Police opioid seizures and increased risk of fatal overdose: A causal model

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Abstract

Context: Police seizures of illicit opioids remain a dominant strategy for addressing problematic substance use and overdose in the United States and throughout the world, yet qualitative accounts and quantitative analyses exhibit positive associations between police opioid seizures and ensuing risk of fatal overdose. Since these associations run counter to the commonly held belief that removing potent illicit substances from the community has a protective effect on overdose, a causal model is needed to demonstrate this association and convey the overdose risks that follow from police opioid seizures.

Methods: Leveraging well-established biological and psychological outcomes of opioid use disorder and opioid supply interruption, our analysis presents an individual-level casual model that begins at the point of opioid dependence, introduces an interruption to an individual's supply of opioids as the result of a police drug seizure, and presents the physical and behavioral outcomes that increase the ensuing risk of fatal overdose.

Results: The urgent need to prevent or reduce opioid withdrawal symptoms, changes in opioid tolerance resulting from the period of involuntary abstinence following a supply interruption, the uncertain potency of replacement illicit opioids, measures meant to reduce future risk of opioid seizures, and reduced aversion to risky behavior all synthesize to increase a person's risk of fatal overdose in the aftermath of a police opioid seizure.

Conclusions: Strategies that emphasize police opioid seizures without accounting for the elevated risk of fatal overdose that results can worsen the problem they are meant to address.

Keywords: substance use, opioids, overdose, policing, drug enforcement, war on drugs

Introduction

A growing body of evidence shows that when a person is dependent on opioids, temporarily interrupting their supply of them exposes the person to an increased risk of overdose. The first studies explored this assertion qualitatively, finding that people problematically dependent on opioids reported this increased risk when asked about their personal experiences. Conversely, people who use drugs (PWUD) also reported that steady access to a drug supplier they could trust, who provided a basically consistent supply, could warn of inconsistencies, and who might supply naloxone, was protective of overdose.[1] More recently, a quantitative analysis found a statistically significant spatiotemporal association between police opioid seizures and overdose during a two-year period in Indianapolis, Indiana.[2] The analysis found that fatal overdoses more than doubled within three weeks of the police seizure, in a radius of up to 500 meters from the seizure's site, and this association held when considering all quantities of opioids seized, regardless of whether they were taken from a dealer or an individual who uses drugs.[2]

Many people find the conclusion that police drug seizures increase overdose risk strongly counterintuitive, considering that governments act to interrupt the supply of illicit drugs to ostensibly reduce risk and save lives. To that end, the presumption is that reducing the quantity of illicit drugs in circulation and interrupting their consumption by people dependent on opioids is believed to reduce risk. But at least in the proximate sense, the best evidence does not bear this presumption out. To address this gap between emerging research findings and many people's intuitions, and to promote the rigorous interrogation of this proposition, this paper proposes a discrete causal model by which increased exposure to overdose arises from the aftermath of a police drug seizure, a phenomenon that has critical implications for our present public health and drug enforcement policies. In doing so, it intends to bolster our understanding of the health outcomes of police drug enforcement and suggest ways to interrupt the causal chain to reduce overdose mortality. Barring such a model, the evidence we produce to explore this relationship will continue to face its inherent limitations. Qualitative research conveys the lived experience of increased exposure to overdose in the aftermath of police drug seizures with nuance, but the method inherently precludes broad generalizability. In contrast, quantitative analyses of administrative data can demonstrate statistically significant associations, but do not readily illuminate the causal pathways that suggest where to effectively intervene. Both veins of research would benefit from the development of a model that conveys how personal experience and quantitative correlation can be understood as causation. By presenting such a model here, this paper is giving guidance about where future research on this topic should go, and what intervention designs might look like.

The model we present takes policing as its primary focus. It concerns the events that we commonly understand to be police drug seizures: the arrest of people for drug possession, the seizure of contraband drugs that people preemptively discard to avoid arrest by police, and the arrest of distributors and suppliers accompanied by the seizure of their drugs as evidence. It also takes up overdose as the outcome of interest, although there is evidence that police drug seizures can increase the risk of other harms as well. For instance, in the aftermath of police contact, people may change the way they consume drugs by speeding the act of injection or sharing syringes (thereby reducing the probability that any one person will be criminally liable for possessing one), increasing the risk of abscess and infectious disease in doing so. To keep our causal model as direct and compelling as possible, these other outcomes will not be its focus.

The paper will therefore proceed as follows. It will present the principles that underlie the causal model, establishing each principle independently by discussing the biological and pharmacological factors that give rise to it. We will then show how these factors come together in a causal chain to explain how police drug seizures increase overdose risk and then complement this model with behaviors that might follow a drug seizure to further its explanatory power. We close by discussing several policy responses to the risks the model presents, stressing that there are several potential ways to mitigate the overdose risks that result from seizures, although they vary in feasibility and acceptability given individual contexts and political climates. We then discuss our model's limitations and suggest avenues for further research.

Principles underlying overdose as a result of drug seizures

There are four factors that drive our model, each one an evidence-based premise that combines to increase fatal overdose risk when a personal drug supply is interrupted by a police drug seizure:

1) **Supply interruption sends people who are physically dependent on opioids into withdrawal, and the most common outcome is that they will avoid or reduce the condition with a replacement supply of opioids.** Opioid dependence is defined by the physical experience of opioid withdrawal, its psychological toll, and the ways in which they guide and modify behavior.[3] The most common responses to the onset of opioid withdrawal are to avoid it, reduce it, or reverse it. For many people, this requires gaining access to a replacement supply of opioids (which could include treatment medications) or being forced to endure a period of detoxification that is, by all accounts, extremely painful and difficult to bear.[4,5] Its symptoms can last weeks,[6] and are potentially life-threatening,[7] and therefore motivate strong survival behaviors. The idea that a person with problematic opioid dependence can detoxify by enduring a few days of discomfort reflects a deep misunderstanding of the physiological processes and changes to the body and brain that have occurred when a person is heavily dependent on opioids.[8] In

response, some may attempt to manage the symptomatic presentations of their withdrawal symptoms by means such as benzodiazepines, sedatives, cannabis, or other substances, which have been shown to provide some relief to individual symptoms without alleviating withdrawal themselves.

2) **Supply interruption reduces a person's tolerance of opioids and does so to a degree they cannot measure with precision.** Even short interruptions in the supply of opioids affect a person's tolerance of the substance. Prolonged use increases tolerance, such that greater quantities are necessary to avoid withdrawal, produce a euphoric effect, or simply maintain bodily homeostasis, and interruptions have the opposite effect, which is why physicians may alter the dose of patients who use prescribed opioids after periods of interrupted use. It is critical to note, however, that several factors affect the actual loss of tolerance, from genetic predispositions to body composition, and reductions in tolerance can therefore not be precisely measured. When a person resumes consumption, it will be with a tolerance for opioids that is reduced by an uncertain amount, making dosing much more a matter of estimation than it would otherwise be.

3) **The replacement supply of illicitly produced opioids sought proximal to a seizure event is likely to be of a different, uncertain potency than the interrupted one.** In saying this, it is critical to note that we do not mean the new supply is likely to be more potent. In presenting our model to a variety of nonspecialist audiences, one misconception that frequently arose was that initial heroin supplies were replaced with a resupply of fentanyl. Our model does not depend on pharmaceutically produced opioids or heroin being replaced by fentanyl. Instead, it presumes that fentanyl has saturated the nation's illicit opioid markets,[9,10] is what people who use illicit opioids are likely to consume, and what replacement supplies most likely consist of. The variability in potency that powers the model here arises from the heterogeneity in which illicit opioids are cut for distribution to the end user, and the unsuspected presence of fentanyl in counterfeit analgesic pills or adulterated substances. Since illicit manufacturing and packaging processes are not carried out to any standard, or with reliable precision, barring the illicit consumption of pharmaceutically produced opioid analgesics, there will most likely be variance between the potency of an initial supply of illicit opioids and its replacement.

4) **People experiencing opioid withdrawal have a reduced aversion to risk.** It is well-documented that the symptoms of opioid withdrawal range from extreme discomfort to acute pain and trauma. The motivation to reduce these symptoms is powerful, and leads people to take risks they would not otherwise assume but for the need to escape the sensation of withdrawal.[11] Such risks are wide-ranging; for example, they can include engaging in criminal activity to obtain funds for drugs, patronizing new drug merchants with uncertain reputations, using replacement substances of unknown quality, perhaps using them by a new and unfamiliar route of administration, or engaging in

unprotected, risky sex. In our model, we posit that one of the risks a person will be less averse to is consuming a replacement opioid supply of an uncertain potency.

5) **Efforts at self-treatment after a police opioid seizure can also increase risk of overdose.** If a person loses their supply of opioids and begins to experience withdrawal, they may seek sedatives or other substances to alleviate symptoms until they can resume opioid use or fully detoxify, such as by taking prescribed or illicit benzodiazepines. This alternative poses its own set of risks. Benzodiazepines compound the respiratory depression of opioids, and can cause overdose if they are consumed together or in close succession.[12] Moreover, the illicit market for sedatives has been heavily compromised by counterfeit pills, introducing the dangers of uncertain dosing discussed above.[13]

There is also an ancillary factor that plays a role in the model**: the margin of error for correctly dosing fentanyl and other powerful synthetic opioids is very small**. The challenge of safely dosing illicitly-supplied fentanyl is driving the present wave of the nation's overdose epidemic,[9,10] since a comparatively small difference in the volume of this powerful synthetic in a given dose, or its presence in other substances, can spell the difference between safe use and overdose for many consumers. Not only does dosing vary by supply source, merchant, and batch (given the *ad-hoc* means of preparing and packaging drugs for smuggling and consumption), but for any unit of difference in the amount of opioid in a supply, the dose is going to be much more potent if it is a unit of fentanyl than some type of less potent alternative. We consider this an ancillary factor because the model suggests people whose supply of illicit opioids are interrupted by a police seizure will suffer an increased risk of fatal overdose regardless of the type of opioid involved. Rather, highly potent synthetic opioids such as fentanyl greatly increase the magnitude of this risk because any given unit of inconsistency represents a much greater variance in potency than the variance per unit found in heroin or pharmaceutically produced analgesic pills.

The causal model

Our model proceeds through the eleven parts presented in **Figure 1** as follows. The figure's solid arrows represent causal relationships with no alternatives in the model, and the dotted arrows represent possible branches. Green arrows signal ways to lower risk, and red signals a pathway to elevated risk.

Parts 1 through 4 present the basic stasis of consistent supply for people who have transitioned from opioid use to a state of dependence. A person with opioid dependence **(1)** exhibits increasing physical and psychological dependence on opioids **(2)**, as well as an increasing pharmacological tolerance for the effects of the drug **(2)**. As their tolerance increases, the general consistency of their supply **(3)** allows them to adjust their dose accordingly. There is still risk to this behavior, including instances of polydrug use that can introduce unpredictable variables and the inherent instability of an illicit drug supply, but this general consistency in

comparison to a seizure event means that the person's opioid supply is not exceedingly difficult to dose as needed, thereby reducing overdose risk. Overdose may still occur, but it is comparatively more likely to be nonfatal **(4)**, or imprecise dosing may not be sufficient to alleviate withdrawal and lead to the risks that arise from repeat dosing **(4)**. The result is the continued cycle of opioid dependence as described above. People may age out of this cycle over time, in which case they would leave the model by ceasing use by completing the withdrawal period and not re-initiating use, or by entering treatment **(5)**. It is worth noting that most people who are dependent on opioids do not overdose, and are not lifetime users, but rather age out in this way.

For the person actively dependent on opioids, the path toward an elevated exposure to fatal overdose begins with the type of supply interruption that results from a police opioid seizure **(6)**. The interruption could be the result of an arrest of the person, or their supplier; either event deprives the person of the opioids necessary to maintain their cycle of use and suffices to bring about the physical effects of involuntary abstinence: withdrawal and decreased tolerance **(7)**. These effects produce efforts to avoid withdrawal with a new opioid supply or self-manage it using sedatives or cannabis combined with reduced aversion to the risks associated with consuming these substances **(8)**. The result is seeking a replacement substance of uncertain potency, especially if it is from a new dealer, although this variance is ultimately dependent on the structure and sources of the community's drug supply network **(9)**. Consuming the replacement supply occurs at the nexus of two risk factors and a catalyst: a reduced but indeterminate tolerance to opioids, an uncertain potency that precludes accurate dosing (compounded by not knowing what that dose should be in light of lowered tolerance), and the reduced aversion to risk that comes with avoiding or escaping opioid withdrawal. This reduced aversion means that even if a person apprehends the pending hazards, they will disregard them, and/or engage in the additional risk behaviors described in the next section. This results in a significantly increased exposure to the risk of fatal overdose **(10)**.

At any point in the model, a person can attempt to enter treatment, and if it was effective, they would leave this causal pathway. A return to use, however, will place them back in the pathway at **(9)**, facing overdose risk. Whatever motivated this return to use necessarily made them less averse to the risks of opioid dependence, their new drug supply will be of an unknown potency, and their tolerance will be significantly reduced by some indeterminate amount, so it may affect them in unknown ways. This accords with research that a return to use after a period of abstinence poses an elevated risk of overdose compared to the risks a person faced if they were consistently supplied when they were dependent on opioids. The model as related here is therefore neither directed, nor acyclic. People can remain in a basic stasis given a consistent supply of opioids, although escalating frequency and volume of use as dependence and tolerance increase, and treatment can either remove them from the cycle entirely, or, with a nonfatal relapse, can return them to the provisional stasis expressed by steps **(1)** through **(4)** of the model.

[Figure 1 about here]

Other behavioral responses to police drug seizure

Our model is principally driven by physiological factors. For example, reduced aversion to risk arises from the need to limit acute physical withdrawal symptoms. There are other behavioral factors, however, that emerge from a risk calculus that is not physical in the proximate sense. Rather, they result from decisions meant to reduce the probability of additional supply interruptions by police, and tactics to reduce or reverse the withdrawal that leads to riskier behaviors on their face. We describe five of them here but note that they fit our model only as adjuncts to the primary causal process described above.

- **Use in private places** In order to avoid the attention of police, especially when a prior seizure was the result consuming drugs in public, people who use drugs may shift to doing in more secluded or private places, such as indoors, in tents, or in vehicles. Using in private spaces decreases the likelihood that someone who is overdosing will be discovered and revived in time to avert death or irreversible injury.

- **Using alone** Regardless of whether the person is using in public or not, solitary use increases the risk of overdose. Many people use alone to protect themselves from exposure to police or to limit their visibility to other people, who may call police or otherwise express the stigma associated with drug use. When someone is in withdrawal, using alone may be a response to the need for rapid abatement of physical symptoms, which can increase risk-taking behavior.

- **Electing not to keep naloxone on hand** In the aftermath of police opioid seizures, PWUD and their associates may believe carrying naloxone or its presence at the location was one of the factors that elevated the suspicion of police and led to a seizure.[14] If that is the case, PWUD may elect not to have it on hand in the hopes of averting future seizures. Doing so creates the risk that it will not be available to avert a fatal overdose.

- **Rushed consumption** If a person believes they have no option but to consume drugs in public, but a prior seizure leads them to fear police intervention, they may rush the process of consumption, which runs counter to the harm reduction adage of "going slow." When consuming a new supply of drugs, a user can test a small quantity of the substance and then adjust the dose as its potency becomes clear, but rushed consumption increases risk as people use a larger amount sooner, either to avoid arrest or to abate withdrawal.

- **Hesitance to seek help for an overdose** People present at the scene of an overdose may be hesitant to seek help if it ultimately means calling 9-1-1, for fear that police will respond and make arrests. People in recent contact with police that resulted in a drug seizure may likewise hesitate to seek help when they witness an overdose or call 9-1-1 if

they witness one, out of the fear of arrest and another drug seizure. This may lead them to hope the overdose passes without turning fatal rather than try to reverse it. When they do call, people may downplay or obscure the fact that an overdose emergency is occurring.[15] Although this may result in medical personnel being dispatched without police, it may also delay the administration of naloxone of police officers who were poised to arrive first,[16,17] elevating the risk of death or serious morbidities.

Implications for policy and practice

The model presented here allows us to examine the points at which overdose risk can be averted or reduced. We present them along a general arc from the interventions that are likely to be the most feasible and acceptable given the present policy environment to the ones that would require more significant shifts in norms, laws, and culture. It is likely that the interventions requiring the most significant shifts may be the ones that offer the greatest potential to reduce the overdose risks described by this model. In sum, these interventions work by either preventing the move from risky use **(10)** to fatal overdose **(11)** by shunting people back toward a comparatively safer stasis or better equipping them with safe supplies **(1-4)** by referring them to medications to treat opioid dependence **(5)**, or moving further upstream and preventing disruptive supply interruptions **(6)** in the first place, promoting the ability of people with opioid dependence to consume drugs with a greater level of safety and consistency prior to entering treatment **(5)**, which is in and of itself a possible intervention. Another possibility is that a person will eventually desist from substance use over time, as most people with problematic opioid dependence will not die over an overdose, but eventually age out of it. Given this approach, the following are possible changes to police any practice that would prevent, interrupt, or reduce overdose risk related to opioid seizures.

Cautionary publicity about police drug seizures, especially notable incidents

Official acknowledgement that police drug seizures can increase risk of overdose would alert people dependent on opioids to the impending hazards and empower them to better manage the risks. Such an acknowledgment could also pave the way for warnings about particularly notable seizure incidents. For example, public officials in Manchester, New Hampshire issued a warning to the community that police had made a significant high-level drug seizure, and deployed overdose response teams to the area concerned as a protective measure, emphasizing both harm reduction measures and linkages to MOUD.[18,19] In doing so, they explicitly cited the Ray, Korzeniewski, Mohler, Carroll, del Pozo, Victor, Huynh and Hedden [2] study that associated police drug enforcement with increased overdose. Such public measures remain rare, however, since they hinge on the still counterintuitive recognition that police drug seizures, despite the goal of reducing harm, can have the proximate effect of increasing them.

Linkage to MOUD

Linking people with opioid dependence to the medications that can effectively treat it interrupts the pathway to overdose by removing the risks associated with consuming illicit opioids of any potency.[20] In our model, it forecloses overdose risk by statically positioning the person at step **(5)**. It does not, however, address the risks faced by people who are pre-contemplative about treatment and seek a replacement supply as withdrawal sets in, which will be most of the population of concern at any given time. Moreover, as our model reflects, relapse from treatment back to substance use places a person at elevated risk by moving them through the model to **(10)**, as a person will resume substance use with a supply of unknown potency and a diminished but unknown tolerance as discussed above. Linkage to MOUD also requires that there be sufficient and immediate access to medications in the aftermath of a seizure.

Despite these limitations, linkage to MOUD in the aftermath of a police drug seizure will remain an appealing policy option because it is the least contested and controversial response: it signals a person's efforts to make a decisive change in their own exposure to overdose risk that is less susceptible to the stigma and biases that typically accompany harm reduction efforts and legal reforms. Despite this appeal, as a response that intends to prevent overdose and save lives, linkage to MOUD will not offer protection to most people whose drug supply is interrupted by a police opioid seizure. Even the most robust, low-barrier linkages to MOUD will only impact people who actively seek out the medication or engage with the treatment that is offered to them. This is a small minority of the at-risk population of PWUD at any time, most of whom are not contemplating treatment and would not accept MOUD if it were offered to them. In terms of the Stages of Change,[21,22] the intervention does not reach PWUD who are in a state of precontemplation, i.e., the majority of PWUD at a given time.[23,24] The interventions below fill the resulting gap, as illustrated in **Figure 2**. This suggests an effective response should be a comprehensive one.

[Figure 2 about here]

Community naloxone distribution

While the distribution of naloxone to lay persons in the community for the purposes of layperson overdose reversal has widespread political and cultural acceptance, it depends on saturating at risk communities with a quantity of naloxone substantial enough to reverse a meaningful number of overdose events. Success in this regard would require a large, sustained investment in naloxone programs targeted to PWUD. At the individual level, it would interrupt the model when two conditions are satisfied: a person uses drugs in the presence of someone who abstains from risky drug use or coordinates their use to prevent simultaneous overdose, and that person has access to, or can summon a bystander with naloxone. This intervention moves people from instance of dangerous use **(10)** back toward stasis **(1-4)**.

Access to harm reduction services and education

Harm reduction interventions would directly supply people dependent on opioids with naloxone and the knowledge necessary for its effective administration, reducing risk in doing

so. As people in drug-using communities facing greatly elevated overdose risks, this manner of naloxone distribution has the potential to be more effective than widespread distribution or distribution to first responders.[25] Harm reduction services can also offer education and training about the importance of "going slow" (i.e., not rushing consumption), and not consuming drugs alone, while innovative measures include prescribing medications such as single-dose buprenorphine[26,27] or using cannabis or sedatives as a temporary form of withdrawal support, thereby reducing the risks that come with withdrawal-motivated behaviors. Together, these interventions can reduce the probability that a person proceeds from step **(10)** of the model to fatal overdose **(11)** by shunting them back toward comparative stasis **(1-4)**. Harm reduction services can also provide people dependent on opioids with linkage to treatment **(5)**.

Drug checking services

Analyses of the composition of drugs performed by community drug checking programs can likewise reduce overdose risk by providing reliable information about what a replacement substance may contain.[28] They may be especially useful if a person resorts to a replacement substance such as opioid pills, or non-opioids such as benzodiazepines for the purposes of managing withdrawal symptoms before resupply, both of which are likely to be counterfeit and contain unpredictable amounts of fentanyl. As with other harm reduction services, the knowledge gained from drug checking could be leveraged to promote safer use behaviors, which can move people from steps **(10)** to steps **(1-4)** rather than **(11)**.

Overdose prevention centers

Places where people consume drugs under supervision and are revived if they overdose, offer the potential to eliminate the risk of fatal overdose after a person with a reduced, uncertain tolerance uses drugs of uncertain potency. As with other harm reduction services, the user is fully exposed to the risks of supply interruption as a result of seizure **(10)** but mitigates them by preventing what would otherwise be a fatal overdose **(11)** either through an effective reversal, or preventive measures, moving the person to point **(4)** in the model. Similar efforts may also reduce risk through remote observation, such as via phone, app, biometric sensors, or motion detectors.

Decriminalization of drug possession

Attempted in Oregon 2021 and subsequently reversed in 2024, decriminalization would partially mitigate the hazards of a supply interruption **(6)** for people dependent on opioids. It would do so by preventing or limiting the duration of the supply interruptions that occur when a user is arrested for possession and detained or possibly incarcerated. It would not, however, prevent the interruptions that come from the apprehension of drug sellers and the seizure of their inventory. In this way, successful decriminalization programs that still enforce laws against drug dealing like the one implemented in Portugal would not eliminate the risks of our model. Rather, they would lessen incidence of personal drug seizures, and the duration of supply interruptions from incarceration, thereby lessening symptoms of withdrawal and

reductions in tolerance **(7)**. The Portuguese system of decriminalization also offers immediate, no-cost linkage to medications that treat opioid dependence **(5)**, lowering the risks of a supply interruption through that pathway as well. The very low rate of overdose in Portugal, where heroin rather than fentanyl remains the principal source of illicit opioids, may support the hypothesis that the severity of the overdose risk described by our model is greatly increased by fentanyl, its great potency, and its small margin of error in dosing.

Safer supply

The consistent and uninterrupted provision of opioids of known potency to people with opioid dependence, such as analgesics or pharmaceutically manufactured heroin,[29] could limit overdose by keeping people in comparative stasis **(1-4)** rather than subjecting them to supply interruptions **(6)**. While some Canadian jurisdictions have embarked on such an initiative, the programs have high barriers for enrollment and serve small numbers of clients, limiting their ability to reduce the overdose risk resulting from drug seizures in the larger population. The rationale for safer supply also suggests that our model may see fewer overdoses if the illicit opioids were the pharmaceutically produced analgesics that were the origin of the present opioid epidemic, although erratically dosed counterfeit pills, which have proliferated throughout the illicit opioid market, would likely confound such a reduction.

Legalization and regulation

As with safer supply, legalization and regulation would bring the manufacture of recreationally used opioids under a regime that would closely monitor their consistency and potency and provide a means for commercial distribution that would preclude dealer-related supply interruptions. This would do two things: prevent the supply interruptions arising from police drug seizures in the first place **(6)** and ensure that the drugs consumed by people were regulated to the extent that their potency was consistent and well-known, regardless of whether a user experiences some type of interrupted supply or not **(3 or 9).**

Legalization, especially when accompanied by safer supply practices, would also likely lessen the circumstances in which people experienced withdrawal and reductions in tolerance due to extended supply interruptions **(7)**, providing several means to escape the causal pathway from a supply interruption to fatal overdose. It would also likely decrease the frequency of several other behaviors that contribute to overdose risk, such as rushed use, clandestine use, and variance across suppliers and between batches. It is critical to note that all of this is said without regard to the political reality that legalization is the least likely of the drug policy interventions discussed here to be implemented, due to a pronounced lack of political and cultural acceptance of the idea.

Discussion

The extent to which police drug seizures impact the broader community in terms of the availability and consistency of the drug supply is ultimately unknown, likely to be highly dependent on local contexts, and deserves further study. We do know, however, that police opioid seizures certainly affect the person the drugs are taken from, and their direct connections, and our model explains the elevated overdose risk that results. The strength of this model lies in its reliance on well-known features of opioid dependence and withdrawal, and a well-established understanding of certain basic mechanics of the illicit drug market. That people who consistently consume opioids will experience increasingly acute dependence and greater tolerance is not open to debate, and neither is the intense desire—or physiological need—for people dependent on opioids to avoid or mitigate withdrawal, which is a known motivator of risky behavior. The same can be said of the decreased opioid tolerance that comes from abstinence, whether voluntary or involuntary. The inconsistency in the potency and contents of the illicit drug supply in the case of heroin and fentanyl are also well-established, which underlies the main argument for safer supply initiatives.

In showing how these factors come together, the model moves from anecdotal accounts and quantitative research to a logic model that illustrates the causal chain between a drug seizure, the ensuing supply interruption, and increased exposure to overdose, underwriting our prior spatiotemporal analysis of the association between the two. If the four premises presented at the outset of this paper are correct, then they are sufficient to establish the validity of the model. It is important to recall that this validity does not depend on an actual increase in fatal overdose, but an increase in its risk, which can then be reduced by taking the appropriate precautions. We posit that many fatal overdoses occur because the desire to avoid withdrawal in the aftermath of a supply interruption is very strong, and often the reason people do not take the recommended precautions. The behavioral factors we present here complement the formal model by further exacerbating this risk, but the model does not depend on them for its validity.

Despite such strengths to our model, it has limitations that call for both caution and further research. Although it is an ancillary aspect of or model, we do not know how much elevated overdose risk arises not just from general variance in the composition of a replacement opioid supply, but the variance of fentanyl and other highly potent synthetic opioid supplies in particular. The makeshift production processes employed by the illicit market, which can take place in private residences and other crude, repurposed spaces, is far removed from a proper pharmaceutical manufacturing operation, resulting in variance in the volume of the active opioid per dose. We hypothesize that compared to pharmaceutically produced and heroin-based opioids, powerful illicitly packaged synthetics such as fentanyl are inherently more difficult to safely dose, since even the smallest variations in the volume of the active opioid could yield great differences in potency.

It is also worth noting that the model presented here only considers the near-term effects of police drug seizures. The quantitative work that motivated this paper considers overdose up to three weeks after a police drug seizure, and the model is meant to provide a causal explanation for events on this time horizon. It does not examine the long-term effects of drug

seizures on a community, especially large ones that might have a more significant impact on the drug market. So, while we are unaware of any police drug seizure that was significant enough to have a durable effect on the price and/or availability of illicit drugs in the US, our model is not meant to describe mid- to long-term effects. It therefore cannot rule out the possibility that drug seizures of a size and type sufficient to cause a sustained supply shortage may foreclose the induction of new drug users, or promote treatment seeking among existing users, therefore lowering the community's overall rate of opioid dependence, or the extent to which this may offset the negative effects we describe here at the population level. Given the constant occurrence of police drug seizures across the nation, and the persistence and worsening of the overdose crisis, we would hypothesize this population level effect is minimal in comparison to the elevated risk of overdose.

Relatedly, as a model that draws on data from urban centers, it is unclear how the overdose risks our model produces could be exacerbated or reduced by seizures in rural areas. The considerably greater distances and smaller populations involved in rural illicit drug distribution may matter. They could relate to longer timeframes for resupply that increase withdrawal symptoms with reduced access to harm reduction resources, or it may increase the likelihood that a replacement substance comes from a different supply chain with an inherently different or more volatile potency. Conversely, the tight-knit nature of small rural populations may yield more transparency and trust across dealer networks. More research is necessary to understand how geography affects the model.

This analysis does not adjudicate the competing priorities that drive narcotics enforcement and police drug seizures in many communities. There may be reasons for enforcement and the accompanying seizures that communities and their elected officials find compelling despite their iatrogenic effects. For example, police seizures might provide a way to reduce serious violence between competing drug suppliers, or a drug selling operation may have a significant negative impact on the public order of a neighborhood, and there is a strong desire among community members for the police to reduce or eliminate it. The role of policies and laws in addressing these issues—or failing to do so—is complex and far beyond the scope of this paper. What our model does do, however, is suggest that there may be serious negative health outcomes associated with law enforcement to address these concerns, even though the approach may have community support, and be culturally ingrained in our approach to problematic substance use. If that is the case, it is incumbent upon communities to account for these outcomes. It is counter-intuitive that drug seizures can increase overdose risk, making the public's recalcitrance understandable, so the causal model discussed here may offer a critical means to shape future support for evidence-based drug policy proposals.

Finally, our causal model does not necessarily depend on policing to yield its exposure. In theory, an any abrupt supply interruption could be the triggering event that sets PWUD on the pathway to increased overdose risk, as described by our model. The fact that policing routinely creates the necessary conditions, indeed by design, and that they occur with such great frequency, is what makes the proposed model a critical component of understanding how

policing exacerbates the health risks faced by people with opioid dependence. Release from a period of incarceration is a prime example of another event that substantially increases risk of overdose,[30,31] and researchers have presented the corresponding causal framework [32], while emphasizing the particular role of fentanyl in generating these overdoses.[33] We therefore invite others to explore the ways in which our model can be generalized beyond police settings, or contrasted with other models, but policing is our focus here.

Conclusion

The model presented here contributes to the body of knowledge about how criminal justice interventions intended to address the effects of addiction and overdose can have iatrogenic consequences that worsen health outcomes of people dependent on opioids. In the case of arrest and imprisonment, the moral consequences of punishment are meant to be complemented by a period of detoxification and abstinence. In practice, we have seen this is neither an effective way to promote recovery, nor safe for the people it is imposed on: release from jail or prison is believed to be the period of highest overdose risk for people dependent on opioids [32]. By the account here, drug seizures by police, whether they are from an individual who possesses drugs for personal use or someone with large quantities intended for distribution, comprise a mechanism that increases harm rather than reduces it. It is critical that future research continues to explore this outcome, assesses its prevalence across settings, estimates the magnitude of the effect, discerns which variables are protect against risk, and brings greater clarity to the risks imposed at the individual and community levels. Regardless, if research continues to exhibit a positive relationship between seizures and overdose, legalization and regulation of opioids would broadly incentivize the drug market to reduce or eliminate products of uncertain potency, decisively lowering the overdose risks resulting from uncertain dosing, as well as moderate the risky behaviors that result from the fear of drug seizures. Legalization, however, has yet to be even a remotely feasible political possibility in the United States. It is likely that police drug seizures will remain a core feature of our response to illicit substances, and that such enforcement efforts will intensify, as zero tolerance policies for drug possession hold perpetual appeal in communities that hope they will reduce risk. To safeguard health, it is critical that we understand the full range of consequences for these and other policies based on police drug seizures.

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Figure 1. The causal pathway from opioid dependency to fatal overdose following a police opioid seizure

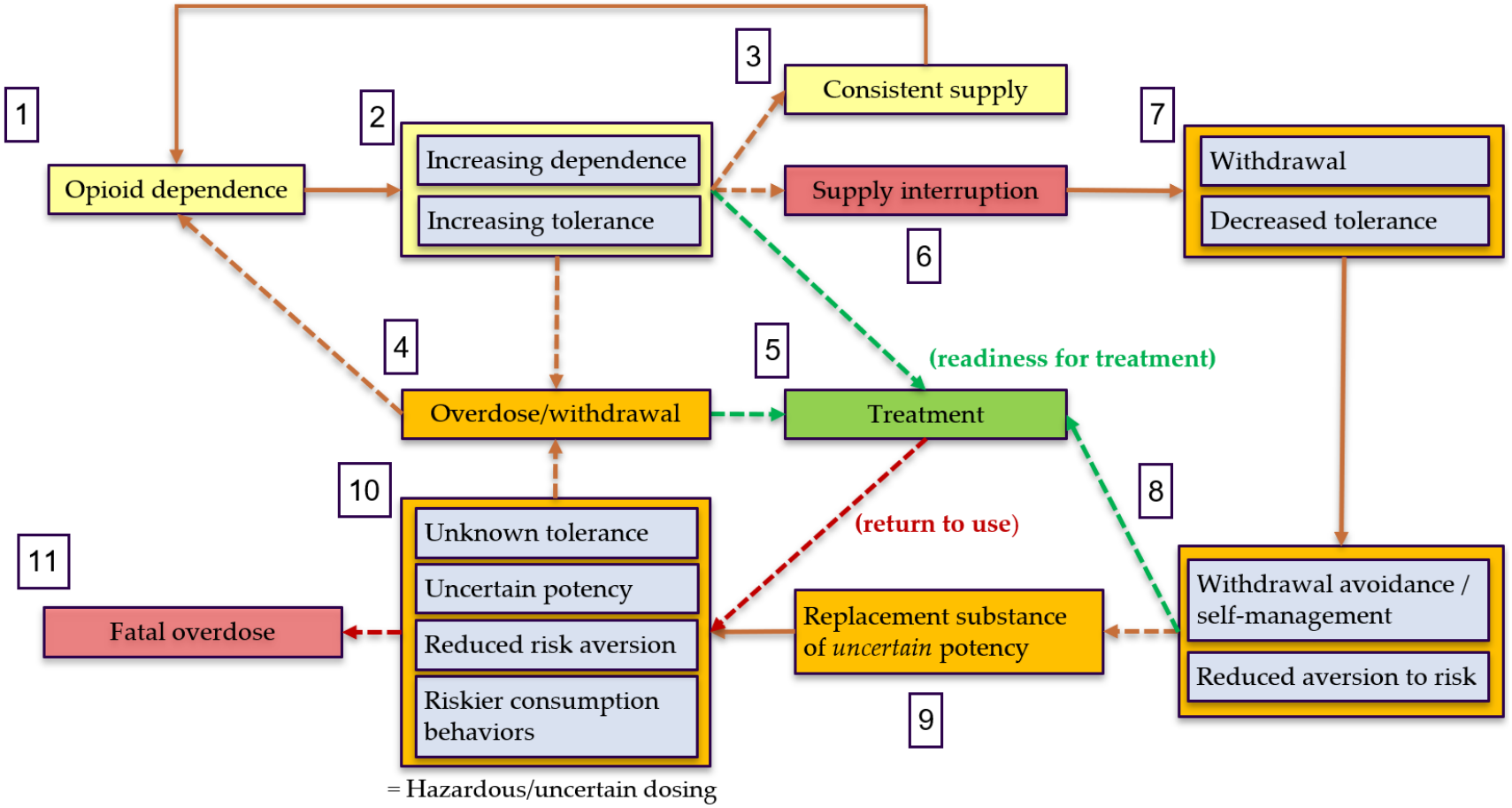

Figure 2. Interventions to prevent overdose in the aftermath of a police drug seizure mapped onto the Stages of Change