involving carfentanil, blood concentrations varied considerably, making it difficult to determine the extent of carfentanil's contribution in cases involving multiple substances.

Surveillance is further complicated by the lack of standardized toxicology testing across jurisdictions. Medical examiner and coroner offices vary in their funding, testing methodologies, and the range of substances included in toxicology panels. As a result, newer synthetic opioids are not always routinely tested for, and overdose deaths may be classified broadly as involving a synthetic opioid rather than identifying the specific compound (Spencer et al., 2024). Furthermore, national drug surveillance systems typically categorize substances into broad

classes, such as “synthetic opioids” or “benzodiazepines”, limiting the ability to monitor specific drugs such as carfentanil (Friedman & Shover, 2023). The rapidly evolving illicit drug market complicates this further, new synthetic opioids and drug combinations may emerge before laboratories have validated methods to detect and identify them.

Limitations of Overdose Data Accuracy

Although overdose surveillance data provide valuable information about the extent and trajectory of the synthetic opioid crisis, several limitations affect the accuracy and completeness of these datasets. National overdose data are often reported provisionally and may be revised as death certificates are finalized and forensic investigations are completed (CDC, 2024). Consequently, preliminary overdose mortality estimates may underestimate the true number of deaths because toxicology testing and death investigations often require weeks or months to complete. Additionally, the quality of toxicology data is limited by the lack of standardized testing practices across jurisdictions. Medical examiner and coroner offices differ in their toxicology testing capabilities, available resources, and the substances typically included in test panels, with some jurisdictions not consistently testing for newer synthetic opioids. As a result, overdose deaths may be classified into broad drug categories when specific substances are not identified, limiting the ability to assess the contribution of individual drugs. Furthermore, polysubstance use complicates cause-of-death classification, as many overdose fatalities involve multiple substances, making it difficult to determine the relative contribution of each drug to the fatal outcome (Jalali et al., 2023).

CLINICAL ANALYSIS

Pharmacology and Potency of Carfentanil

Carfentanil is known chemically as methyl 1-(2-phenylethyl)-4-phenyl(propanoyl)aminopiperidine-4-carboxylate. This is a synthetic opioid compound that is classified as belonging to 4-anilidopiperidine. This compound is chemically similar to fentanyl. However, carfentanil is far more potent compared to fentanyl. Carfentanil is known to be a full agonist for the mu-opioid receptor (μOR), it is this feature that makes it highly pharmacologically active. According to a comprehensive review of carfentanil by Ringuette et al (2020), carfentanil is known to have recently emerged as a problematic contaminant in other drugs of abuse due to its remarkable potency and ease of synthesis.

It is interesting to note that despite the significant difference in the therapeutic index of carfentanil and fentanyl, the LD50 of carfentanil and fentanyl in rat models was nearly identical, i.e., 3.39 mg/kg for carfentanil and 3.05 mg/kg for fentanyl (Leen & Juurlink, 2019). The actual LD50 of carfentanil in humans is not known. The pharmacology of this drug makes it very dangerous as it can kill a person through respiratory depression even if the dose of the drug taken by the individual is not visible to the naked eye.

Currently, carfentanil is only used as an anesthetic for animals. Moreover, carfentanil has not been approved for any clinical use in human medicine, meaning that there is limited pharmacokinetic and pharmacodynamic information available for it (Misailidi et al., 2017). This is likely to cause problems in determining the most likely course of action in case of suspected carfentanil exposure. Ringuette et al (2020) state that "many of the same contraindications for fentanyl may also apply to carfentanil given their similarity in structure and binding modes," and this is true, but it is also likely that this is not enough information for making an accurate decision about carfentanil and its exposure in human medicine. The pharmacokinetics of carfentanil in animal models indicate that it is rapidly absorbed and has a half-life of 5.5 hours, and this is unaffected by the route of administration (Misailidi et al., 2018). The half-life of carfentanil is also important in determining the most likely course of action and is discussed in detail in the following sections.

Symptoms of Carfentanil Toxicity and Overdose Signs

The symptoms of carfentanil overdose and toxicity are the same as all opioid overdoses and poisonings, but they are more pronounced in carfentanil compared to those of heroin and fentanyl. According to case studies of carfentanil abuse, the symptoms of carfentanil toxicity include "symptoms consistent with opioid toxicity, including severe respiratory depression" (Negri et al., 2021). The most prominent symptoms of opioid overdose and toxicity include miosis, or constricted pupils, respiratory depression leading to apnea, lowered levels of consciousness, and bradycardia, which are all symptoms of carfentanil toxicity, but they are more pronounced in carfentanil compared to those of heroin and fentanyl.

The potency of carfentanil is such that the line between an amount of drug that is euphoric and an amount of drug that is lethal is essentially nonexistent. Carfentanil users who think they are using heroin or fentanyl may not be aware that they are using carfentanil, as is evident from the toxicological analyses of samples of urine and blood of users of heroin. According to a study conducted in 2017, 97 samples of urine and blood of users of heroin were analyzed, 25 of which were found to contain carfentanil, either by itself or in combination with other derivatives such as butyrylfentanyl (Drummer, 2019). This shows that users are not even aware that they are using carfentanil, and the deaths are unintended.

Case Studies

Due to the fact carfentanil has no approved human indications, there is limited clinical literature concerning carfentanil; however, some case studies can be informative. In a case study done by Ringuette et al., (2020) it is noted that "a patient presented after being exposed to carfentanil. After treatment with an unspecified dose of naloxone, he recovered." In another case study, it is noted that "a 34 year old male presented with respiratory failure and repressed levels of consciousness after insufflating a white powder later confirmed to contain carfentanil" (Uddayasankar et al., 2018). What is of interest in this case study is that the patient "showed no improvement after a single 2 mg dose of naloxone delivered intravenously" (Uddayasankar et al., 2018).

What is evident from these two case studies is that carfentanil overdose can cause severe respiratory depression. The ineffectiveness of naloxone dosing, which is used in treating overdose cases, can be attributed to several factors, such as the dosage of carfentanil taken, mode of administration, and patient history.

Naloxone Responsiveness and Dosing Challenges

Naloxone Hydrochloride is an antagonist of opioids. It works by competitively displacing opioids from opioid receptors. It has gained wide acclaim and is considered an effective response in an overdose case. The American Medical Association and the World Health Organization endorse naloxone hydrochloride for overdose cases (Lavonas et al., 2015). These organizations are of the view that naloxone hydrochloride reduces response time in cases of overdose. In Philadelphia, in 2015, a standing order was issued to allow access to naloxone hydrochloride (Pennsylvania Society of Health-System Pharmacists, 2015). This standing order has also allowed community-based naloxone programs, especially Prevention Point Philadelphia in Kensington.

However, carfentanil also poses some challenges in treating overdose cases with naloxone. Naloxone is an antagonist of opioids. It competitively displaces opioids from opioid receptors. Its duration of action is less compared to carfentanil. In fact, it is stated that: "Multiple doses may be needed to reverse carfentanil's effects" (Misailidi et al., 2017). Meanwhile, only one or two doses of naloxone are considered enough to treat a heroin overdose.

However, carfentanil has a high receptor binding affinity. Its half-life is 5.5 hours. Naloxone is expected to be displaced from the receptor before the effects of carfentanil are reversed, which could lead to recurring episodes

of respiratory depression. Other opioids have also been studied for their potential use as antagonists of carfentanil. Naltrexone was studied for its potential use as an antagonist of carfentanil in the binding process with the μOR in an animal model (Yong et al., 2014). Additionally, nalmefene was studied for its efficacy in relation to carfentanil-induced loss of righting reflex and respiratory depression, with naloxone used as a control. It was observed that nalmefene "dose-dependently decreased the duration of loss of righting reflex and reversed the respiratory depression caused by carfentanil" (Yong et al., 2014). PET imaging was used to demonstrate that both intravenous and intranasal naloxone administration resulted in a comparable reduction in occupancy of the μOR by ^{11}Carfentanil (Johansson et al., 2019).

The naloxone programs in Kensington have shown significant effects in the face of challenges. A prospective observational cohort study using the UnityPhilly smartphone app was conducted, which showed that 291 opioid overdose signals were sent by 112 volunteers in a year (Schwartz et al., 2020). Of those, 74 cases were associated with the administration of at least one dose of naloxone by a layperson, with 95.9% (71/74) of them successfully reversed (Schwartz et al., 2020). The median dose used was 1 dose (4 mg) per reversal, with an interquartile range of 1 to 2 doses (Schwartz et al., 2020). EMS were preceded by layperson intervention 5 minutes or more in 59.5% (Schwartz et al., 2020). It should be noted that "in the minutes immediately following opioid overdose, 'time is brain'" (Schwartz et al., 2020).

It should be noted, however, that these studies were not designed to differentiate between fentanyl and carfentanil overdose and that the results of this study, and others like it, may have been skewed to report such high success rates because of the commonality of fentanyl use in the Philadelphia area and the time period in which this study was conducted. If, in fact, carfentanil was as prevalent as fentanyl, then the need for multiple doses of naloxone would be even greater.

Risk of Delayed or Recurring Respiratory Depression

One of the more significant aspects of carfentanil overdose, as well as the use of any opioid, is the risk of delayed or recurring respiratory depression in those patients that initially respond to naloxone administration. The duration of action of naloxone is between 30 to 90 minutes, depending on the route of administration (National Institute on Drug Abuse, n.d.). This is well within the half-life of 5.5 hours of carfentanil. Those patients that initially respond to naloxone administration will likely experience a re-occurrence of respiratory depression as soon as the antagonist is metabolized and cleared from the system, yet the carfentanil will still be active and available to bind to opioid receptors.

This, of course, has significant implications for both prehospital and hospital-based emergency medical services. In the prehospital setting, a patient may be treated for a suspected opioid overdose, respond to naloxone, and then refuse transport to the hospital, where they may again succumb to the effects of respiratory depression in a non-monitored environment. The results of the UnityPhilly study, as referenced earlier, also show that "recovery without hospital transport was reported in 52.7% (39/74) of cases" (Schwartz et al., 2020). While this, of course, is a positive result in terms of patient autonomy and the nature of this particular community, it does go a long way toward illustrating the concern that this study and others like it have raised regarding the safety of a particular population that may be at risk for exposure to this drug, as well as others.

The possibility of recurrent respiratory depression in the ED setting mandates long periods of observation and the possibility of continuous infusion of naloxone in order to counteract the continuous respiratory depression that is possible with carfentanil overdose. The period of observation may be beyond the current ability of the ED to manage, considering the already overburdened system.

Clinical Management Challenges in the Emergency Department

The clinical management of a patient suspected of having overdosed on carfentanil poses several challenges to the emergency physician. The clinical management of the patient extends beyond the pharmacological effects of the drug in question. The first of these is the inability to definitively diagnose the patient suspected of having overdosed on carfentanil in a timely fashion. For instance, it was seen that the patient in the case study in Ringuette et al. (2020) could not be definitively diagnosed in the ED setting since standard urinalysis was unable to detect the presence of carfentanil. The definitive diagnosis of the patient can be made only in retrospect via mass spectroscopy.

The second clinical management challenge in the ED setting is the empirical question of the dosage of naloxone that needs to be infused in the patient suspected of having overdosed on carfentanil. For instance, it was seen that in the case study in Ringuette et al. (2020) the patient was given an intravenous dose of naloxone at 2 mg. However, this dose was completely ineffective in the patient and might have been woefully inadequate in countering the effects of the carfentanil in the patient's system.

Thirdly, there is the issue of co-ingestants and their impact. Results from toxicology tests have shown the presence of carfentanil and other fentanyl analog compounds (Misailidi et al., 2018). This is definitely the case in the community around Kensington, where polysubstance abuse is the norm and not the exception.

Fourth, emergency departments in neighborhoods such as Kensington are strained by the large number of patients presenting with opioid overdoses. Philadelphia has the highest per capita overdose death rate of any city in the United States (Kriston, 2024). This means that there is an overwhelming volume of critical overdose patients that require intensive and exhaustive management. The addition of carfentanil to the equation complicates the management of opioid overdoses, increasing both the clinical acuity of the patients and the demands placed on emergency departments and prehospital providers.

Difference in Presentation Compared to Fentanyl Overdose

Although carfentanil and fentanyl have the same chemical structure and the same mechanism of action in that they are agonists of the μOR receptor, the presentation of the carfentanil overdose is quite different from the fentanyl overdose in several ways. Perhaps the most obvious way in which the carfentanil overdose differs from the fentanyl overdose is the degree and length of the respiratory depression. The fact that carfentanil is 100 times more potent than fentanyl means that the presentation of the carfentanil overdose will be quite pronounced in comparison to the fentanyl overdose (Leen & Juurlink, 2019). Furthermore, the speed at which the respiratory system is impaired may be faster.

The way in which the body responds to the naloxone treatment of the carfentanil and fentanyl overdoses is another way in which the presentation of the two overdoses differs. The fentanyl overdose responds to one to two doses of naloxone, whereas the carfentanil overdose requires multiple doses of naloxone (Misailidi et al., 2018). A notable difference in the presentation of a carfentanil overdose and fentanyl overdose was in the case of the 34-year-old male patient who showed no signs of recovery after the one dose of 2 mg intravenous naloxone that was administered to him (Uddayasankar et al., 2018).

Lastly, there is also the possibility of the victim of carfentanil overdose relapsing into respiratory depression. This is because carfentanil's half-life is much longer than that of fentanyl. While the symptoms of fentanyl overdose can be adequately reversed with just one dose of naloxone, carfentanil's long half-life means that its effects will be felt for a long time, even after what is normally the duration of stay in the hospital.

Withdrawal Considerations

The withdrawal considerations in carfentanil addiction cases is also a complex issue. While it is true that opioid withdrawal syndrome is not life-threatening but extremely uncomfortable, the withdrawal syndrome in carfentanil addiction cases may be particularly severe.

The precipitation of acute withdrawal symptoms following the use of naloxone in carfentanil overdose is a particular issue in carfentanil overdose management in the ED setting. The need to utilize high doses of naloxone in carfentanil overdose management in order to reverse the life-threatening respiratory depression caused by carfentanil overdose also carries with it the risk of precipitating withdrawal symptoms that include vomiting, agitation, and cardiovascular instability. The main issue in carfentanil overdose management is using adequate doses of naloxone in order to reverse respiratory depression caused by carfentanil overdose without completely displacing carfentanil from opioid receptors, which is complicated by carfentanil's high receptor affinity.

The process of transitioning to medication-assisted treatment among those who seek treatment facilities to be treated for carfentanil addiction also has its unique challenges, which include the need to wait for a long period of abstinence before the induction of buprenorphine treatment so that there is no precipitation of withdrawal symptoms and the ineffectiveness of methadone in treating withdrawal symptoms among those addicted to ultra-potent opioids.

Ethical Tensions in Clinical Care Decision-Making

The clinical care decision in the management of the carfentanil overdose is not only pharmacological in nature but also has ethical tensions in clinical care decision-making in the ED setting. Emergency department (ED) clinicians may frequently encounter patients who experience a carfentanil overdose, are successfully resuscitated, and are subsequently discharged, only to experience another overdose shortly thereafter. This raises an ethical dilemma regarding the management of patients who refuse further treatment or monitoring despite their high risk of recurrent overdose following discharge.

The high rate of refusal of hospital transport in the community-based naloxone programs that was observed in the UnityPhilly study at a rate of 52.7% is the result of the patient's autonomy and the complex social dynamics in the neighborhood setting in Kensington, in which mistrust of medical institutions and law enforcement is rampant (Schwartz et al., 2020). In fact, the participants in the UnityPhilly study "reported an aversion to communicating with EMS or other authorities, especially if there was a chance of interaction with law enforcement—they did not trust police, and feared that they or others could be arrested" (Marcu et al., 2020). The mistrust of law enforcement and medical institutions that is the result of the criminalization of the patient's behavior has a direct impact on clinical care in that the patient does not seek the long-term care that is needed in the management of the carfentanil overdose.

PHARMACOLOGY

Carfentanil is a mu-opioid receptor agonist that falls within the fentanyl analogue opioid class. It is estimated to have an analgesic potency approximately 10,000 times that of morphine and 100 times that of fentanyl. It was first synthesized by Janssen Pharmaceuticals in 1974 under the brand name Wildnil® and approved for veterinary use as an intramuscular tranquilizer for large animals.

Chemical Structure & Properties

The potency of carfentanil is closely linked to its chemical structure, particularly its 4-anilidopiperidine core, which is adapted to bind tightly to opioid receptors in the brain. A key structural distinction from fentanyl is the presence of a 4-carbomethoxy group, which markedly enhances receptor binding affinity. These modifications allow carfentanil to interact more precisely and strongly with the μ-opioid receptor, contributing to its increased potency (PubChem, 2026). In its free base state, carfentanil is a white substance with a granular or crystalline texture (Leen & Juurlink, 2019). When converted into citrate or oxalate salts, it forms a clear, odorless liquid that is highly soluble in water (Wildlife Pharmaceuticals Inc).

Pharmacokinetics

The pharmacokinetic properties of carfentanil are limited to animal and in vitro studies, with few case reports documenting both intentional and accidental human exposure. The approved routes of administration in animals include intramuscular, intravenous, transmucosal, and oral. In humans, exposure most commonly occurs through contaminated heroin or fentanyl. The use in humans mirrors that of these substances, including oral intake, often via counterfeit tablets, intravenous injection, and nasal insufflation (Leen & Juurlink, 2019). Carfentanil is highly lipophilic, with a reported logP value of ~3.7, which suggests extensive distribution into extravascular tissues such as the brain and adipose tissue. As a result, this contributes to a large volume of distribution and may explain the phenomenon of "re-nacrotization," in which opioid toxicity reappears hours to days after apparent recovery (Leen & Juurlink, 2019). Proposed mechanisms include redistribution of the drug from tissue reservoirs after antagonist clearance, formation of active metabolites, insufficient antagonist dosing, and faster metabolism of the antagonist relative to the opioid (Miller et al., 1996).

Carfentanil undergoes rapid metabolism via the hepatic cytochrome P450 enzyme system. Although the exact enzymes involved have not been identified, CYP3A4 is considered the most probable based on its structural similarity to fentanyl (Leen and Juurlink, 2019). In vitro studies using human liver microsomes have identified two primary phase I metabolic pathways: piperidine ring monohydroxylation and N-dealkylation, yielding norcarfentanil. The major phase II metabolite is a glucuronide conjugate of hydroxylated carfentanil. However, the relevance of these pathways to in vivo human metabolism remains unclear (Leen and Juurlink, 2019). According to Feasel et al. (2016) the high lipophilicity of carfentanil may facilitate its distribution into cellular compartments, thereby decreasing its availability for hepatic metabolism and extraction. This property may lead to extended drug exposure and help explain the re-narcotization phenomenon in animals (Feasel et al., 2016). Carfentanil is eliminated through bile and urine, as shown through animal models. These elimination routes are predicted to be the same in humans (Feasel et al., 2016).

Ligand-receptor binding studies further support this, reporting the equilibrium dissociation constant (Ki) values of 0.024 nM for μ_1 receptors, 3.3 nM for δ receptors, and 43 nM for κ receptors. In comparison, fentanyl exhibits higher Ki values, 1.9 nM (μ_1), 153 nM (δ), and 197 (κ), indicating lower receptor affinity (Akorn, 2012). These findings suggest that carfentanil binds to opioid receptors, particularly μ_1, more strongly than fentanyl.

Therapeutic index: The therapeutic index, defined as the ratio between the median lethal dose (LD_{50}) and the median effective dose (ED_{50}), is commonly used to assess a drug's safety margin, with higher values suggesting a greater difference between effective and harmful doses (Leen & Juurlink, 2019). Carfentanil has been reported to have a much higher therapeutic index (approximately 10,600) compared to fentanyl (300) and morphine (70) (Wax et al., 2003). However, this is misleading, as it gives the impression that carfentanil is safer than fentanyl. In reality, animal studies show that their lethal doses are quite similar, with rat LD_{50} values of 3.39 mg/kg for carfentanil and 3.05 mg/kg for fentanyl (Akorn, 2012). The inconsistency between potency and lethality is likely due to the reliance on animal data, which may not accurately reflect effects in humans.

Management of Carfentanil Exposure: Treatment of opioid toxicity primarily focuses on maintaining airway, breathing, and circulation, along with the timely administration of an opioid antagonist. Naloxone is the preferred agent for reversing the effects of carfentanil due to its competitive action against the μ-opioid receptor. It is widely available in different formulations that can be delivered intravenously (IV), intramuscularly, or intranasally, with effects seen within minutes depending on the route of administration (Leen & Juurlink, 2019). Due to carfentanil's high receptor affinity and potential for delayed toxicity, repeated doses of naloxone may be required. Although higher initial doses than standard recommendations have been proposed, the optimal dose is not well established and should be guided by clinical response rather than a fixed amount (Lavonas et al., 2015). The goal of treatment is restoration of adequate ventilation, and in some cases, mechanical ventilation may be required when naloxone is insufficient.

An observational study of fentanyl overdoses in the emergency department found that naloxone doses sufficient to reverse respiratory depression ranged from 0.4 to 12 mg, with only 15% of the ED cases adequately treated with 0.4 mg of naloxone. Naloxone doses of at least 6 mg were required during six ED visits, with one patient requiring 12 mg (Schumann et al., 2008). This data implies that large doses of naloxone are not needed in most cases. Additionally, this may also hold for carfentanil, given evidence from animal studies indicating similar lethality to fentanyl. These findings are further supported by position statements from the American College of Medical Toxicology (ACMT) and the American Academy of Clinical Toxicology (AACT), which suggest that naloxone doses above 10 mg are unlikely to improve outcomes. In suspected carfentanil exposure, an initial 2 mg IV dose of naloxone may be reasonable, with repeat administration every few minutes until respiratory function is restored (Moss et al., 2017).

In cases where naloxone is unavailable, naltrexone may be considered as an alternative opioid antagonist, although its slow onset and longer duration make it less ideal in acute settings. In addition to pharmacological treatment, supportive care remains the main pillar in recovery. This includes proper airway management, ventilatory support, cardiopulmonary resuscitation when indicated, and transport to a medical facility for ongoing monitoring and care (Leen & Juurlink, 2019).

ETHICAL ANALYSIS

Harm Reduction: Principles and Practice

Harm reduction is an approach focused on minimizing the harms associated with drug abuse and yields both medical and ethical impacts on PWUD and society as a whole (Hawk et al., 2017). Harm reduction approaches accept PWUD as they are, while also tailoring their treatment to fit their needs (National Harm Reduction Coalition, 2024). Furthermore, there are certain principles that are quintessential to an understanding of harm reduction, as listed by the Harm Reduction Coalition:

- Accepts, for better and or worse, that licit and illicit drug use is part of our world and chooses to work to minimize its harmful effects rather than simply ignore or
- condemn them.
- Understands drug use as a complex, multi-faceted phenomenon that encompasses a continuum of behaviors from severe abuse to total abstinence and acknowledges that some ways of using drugs are clearly safer than others.
- Establishes quality of individual and community life and well-being—not necessarily cessation of all drug-use—as the criteria for successful interventions and policies.
- Calls for the non-judgmental, non-coercive provision of services and resources to PWUD and the communities in which they live to assist them in reducing attendant harm.

- Ensures that PWUD and those with a history of drug use routinely have a real voice in the creation of programs and policies designed to serve them.
- Affirms PWUD as the primary agents of reducing harms associated with their drug-use and seeks to empower users to share information and support each other in strategies which meet their actual conditions of use.
- Recognizes that the realities of poverty, class, racism, social isolation, past trauma, sex-based discrimination and other social inequalities affect both people's vulnerability to and capacity for effectively dealing with drug-related harm.
- Does not attempt to minimize or ignore the real and tragic harm and danger associated with licit and illicit drug use.

Harm reduction is a new paradigm in drug use in which there is a shift from an abstinence-based approach and criminalization of drug users to a more pragmatic approach in which there is a reduction in the harm associated with drug use without necessarily requiring abstinence from drug use (Marcu et al., 2020; Michaud et al., 2024). In fact, according to Harm Reduction International, harm reduction is "policies and programs which aim to reduce the health, social, and economic costs of legal and illegal psychoactive drug use without necessarily reducing drug consumption" (Harm Reduction International, n.d.). This is in line with three key elements: pragmatism, humane values, and harm (Csete, 2020; Harm Reduction International, n.d.).

In Kensington, harm reduction strategies have been implemented in the form of programs that include "Prevention Point Philadelphia," which is "the only city sanctioned syringe exchange program in Philadelphia and one of the primary distribution sites for naloxone and other harm reduction strategies" (Prevention Point Philadelphia, n.d.). "UnityPhilly" is an application that was developed in order to facilitate harm reduction strategies in the digital age in which community members, including opioid users, can be able to respond to potential overdoses (Marcu et al., 2020). The study indicated that harm reduction strategies in which community members were provided with naloxone and were able to quickly communicate in case of an emergency were likely to facilitate overdose reversal before EMS arrives, where layperson intervention occurred 5 or more minutes before EMS in 59.5% (Schwartz et al., 2020).

"The 'harm reduction model... calls for a complete overhaul of drug policy that favors a public health approach, seeking to reduce the harm associated with drug use, rather than eliminating drug use entirely' (Sidak, 2023). In this way, the harm reduction approach directly contradicts the fundamental principles of drug criminalization policies, as drug criminalization policies assume that criminalization can be a successful deterrent for drug use, and that abstinence from drug use is the only solution to drug use. In fact, as Sidak (2023) states, "harm reduction models operate under key tenets that many view as radical shifts away from previous models of drug policy that privilege medicalized or law enforcement approaches."

Ethical Justification for Harm Reduction

The ethical justification for harm reduction drug policies can be grounded in a number of different ethical theories. First, from a utilitarian perspective, a harm reduction drug policy maximizes happiness or well-being, as a harm reduction drug policy eliminates drug use-related morbidity and mortality, as well as drug use- and drug criminalization-related social and economic costs. Second, from a deontological perspective, a harm reduction drug policy treats drug users as ends in themselves, and not as a means to an end, i.e., as a means to dissuade others from engaging in drug use.

Holland also has a very insightful discussion of the ethical considerations: "The consequences of criminalizing people who use drugs outweigh the risks they face from drug use, and there is not convincing evidence that this prevents wider drug use or drug-related harm" (Holland, 2020).

The instrumentalization of the individual—using them as a means to an end to protect others—is "clearly incompatible with contemporary public health ethical guidelines" and the philosophical views of Kant and Mill, who "decried the instrumentalization of human beings" (Holland, 2020).

The Supreme Court of Canada decision in the case of the Insite injection clinic is also of particular importance in the ethical considerations of harm reduction: "The decision rested on the fact that 'the morality of an activity, such as drug addiction, isn't enough to ignore someone's rights to security of their person' (Small, 2012), which is also an indication of the fact that the ethical considerations of harm reduction are no longer in debate: 'Every single health authority and region should have a proactive policy detailing best practices in harm reduction when it is epidemiologically indicated. It is simply not acceptable to pretend harm reduction doesn't exist or to let moral opposition rather than evidence-based analysis guide decisions in this area' (Small, 2012)."

With carfentanil, the ethical considerations of harm reduction are particularly strong, given the lethality of the drug and the fact that any delay in response—because of fear of accessing services due to criminalization, lack of naloxone available, etc.—can result in death. The ethical considerations of harm reduction in such cases cannot be ignored in favor of an ineffective and counterproductive approach to harm reduction.

Moral Distress Among Clinicians

Moral distress, which is defined as the psychological pain experienced by clinicians due to their knowledge of the appropriate action that ought to be taken in a particular situation but is unable to do so because of institutional, legal, or system barriers, is an understudied consequence of the opioid crisis. Clinicians in Kensington, such as emergency physicians, nurses, and paramedics, often witness patients in extremis due to carfentanil overdose. Some patients have been revived from carfentanil overdose on multiple occasions.

Moral injury is originally defined in relation to individuals in the military but is also used in relation to individuals using drugs, as well as clinicians in healthcare settings. According to Michaud et al., (2024) "moral injury is a response to traumatic events that violate an individual's moral compass or sense of justice, characterized by guilt, anger, and despair." Although the study is used in relation to the concept of moral injury in relation to individuals using drugs in their encounters with law enforcement, it is also used in relation to clinicians in relation to their encounters with the opioid crisis, especially in relation to their inability to address the opioid crisis in relation to the devastating consequences of carfentanil exposure.

Ethical issues at various levels emerge for clinicians. For instance, at the individual level, healthcare workers are faced with the challenge of balancing their role in saving lives with their role in respecting their patients' autonomy, including those who choose to stop treatment or those who choose to use drugs as soon as they are reversed from their effects. At the systemic level, healthcare workers feel the futility of the healthcare system in managing addiction, the criminalization of their patients, and the role of societal factors in drug use by their patients, such as poverty, homelessness, and trauma. This, therefore, creates a condition of moral distress, which may lead to burnout, compassion fatigue, and turnover of healthcare workers, thus creating a further drain on the healthcare resources needed to combat the crisis.

The Dual Role of Healthcare Workers In the Context of Punitive Drug Policies

The dual role of healthcare workers in the context of punitive drug policies has been well documented. Golichenko & Chu (2018) describe the situation thus:

"In punitive drug policy environments, healthcare providers 'must often balance state objectives such as drugs and crime prevention with their clients' rights and freedoms.' This generates 'concurrent—and often mutually exclusive—obligations to law enforcement on one hand and to their patients on the other' (Golichenko & Chu, 2018).

Their work focuses on Russia, but the dual role of healthcare workers is an issue everywhere, including the United States, where drug use is criminalized."

Criminalization Versus Public Health Approaches

One of the most debated problems with the opioid epidemic is the debate between the criminalization model of drug use and the public health model of drug use. The criminalization model, which treats drug use as a moral failing that must be penalized, has been the dominant policy perspective in the U.S. for many decades. However, there is now widespread agreement among public health agencies, international agencies, and academic researchers that the criminalization model has been unsuccessful and that the public health model is both ethically and empirically justified.

The World Health Organization, American Public Health Association, and United Nations Office on Drug and Crime support changing the current criminal justice system of dealing with drugs to a public health-based system (Gibson et al., 2023). In 2018, the Chief Executives Board of the United Nations, which is composed of 31 agencies of the United Nations, came out with a position paper declaring unanimous support for the decriminalization of possession of drugs for personal use (Gibson et al., 2023). These recommendations also come from the Royal Society of Public Health, Canadian Association of Chiefs of Police, and Lancet Commission on Drug Policy and Health (Holland, 2020).

The ineffectiveness of the current system in dealing with drugs is also shown in some aspects. First, Holland states that "It is not possible to eliminate all drug use and associated harms. The current approach is not only ineffective in preventing drug-related harm but itself directly and indirectly causes incalculable harm to those who use drugs and to wider society" (Holland, 2020). The current system of dealing with drugs, which is based on criminalizing the use of drugs, has failed to reduce the availability of drugs, failed to reduce the use of drugs, and has also led to various secondary problems of drugs (Holland, 2020).

The rise of carfentanil in the illegal drug market has been described as "an iatrogenic effect of the 'iron law of prohibition,' which has focused over the years on the suppression of access to drugs, with marginal attention paid to prevention and harm reduction activities" (Negri et al., 2021). The "iron law of prohibition" is defined as "the more efforts that are put into enforcing the law and reducing the supply of drugs, the more the use of drugs with greater potency in exchange for drugs with lesser potency increases, because of their greater profitability and easier transport on a unit weight basis." Carfentanil is the ultimate end product of this process, possessing the unprecedented potency-to-weight ratio that makes it both lethal in microgram doses and compact and transportable in doses sufficient to cause overdose.

The drug enforcement policy also has the immediate consequence of negatively affecting harm reduction activities. In the case of Kensington, there was "an aversion to communicating with EMS or other authorities, especially if there was a chance of interaction with law enforcement—they did not trust police, and feared that they or others could be arrested" (Marcu et al., 2020). This fear response to emergency personnel has lethal consequences in cases of overdose with carfentanil, because of the delayed administration of naloxone and the resulting anoxic brain damage and death.

Gibson et al. (2023) provide a detailed multidisciplinary case for decriminalization, which includes the following benefits: "increasing uptake into drug treatment; reducing criminal justice costs; redirecting resources from the criminal justice system to the health system; redirecting law enforcement resources to prevent serious and violent crime; reducing unjust racial disparities in drug law enforcement and sentencing; minimizing the social exclusion of drug users; and creating a context in which drug users are less fearful of seeking and accessing treatment, using harm reduction services, and receiving HIV/AIDS service." The Canadian news media analysis undertaken by Ferguson & Eliasson (2022) also arrived at the conclusion that "harm reduction and treatment were the preferred solutions instead of criminalization, and public health framing predominantly."

However, it is not an easy and straightforward process. According to Sidak (2023), "opioid dependent users are infantilized and demonized due to a history of negative perspectives on drug use that persist today in drug discourse," and this affects decision-making in drug policy.

Ethical Obligations of Pharmaceutical Development

The pharmaceutical industry has an ethical obligation in the development and marketing of drugs that cause the opioid crisis, although it is also important to note that carfentanil is not for human consumption (Misailidi et al., 2017). However, responsibility for the opioid crisis extends beyond the pharmaceutical industry. Broader social and policy environments also contributed by failing to adequately address emerging patterns of opioid dependence and by not establishing sufficient prevention, treatment, and harm reduction infrastructure. These shortcomings helped create conditions in which highly potent synthetic opioids such as carfentanil could emerge and proliferate. According to Csete (2020), "evidence-based, health-focused drug policies could be an avenue leading to the improved health of the public and thus sustainable development" and could also "help the public worldwide to understand and confront the social determinants and stigma of drug dependence and the futility of abstinence-only approaches." The pharmaceutical industry has an ethical responsibility not only to prevent the creation of an environment that fosters drug dependency but also to provide better ways to counter drug dependency with better drugs and modalities for ultra-potent opioids.

The pharmaceutical industry's role in the development and distribution of naloxone, for instance, can be seen to both positively and negatively influence the way in which the opioid crisis is addressed. While naloxone can be seen to have played a significant role in saving countless lives, the cost of the drug, as well as the fact that several doses of the drug have to be used in order to combat the effects of carfentanil overdose (Misailidi et al., 2018), can be seen to bring into question the role of the pharmaceutical industry in the addressing of the opioid crisis.

The fact that carfentanil can be found on the darknet, with 63 vendors selling the drug in 19 darknet marketplaces (Negri et al., 2021), can be seen to demonstrate the pharmaceutical industry's lack of role in the addressing of the opioid crisis. This is particularly so in light of the pharmaceutical industry's ethical role, which extends beyond the production of pharmaceuticals to include the support of a strong regulatory system to control the sale of the drug.

Distributive Justice and Marginalized Populations

The opioid crisis involving carfentanil can be seen to bring into question the distributive justice of the situation. For instance, in the case of the opioid crisis in the Kensington neighborhood of Philadelphia, the environment of the community can be seen to be characterized by poverty and marginalization, with 30% of the population of the UnityPhilly study sample being homeless (Schwartz et al., 2020).

As he states in his ethical assessment, "If there were benefits from a criminal justice approach to drugs, it would still be ethically questionable that these benefits were dependent upon causing harm that was principally borne by particular groups according to the color of their skin" (Holland, 2020). The drug policy in policing is characterized by "high levels of racial disparity in the criminal justice system and by practices that are wholly disproportionate to the offenses involved" (Global Commission on Drug Policy, 2016), and drug criminalization is also recognized as "a tool of social control that causes harm not only to people involved with drugs. The whole society is affected" (Global Commission on Drug Policy).

Distributive justice is an ethical theory of justice that holds that benefits and harms of social policies should be distributed equitably across society. In the case of the carfentanil crisis, it would require the provision of harm reduction services, naloxone kits, medication-assisted treatment, and housing for the drug-using community, not as

charity but as a right. In fact, the Supreme Court of Canada has recognized that addicted persons have a right to "the security of their person" (Small, 2012).

Valles also indicates that mass incarceration, which is partly fueled by the war on drugs, "is a bioethics issue that should be addressed in medical education" and bioethicists should be involved in "thinking through structural racism, police violence, and mass incarceration" (Valles, 2023). The intersection of the carfentanil crisis and mass incarceration is particularly egregious because those arrested for overdoses and are otherwise fortunate enough to be revived with naloxone may be arrested and subsequently denied treatment, only to be released back into an environment in which they may have originally resorted to drugs in the first place with their tolerance lowered and their chances of fatal overdose heightened.

The experiences of those in the drug-using community and their interactions with law enforcement also highlight another aspect of distributive justice and its effect on PWUD. In fact, Michaud et al. (2024) indicate how "the uneven spatial distribution of drug law enforcement underscores the ways in which the liminal legal status of PWUD is produced by an interplay of interrogation practices and assumptions of culpability differentiated by public versus private spaces." Those in public spaces are also more likely to be homeless.

Correctional facilities also demonstrate an aspect of distributive justice, which affects PWUD. According to Ricciardelli et al. (2023) individuals in correctional facilities are "at disproportionate risk of suffering substance-related harms" and correctional staff experience fentanyl or carfentanil on a monthly basis, but only 8% of them feel they are prepared to use naloxone. This means that individuals who are incarcerated, who are already at the lowest rung of society, are at an increased risk of fatal overdose with limited access to life-saving interventions.

The Darknet and the Globalization of the Carfentanil Threat

The globalization of carfentanil through darknet marketplaces represents a new, frightening dimension of this opioid crisis. Negri et al. (2021) identified carfentanil in the sale lists of 63 vendors on 19 darknet marketplaces, which poses "unprecedented health and safety concerns in terms of both hazardous voluntary consumptions and potential use to harm others." Carfentanil was "sold as part of a much wider repertoire of products, including other drugs, weapons, protected wildlife and human organs being sold by the same vendors" (Negri et al., 2021).

However, the trade of carfentanil in the dark net poses challenges to law enforcement agencies and health authorities. The number of transactions in crypto markets has tripled since the closure of Silk Road in 2013, and the revenue generated has doubled in less than three years (Negri et al., 2021). The ease of manufacture of carfentanil and its potency to weight ratio make it suitable for trade in the dark net, as it can be mailed in small amounts without arousing suspicion but can contaminate large amounts of street drugs when received.

According to Negri et al., (2021) "it is crucial that this issue is tackled through continued collaboration with law enforcement agencies and investment into novel scientific methods for the monitoring of the darknet in order to promptly identify future threats and safeguard the health and the security of citizens." However, history shows that shutting down individual markets will only push users to other markets, and that what is needed is more than just law enforcement. A comprehensive solution is one that combines law enforcement with other solutions, such as public health action that involves services such as drug checking services, naloxone distribution, and treatment for opioid use disorder.

Toward an Integrated Clinical and Ethical Framework

A comprehensive solution to the carfentanil crisis involves integrating aspects of clinical medicine and ethical analysis. The pharmacological properties of carfentanil necessitate an update of the dosing and duration of naloxone action from a clinical point of view. The crisis also necessitates an overhaul of the drug policy from an ethical point of view, with particular emphasis on marginalized populations.

This is summarized in the following words of Csete: "The history of drug control... is littered with policies energized by pious moral judgement, implemented by gross misapplication of criminal law, and exemplifying a rejection of science that is at times nearly inexplicable" (Csete, 2020). The crisis caused by carfentanil represents an opportunity and a need to do better and to build a new policy that is evidence-based, equitable, and that honors the dignity of human life.

The harm reduction approach, with its basis in the principles of autonomy, beneficence, non-maleficence, and justice, offers the most promising approach to addressing the crisis. The Kensington approach has been proven to be evidence-based and has the ability to prevent overdoses in even the most challenging settings (Schwartz et al., 2020). However, it must be supported with the resources and the drug policy that does not criminalize the populations most in need of the policy.

DISCUSSION

The emergence of carfentanil in illicit street drugs represents a qualitative rather than a quantitative shift in the problem of the opioid epidemic. In fact, the extremely high potency and long-acting effects of carfentanil, and the inability of naloxone to reverse overdoses caused by it, represent a problem that the current clinical and community resources are insufficient to address. The disproportionate impact of the crisis caused by carfentanil on vulnerable populations such as those in the Kensington neighborhood of Philadelphia represents the distributive injustice and the ethical bankruptcy of the current approach to the problem of drugs in the United States.

The clinical data reviewed in the current manuscript supports the assertion that carfentanil overdose is distinguishable from fentanyl overdose in its severity, naloxone response, and risk of recurrence of respiratory depression (Misailidi et al., 2017; Ringuette et al., 2020). These distinctions have immediate implications for the care of patients in the emergency department, naloxone distribution in the community, and harm reduction in general. Development of long-acting naloxone, drug checking to detect carfentanil in the illicit drug supply, and expansion of safe consumption sites are all clinically indicated interventions that are presently limited by legal and political constraints.

As indicated in the ethical analysis presented in this paper, it is imperative to understand that there is a convergence of concern in terms of moral distress for healthcare providers, distributive injustice for marginalized communities, the failure of the criminalization approach, and the pharmaceutical industry. These issues converge in such a manner that requires us to make a paradigm shift in our approach to drug policies. The evidence is unequivocal in demonstrating that "as a matter of public health, there needs to be economic restoration to these most impacted communities who have experienced generations of harm" (Gibson et al., 2023), and that "drug policing is marred by high levels of racial disparity in the criminal justice system and by practices that are wholly disproportionate to the offenses involved" (Global Commission on Drug Policy, 2016).

Moreover, it is imperative to understand that the Kensington model also represents a microcosm of what has been successful with our current drug policies. For instance, naloxone programs have been successful in demonstrating the efficacy of layperson intervention in saving lives and have been effective in allowing EMS response time to arrive on the scene even before layperson intervention occurs (Marcu et al., 2020). However, the fact that there is a mistrust of law enforcement and medical providers in this community (Schwartz et al., 2020), that the current doses of naloxone are ineffective in countering carfentanil (Misailidi et al., 2018), and that treatment infrastructure is virtually nonexistent have also demonstrated that, although important, our current drug policies are insufficient in addressing this crisis.

The above discussion has sought to illustrate that carfentanil is among the strongest drugs in the illicit market, and its presence in our communities, as exemplified in Kensington, Philadelphia, has created a crisis of unprecedented magnitude. The clinical issues with carfentanil include its potency, inability to be reversed with

naloxone at doses that we have access to, prolonged duration of action, and ability to cause recurrent respiratory depression.

The ethical dimensions of the crisis have also been significant. The criminalization of drug use not only has not reduced but also has increased the suffering of marginalized populations (Csete, 2020; Gibson et al., 2023; Holland, 2020). Harm reduction, grounded in pragmatic philosophy, human dignity, and evidence-based practice (Small, 2012) is the most ethical and evidence-based approach in dealing with the crisis. The moral suffering experienced by clinicians (Michaud et al., 2024; Riccardelli et al., 2023), the distributive injustice experienced by marginalized populations (Holland, 2020) and the ethical responsibility of the pharmaceutical industry (Csete, 2020) all point towards addressing the crisis in an integrated manner that transcends the dichotomy of clinical practice vs. social policy. The solution requires courage—courage to move beyond failed policy, courage to invest in solutions that work, courage to listen to individuals affected by these issues, and courage to understand that the deaths caused by carfentanil overdose are not part of a problem that cannot be fixed but part of a problem that will be fixed if we change what we need to change. As Csete (2020) writes, "death and disability linked to drug overdoses are eminently preventable." The question is whether we have the will to do so.

EDUCATION & PREVENTION

Carfentanil is still a relatively new synthetic opioid, so many individuals may not know or understand its effects. Public education should emphasize its extreme potency, while also promoting positive prevention behaviors such as carrying naloxone and utilizing test strips. Improving public understanding through education may lead to an enhanced ability of individuals to respond to suspected overdoses and a potential reduction in the distribution of carfentanil within communities in the United States.

A study that compared respiratory depression of carfentanil, fentanyl, and heroin in male mice found these depressive effects to be 18-fold more potent in carfentanil than fentanyl and 206-fold more potent in carfentanil than heroin (Flynn & France, 2025). Because of this extreme potency, smaller dosages of carfentanil can result in overdoses, and even death. Sometimes, the presence of carfentanil may be so small (< 1 ng/mL) that it can be difficult to detect in the blood, which emphasizes that its fatality rates may be even higher than what has been reported (Papsun et al., 2017; Shanks & Behonick, 2017). In some situations, naloxone administration may not be enough to prevent death. While many individuals may have a general understanding of the effects of opioids, it is necessary to go beyond this set of general awareness when looking at a drug like carfentanil. Education to the community should start with emphasis on these extra levels of danger regarding its potency and respiratory effects. With a greater understanding, individuals may be more engaged in promoting preventative efforts focused on reducing the usage of carfentanil in the community.

Carfentanil has been found to be increasingly present in polydrug mixtures. This suggests that individuals may unknowingly consume carfentanil while taking other opioids. Because it is so potent, accidental trace amounts of carfentanil in a drug mixture can be attributed to death. Thus, a potential step in prevention strategy could be the introduction of safe and reliable test strips for carfentanil.

Drug checking technology in the form of test strips has been introduced to detect the presence of specific drugs in a sample previously. For example, test strips for drugs such as fentanyl and xylazine have been developed and distributed to the public. BTNX, Inc. developed test strips that were found to be very effective in detecting fentanyl in drug samples. They detected traces as low as 0.13 mcg/mL, and showed high sensitivity (96-100%) and high specificity (90-98%) for fentanyl in street drug samples (John Hopkins Bloomberg School of Public Health, 2018). Additionally, a study found that test strips may promote positive changes in drug use behavior and perceptions of overdose safety within the population of individuals who inject drugs. The researchers sent out a survey, and the responses indicated that after utilizing test strips, individuals with a detection of fentanyl in their drug sample were 5 times more likely to change their drug use behavior compared to those who did not detect

fentanyl (Peiper et al., 2020). Also, 77% of respondents specified that fentanyl test strips enabled them to better protect themselves from overdose. Some fentanyl test strips can also detect its analogs, such as carfentanil. However, a study comparing two brands of fentanyl test strips (BTNX and DanceSafe) found inconsistent results in detecting fentanyl analogs. Specifically, carfentanil was detected by BTNX at 2000 ng/mL, but much smaller doses can still be lethal (Hayes & Lieberman, 2023). These findings suggest that individuals may use test strips where carfentanil goes undetected, which can lead to an overdose after consumption. Since carfentanil use has been on the rise, it may be advantageous to create test strips specific to detecting carfentanil, especially at the lower quantities. Previous evidence that fentanyl test strips can encourage safer drug use behaviors suggests that this technology can have positive impacts on the community. Thus, the development of accurate carfentanil test strips could help contribute to protection from overdose in those who inject drugs.

Despite their benefits, test strips exhibit some limitations. It is necessary to continue to raise awareness that test strips are subject to the possibility of false negative results, where dangerous levels of opioids can still be present in a drug sample (Rodriguez-Cruz, 2023). One study found the rate of false negatives with fentanyl test strips to be approximately 3.7% (Green et al., 2020). Thus, upon development and distribution of carfentanil test strips, it should be made aware that despite high levels of accuracy, it is possible for an incorrect result and users should proceed with caution.

In the United States, veterinary access to carfentanil is tightly restricted to ensure that only those who intend to use it correctly have possession of the drug Lust et al., 2011). However, there are still reports of recreational human use of carfentanil, suggesting that unauthorized possession may be occurring. Therefore, tighter regulations should be implemented to further prevent carfentanil from entering the human drug supply. One approach could be to more tightly track the distribution of carfentanil within and into the United States. The Food and Drug Administration's (FDA) Center for Veterinary Medicine (CVM) and the Department of Health and Human Services have implemented closer monitoring of the importation of xylazine, another drug, into the United States (Forfa, 2023). This includes ensuring that xylazine entering the United States is actually going to valid animal drug manufacturing or research facilities. However, some xylazine shipments have been able to bypass this by being packaged and labeled to look like FDA-approved drugs. Despite these limitations, the CVM has found and stopped four unapproved shipments of xylazine through import pathways into the United States (Forfa, 2023). These methods should be implemented with carfentanil, and tighter regulations could prove successful in preventing it from entering the human drug supply to some degree.

Community-based education programs should play an important role in raising the public understanding of carfentanil, as well as preventing the spread of carfentanil use within the United
States. These programs can include individuals who have recovered from opioid addiction sharing their experiences, which can provide firsthand perspectives that highlight the dangers of opioids. Specifically, carfentanil is extremely potent when compared to more common opioids (i.e. fentanyl and heroin), so additional risks can be portrayed alongside the widely recognized
effects of less potent opioids. This may help communities understand the importance of engaging
in prevention strategies, especially as carfentanil overdose deaths have been on the rise in recent
Years (Tanz et al., 2024).

In addition to providing awareness, community-based education programs can focus on harm reduction strategies. These programs can teach common signs of opioid overdose, such as
reduced level of consciousness, pinpoint pupils, and severe respiratory depression characterized by slow and/or shallow respirations and cyanosis (Fareed et al., 2011). Also, education can include how to administer naloxone when these symptoms are recognized, which is important in a high-risk community. If individuals are trained to administer naloxone, the chances of survival from a carfentanil-induced overdose may be increased. In addition, community programs can also actively distribute naloxone to individuals in the communities who are at a higher risk, in hopes to further reduce overdose deaths.

The effects of previous community opioid overdose prevention and naloxone distribution programs were analyzed in a systematic review, and the evidence supports success in incorporation of these programs. In the reviewed studies, naloxone was administered successfully 1,949 times across 18 different programs with post-administration survival rates ranging from 83-100% (Clark et al., 2014). This suggests education programs can train people to recognize and quickly respond to potential opioid overdoses. Thus, if these programs are implemented in areas where carfentanil exposure may be of higher risk, the numbers of fatal overdoses may be reduced. Overall, improvements in drug checking technology, increased regulations, and expanded community-based education may provide an effective framework for addressing the risks associated with carfentanil. Utilizing these strategies could help limit the continued rise and spread of carfentanil use in the United States.

RECOMMENDATIONS

Given the increasing prevalence of carfentanil within the illicit drug supply and its significant clinical, public health, and ethical implications, a multifaceted response is required. Effective strategies must balance overdose prevention, harm reduction, research, education, and surveillance. The following recommendations are proposed to mitigate the harms associated with carfentanil exposure and improve outcomes for PWUD, healthcare professionals, and affected communities. In addition to the recommendations included in PDPH's November 2025 public health alert, city officials may consider implementing the following measures:

1. **Promoting research**: Given carfentanil's primary use as a veterinary tranquilizing agent for large animals, there remains limited research regarding its toxicity, metabolism, pharmacokinetics, and physiological effects in humans. Existing evidence suggests that carfentanil's effects may be compounded when mixed with fentanyl, xylazine, medetomidine, or other adulterants increasingly detected within Philadelphia's illicit drug supply and in other jurisdictions nationally and internationally. A stronger understanding of carfentanil's pharmacological properties and its effects on people who use drugs (PWUD) is essential for informing both local and national public health responses. Carfentanil is already classified by the U.S. Drug Enforcement Administration (DEA) as a Schedule II controlled substance due to its extreme potency and medical utility limitations. Therefore, expanded pharmacological, toxicological and epidemiological research into emerging veterinary sedatives and synthetic opioids is necessary to support evidence-based policy making surveillance, scheduling determinations and overdose prevention strategies.
2. **Educating PWUD and making immunoassay test strips more accessible:** Carfentanil has been introduced as an adulterant, alongside fentanyl, medetomidine and xylazine, into the illicit drug supply. Just as for xylazine, fentanyl, and medetomidine may be tested for in a drug sample using immunoassay test strips. Research findings showed that the use of fentanyl test strips among PWUD for drug checking a supply leads to positive drug consumption behavior such as discarding the supply, requesting from a friend to be present during the drug consumption, keeping naloxone at disposal more often, and even offering test strips to friends who are prone to inadvertently consuming fentanyl (Goldman et al., 2019). Emerging drug-checking technologies may eventually permit more reliable detection of carfentanil and other adulterants. Research into designing and implementing carfentanil test strips is imperative. Following similar approaches to promoting fentanyl test-strip use (e.g. educating patients adequately and comprehensively on the dangers and side effects of carfentanil-use) may yield similarly effective outcomes as in the case of PWUD using fentanyl-test strips. Alongside education, creating carfentanil test strips and making them accessible or even distributing them at health fairs aimed at serving PWUD may help further educate PWUD on the dangers of consuming carfentanil adulterated drugs.
3. **Prioritizing wound care**: Carfentanil does not directly cause unique tissue-destroying wounds like veterinary sedatives (e.g., xylazine and medetomidine) do. However, it indirectly impacts wound care

through extreme sedation, immunosuppression, and profound risk of overdose. Patients managing wounds while using carfentanil-contaminated drugs are at higher risk of accidental exposure during dressing changes. Patients may face elevated overdose risks during periods of intoxication or recurrent exposure associated with contaminated drug supplies. Therefore, effective harm-reduction approaches focused on wound management must be endorsed. The availability and accessibility of wound-care services must be given priority. Effective wound-care management prevents bacterial infections and other wound-related complications that may not only harm PWUD but also incur further expenses on the healthcare system. Testimonies from employees at clinics in Kensington suggest that many PWUD are unaware of the locations of wound-care centers or low-barrier clinics close to them. Although such locations have been published on the internet by the PDPH, many PWUD lack access to the internet. Therefore, there is a need for more community-engaged initiatives such as creating a website that is accessible on phones showing the location of wound care sites in Kensington, days and hours of operation, and directions to these locations.

4. **Considering Supervised Consumption Sites:** A Supervised Consumption Site, which is a safe space for PWUD to consume drugs under medical supervision, may also be a viable option for addressing not only the newly witnessed prevalence of medetomidine in the illicit drug supply in Philadelphia, but also possibly mitigating the negative impacts other new adulterants may bring about in the future. Insite, an SIS in Vancouver, Canada, and Onpoint, an SIS in New York City, United States, are two prime examples of how SISs can reduce overdose risk and drug mortality (Kennedy et al., 2019; Facher 2025).
5. **Continuing Medical Education:** Medical students, medical residents/fellows and Emergency Room staff need to have a continuing education on the latest synthetic opioids appearing in Kensington. Unless they are educated to their impact and effects, they will not be able to serve their patients well. Cychlorphine (N-propionitrile chlorphine) is an incredibly potent synthetic opioid belonging to a class of designer drugs known as “orphines.” There is little knowledge of this drug in the Philadelphia area, however, emerging reports from people who use drugs and frontline outreach workers suggest that additional synthetic opioids or designer analogues may be entering the local drug supply. Unless the ER staff are educated on these new drugs, patient’s lives are in jeopardy. There should also be community-based education programs to raise public awareness of these new drugs. This should also include the police, EMS workers, wound care clinics, etc.
6. **Tracking of new synthetic opioids:** More funding should be allocated to the Food and Drug Administration (FDA), Center for Veterinary Medicine (CVM), the Department of Health and Human Services, the Drug Enforcement Administration (DEA), Customs and Border Protection (CBP), and local Departments of Public Health to implement closer monitoring and tracking of the importation of drugs like fentanyl, medetomidine and carfentanil, etc.

LIMITATIONS

The findings in our research are subject to several different limitations; underreporting, polysubstance use, and regulatory and resource constraints.

Underreporting: Carfentanil exposure is likely to be underreported in clinical and mortality data. Typical hospital drug screenings do not test specifically for carfentanil and often require specialized toxicology testing, which may be limited by cost and the need for specialized equipment. Consequently carfentanil could be misclassified as simply fentanyl or not be detected at all. Drug testing tools like fentanyl test strips and Fourier-transform Infrared Spectroscopy machines (FTIR) also have detection limitations and may not identify fentanyl analogs at low dosages. Additionally, postmortem toxicology testing is not standardized and varies within jurisdictions, leading to variability in carfentanil detection. These limitations generate uncertainty of the accuracy of data and complicates efforts to see its true effect on the drug supply.

***Polysubstance Use*:** Carfentanil is rarely used on its own and is typically mixed with other drugs in the illicit drug supply such as heroin, fentanyl, xylazine, alcohol, and benzodiazepines. This polysubstance use makes it challenging to determine carfentanil's specific impact to overdose and mortality. The combination of carfentanil with other central nervous system depressants that magnify respiratory distress make it difficult to pinpoint its independent clinical effects.

***Regulatory and Resource Constraints*:** Regulatory and resource constraints play a large role in the gap in understanding how to prevent carfentanil exposure. Although Carfentanil is approved and tightly regulated for veterinary usage, it has made its way into the elicit drug supply meaning that there are limitations in the monitoring and enforcement of the drug. In addition, limited funding and access to advanced toxicology tools may restrict the availability of testing capable of detecting fentanyl analogs. The lack of widely accessible carfentanil-specific test strips, further contributes to underdetection. In addition, legal and regulatory frameworks may not keep up with the rapid emergence of new fentanyl analogs. This makes it hard to control their distribution effectively. The situation is worsened by a general lack of knowledge about newer synthetic opioids like carfentanil. Research and surveillance often fall behind changes in the illegal drug supply.

CONCLUSION

The emergence of carfentanil in the illicit drug landscape signifies a profound escalation in the multifaceted challenges of the opioid epidemic. Its extraordinary potency renders it an especially lethal contaminant that not only amplifies the risk of individual harm but also strains the healthcare system. Defying conventional treatment protocols, carfentanil exacerbates societal disparities, disproportionately impacting vulnerable populations and neighborhoods such as Kensington, Philadelphia. Addressing this crisis necessitates a paradigm shift that emphasizes enhanced surveillance, innovative harm reduction strategies, comprehensive public health education, and equitable policy interventions. Only through a concerted, multidisciplinary effort can we raise awareness of carfentanil's risks and effectively mitigate its devastating implications for public health and social equity.

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