

## Commentary

## Virtual overdose monitoring services and overdose prevention technologies: Opportunities, limitations, and future directions

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## ABSTRACT

Overdose mortality has continued to rise in North America and across the globe in people who use drugs. Current harm reduction strategies such as supervised consumption sites and naloxone kit distribution have been important public health strategies implemented to decrease the harms associated with illicit drug use however have key limitations which prevent their scalability. This is represented in statistics which indicate that the vast majority of overdose mortality occur in individuals who use drugs by themselves. To address this, virtual overdose monitoring services and overdose detection technologies have emerged as an adjunct solution that may help improve access to harm reduction services for those that cannot or choose not to access current in-person services. This article outlines the current limitations of harm reduction services, the opportunities, challenges, and controversies of these technologies and services, and suggests avenues for additional research and policy development.

## Introduction

North America's overdose crisis reached new heights during the COVID-19 pandemic with rates of fatal overdoses increasing by 96% across Canada and 60% in the United States since the beginning of the pandemic (Ahmad et al., 2023; Public Health Agency of Canada, 2022a). While many factors may have contributed to this increase, recent evidence suggests using drugs by oneself, i.e., alone, and barriers to accessing harm reduction services may be key drivers (Hu et al., 2022; Palis et al., 2022). Despite these high numbers, among those accessing in-person harm reduction services, 50% (n=15) report using substances by themselves often or always (Tsang et al., 2021).

Harm reduction, defined as "supporting measures that reduce the negative consequences of drug and substance use", is a key part of Canada's four-pillar drug and substance use strategy (Health Canada, 2016). Interventions including education on safer consumption of substances, supply of sterile equipment, supervised consumption sites, and distribution of naloxone kits have been successful in decreasing the morbidity and mortality related to substance use (Canadian Research Initiative in Substance Misuse (CRISM), 2019; Potier et al., 2014). Physical harm reduction facilities including supervised consumption services (SCS), their mobile counterparts, overdose prevention sites along with needle and syringe programs have been a valuable resource for people who use drugs. They do this by providing timely intervention in the

event of overdose, improving access to care, preventing transmission of blood-borne illnesses, and providing a protective space away from violence and criminalization (Ivsins, 2022; Levensgood et al., 2021). While no longer considered harm reduction in many circles of medicine, opioid agonist treatment is an additional intervention that has also been impactful in reducing overdose deaths (Santo et al., 2021).

*What are virtual overdose monitoring services (VOMS) and overdose detection technologies?*

More recently, overdose detection technologies and devices have emerged as an adjunct to current harm reduction practices to promote access to supervised consumption and reduce the harms associated with solitary use. These services include smartphone-based virtual overdose monitoring services (VOMS) (which include smartphone application and hotline-based services), wearable naloxone injectors, reverse motion detectors, and overdose prevention buttons (Lombardi et al., 2023). Within harm reduction facilities such as SCS, harm reduction housing sites, and opioid clinics - physical overdose detection technologies have recently been implemented to enable more rapid intervention during overdose events (Lombardi et al., 2023). Due to their need to be implemented within facilities, and requirements for onsite staffing to respond to an overdose event, they have many of the same limitations as other harm reduction services reducing their scalability.

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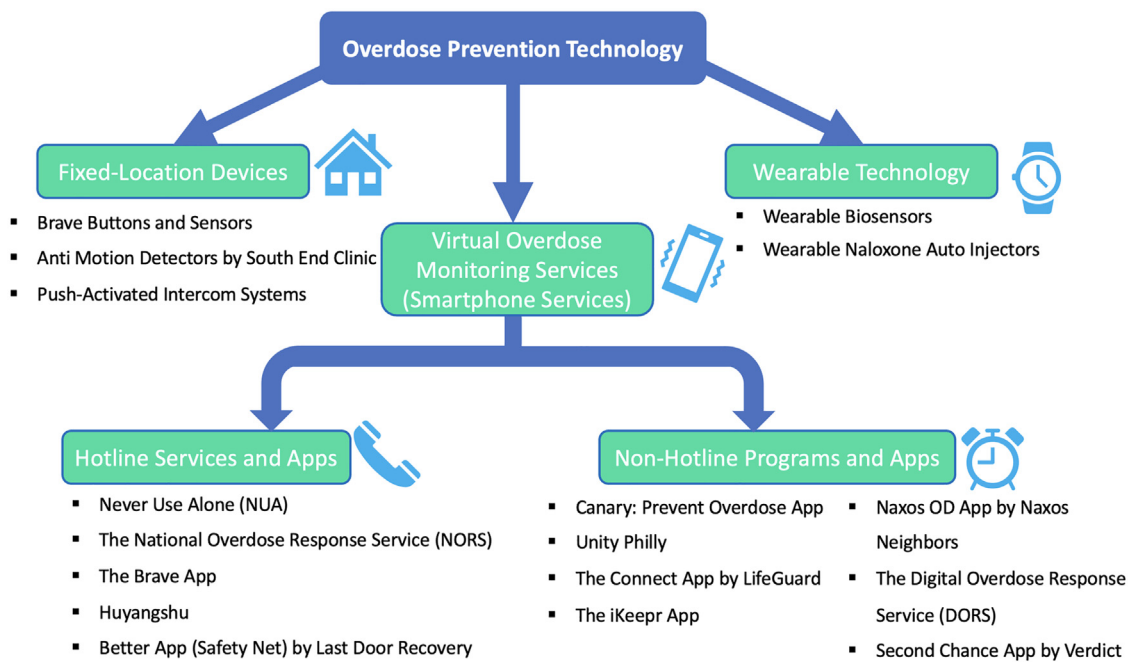


Fig. 1. Overview of various overdose prevention technology including fixed location devices such as buttons and reverse motion detectors, wearable biosensors and naloxone autoinjectors, and smartphone or phone-based services providing virtual overdose monitoring.

VOMS, unlike physical or stationary overdose detection technologies, provide access to harm reduction services for anyone with a phone and cell service and do not necessarily require onsite support. Additionally, they build upon individuals' current access to technologies without the requirement for additional purchasing and installation. These services offer a variety of options for monitoring a substance use session including connection to operators with lived and living experience of substance use (i.e., peers) via hotlines, smartphone application-based timers, or a combination of the aforementioned strategies. These services are used in tandem with a drug use session to provide various overdose responses, including contacting emergency medical services or enacting a community-based response (ie: contacting a friend, family member, or bystander to intervene). Collectively, these services aim to: 1. Expand access to the benefits of harm reduction supports, 2. Reduce drug overdoses and when possible 3. Connect individuals to health and social supports (National Overdose Response Service (NORS), n.d.; The Brave App, n.d.). Fig. 1. depicts these various interventions and brief examples of current services.

Recently studied VOMS including the National Overdose Response Service and Unity Philly, demonstrate early effectiveness in reducing the harms associated with illicit drug use. Pilot data from the National Overdose Response Service indicates monitoring of 2172 substance use calls with 53 emergency responses, two false alarms, and no deaths in just over one year (Matskiv et al., 2022) while Unity Philly enabled more rapid naloxone administration by community bystanders (Schwartz et al., 2020). Additional services include the United States-based Never-Use-Along phone line (Never Use Alone Inc. -800-484-3731 n.d.), Brave mobile phone app (The Brave App, n.d.), LifeGuard's Connect (Powered by evan | A Digital Health Company, n.d.), Digital Overdose Response Service (DORS App, n.d.) and lastly, the BuddyUp app based in the United Kingdom (Jamie, 2023) but these services remain unstudied. The websites and various press releases from these services note high utilization and uptake with tens of thousands of clients and hundreds of thousands of uses (Matskiv et al., 2022; Mertz, 2022; Provincial Health Services Authority, 2022). VOMS also show moderate to high (54-76%) acceptability in people who use drugs (Tas et al., 2023; Tsang et al., 2021).

*How do VOMS and overdose prevention devices fit within the spectrum of harm reduction?*

As a tool to purely reduce overdose deaths, overdose prevention devices are limited in other aspects of harm reduction. They are directly focused on ensuring supervised consumption, and notifying individuals to intervene should someone become unresponsive. These devices however, do not necessarily provide the other key facets of harm reduction such as education, access to sterile supplies, naloxone kits, or connection to addiction treatment, and as such have many of the same limitations as other harm reduction interventions. VOMS on the other hand either directly or indirectly provide access to all these aspects of harm reduction. Much like physical harm reduction sites which encompass diverse elements of harm reduction, VOMS can work in tandem with current harm reduction strategies like providing education on safer consumption of substances, providing information on how to access sterile supplies and naloxone kits, as well as opportunities for treatment and opioid agonist therapy. VOMS are thereby an extension of existing harm reduction provisions, providing a unique opportunity to enhance the reach of harm reduction to various communities that may not have had access to these interventions previously. Most importantly, like overdose prevention devices, they can provide supervised consumption to individuals through technology. While not unique enough to be a new category of harm reduction, it provides a novel medium in which to support substance users by providing improved access to existing harm reduction strategies. Of the various potential harm reduction technologies available, VOMS in particular can also address some limitations that exist with the current landscape of harm reduction.

While more recent reviews describe both VOMS and overdose prevention devices (Donnell et al., 2022; Lombardi et al., 2023; Oteo et al., 2023; Tas et al., 2023; Tay Wee Teck et al., 2023), they do not discuss the potential benefits of these devices and services particularly for populations that do not currently access harm reduction due to various underlying factors including stigma and accessibility barriers among others (Matskiv et al., 2022). Closer examination and evaluation of these interventions are required to better understand their potential impact on overdose prevention, connection to treatment and resources, changes in

substance use behavior, and dissemination of public health information (P. et al., 2023). The purpose of this article is to provide an overview of the opportunities and challenges of VOMS and overdose prevention devices and provide suggestions on directions for future research and policy.

### Limitation of current harm reduction strategies and the potential for VOMS to mitigate them

Much like physical SCSs and needle and syringe programs which incorporate a variety of harm reduction interventions, VOMS also provides access to a variety of harm reduction strategies, albeit with some limitations. A complete table comparing both in-person and virtual services, how they complement each other, and how they differ is presented in Table 1. Further exploration on how VOMS, in particular, mitigates certain limitations of harm reduction broadly is expanded upon below.

#### Geographic, scalability, and access limitations, especially in rural and suburban communities

As previously mentioned, access to harm reduction supports remains a major challenge for many people who use drugs in North America. Drug overdoses disproportionately impact rural communities, which is in part attributed to the lack of harm reduction services available as well as difficulties in implementing these services in rural North America (Hu et al., 2022). These are secondary to factors such as limited funding, community support, and political will.

Harm reduction access is often limited to large urban centers and as a result, there have been calls for novel strategies to address access in rural jurisdictions (Bardwell & Lappalainen, 2021; Montaque et al., 2023). Indeed due to funding, stigma, and political limitations discussed below, there are relatively few harm reduction programs within rural locations (Montaque et al., 2023). For example, the effectiveness of the naloxone kit distribution has been well-researched but is limited as distribution remains underdeveloped in various parts of North America including rural communities (Irvine et al., 2022). Moreover in Canada, the vast majority of individuals using substances do not access SCS. It is estimated that 269,000 citizens self-reported the use of opioids for nonmedical purposes within the past year (Canadian Center on Substance Use and Addiction, 2022). In contrast, SCS has served only 35,000 unique individuals between 2017 and 2019 (Public Health Agency of Canada, 2022b). This would indicate that less than 15% of the Canadian population at risk of overdose have accessed SCS. This may be in part attributed to the limited therapeutic radius provided by these services as an observational study evaluating Insite in Vancouver, British Columbia [28] indicated that the effectiveness of the SCS in reducing overdose rates was only statistically significant within a 500m radius of the site (Marshall et al., 2011).

Interestingly, based on previous research indicating that at minimum 45% of individuals who use substances in Canada have functioning mobile phones (Tsang et al., 2021), the estimates around the potential reach of these services could be up to 150,000 additional individuals who may not necessarily be accessing harm reduction resources. Fig. 2 illustrates the additional reach offered by VOMS in Canada. In the United States, the disparity of access to harm reduction is even more pronounced, as it is reported that 10.1 million people over the age of 12 use opioids non-medically, and many states outlaw harm reduction (Harm Reduction International, 2022). These disparities in access to life-saving services also extend to various low and middle-income countries around the globe (Harm Reduction International, 2022). There is a large potential for VOMS to improve this disparity, particularly for those who face intersectional health inequalities which pose challenges to accessing current harm reduction resources.

VOMS may also offer a long-distance gateway into the healthcare system through mental health first aid, trauma-informed care, peer support, and connection to trusted providers in their communities includ-

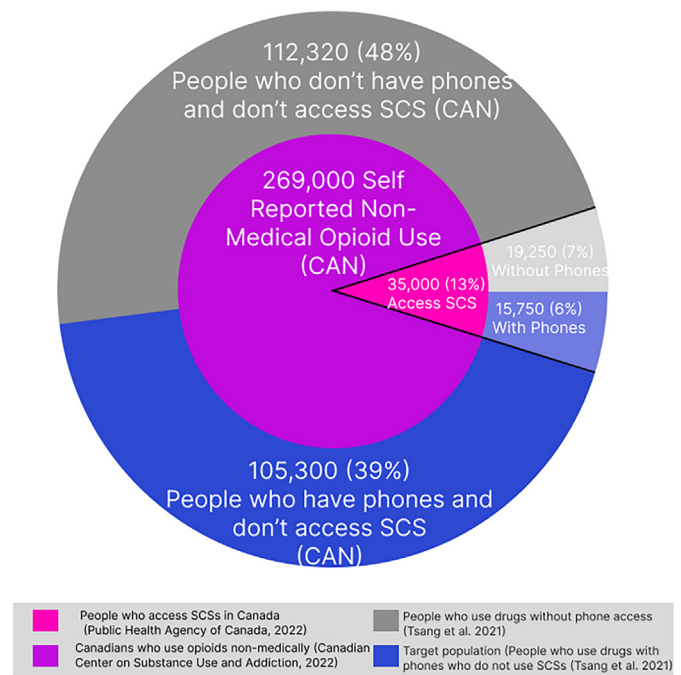


Fig. 2. Target population of VOMS in Canada.

ing addiction specialists, primary care supports, sexually transmitted and blood-borne infection testing clinics, and wound care (Perri et al., 2021). Connection to novel virtual treatment programs like Alberta's Virtual Opioid Dependency programs would ease transitions and remove barriers to addiction treatment programs (Day et al., 2022). In addition, the expansion of novel forms of harm reduction delivery such as Philadelphia's and France's mail-order harm reduction programs help to reach individuals who may be unable to access these services otherwise (Torres-Leguizamon et al., 2023). Furthermore, these services may help to build communities of geographically distanced people who use drugs, facilitating a collective voice to advocate on issues and decisions impacting their communities. While not yet studied, there may be additional benefits to VOMS such as those seen with peer-to-peer connections, which have led to reductions in infectious disease risk behaviors and reductions in substance use in communities (Satinsky et al., 2021).

#### Costs around harm reduction service provision

Acknowledging the therapeutic radius of physical SCSs are 500 meters, and the costs of these facilities being between \$1.13 - 2.26 million USD each, the scalability of physical harm reduction services while crucial, can be costly (Andresen & Boyd, 2010; Khair et al., 2022). These costs are similarly high for syringe service programs ranging from \$0.4-1.9 million USD. The ability to improve access to harm reduction in rural communities and scale various harm reduction strategies remains stunted by funding allocation and human resources needs. While five studies describe the cost-effectiveness of these interventions in reducing healthcare costs overall (Khair et al., 2022; Potier et al., 2014), the effectiveness of these services would likely decrease in areas with smaller populations of people who use drugs and may not be economically beneficial within smaller rural settings or low-density locations such as suburban communities. These financial barriers limit the expansion of harm reduction services particularly outside of urban areas (Montaque et al., 2023). While VOMS vary in development and operational costs, they have the potential to be a cost-effective and easily scalable resource by collectively providing services to multiple small communities throughout North America simultaneously.

**Table 1**  
Comparison of similarities and differences between harm reduction and virtual overdose monitoring services.

Potential Limitations	Current In-Person Harm Reduction Supports	Virtual Overdose Monitoring Services
<b>ACCESSIBILITY ASPECTS:</b>		
Geography for reducing drug overdose mortality	Limited supports in rural and sub-urban communities. Reduction in mortality efficacy with SCS restricted to 500 meters with a trend towards reduction up to 1000 meters (12)	Restricted by cellular/ mobile phone coverage
Hours of operation for some SCSs and harm reduction programs	Limited operational hours for many harm reduction services	All services operate 24/7
Stigma	Potential fear of recognition and repercussions associated with recognition	Anonymity provided through voice only interactions between client and operator or with automatic timer applications.
Technology Requirements	None required	Smartphone, Wifi, data, or telephone required to access these services
Populations supported	Individuals experiencing homelessness Individuals who do not possess a phone or access to data or WiFi (Tsang et al., 2021)	Further research on populations required however targeted populations based on mandates of these services include: Housed individuals using alone Rural and suburban populations Individuals who do not want to access physical SCSs Individuals who possess cell phones.
Routes of access	Harm reduction supports most often cater to injection routes.	No restriction on the route of choice for substance use.
Utilization by specific gender and cultural minorities	Varies based on service location and operation mandates. Statistics indicate women and gender-diverse individuals are less likely to access harm reduction	Further research is required, however preliminary data from NORS indicates the vast majority of users are gender minorities. Varies based on service and application.
<b>IMPLEMENTATION ASPECTS:</b>		
Exemptions are required for the establishment of harm reduction facilities such as SCSs.	Exemption is required by the Federal government for physical SCS (Example Exemption 56 required in Canada only)	As of yet within North America no exemption is required by government agencies.
Scalability of Services	Limited based on location availability, capital costs, operation costs, and staffing.	Easier to scale and spread using technology platforms.
Mitigation of Community and Political Opposition	Harm reduction facilities often face community and political opposition which limits the existing operation and potential scalability	More research is required however there is potential for decreased opposition due to anonymity provided by services through personal smartphones or telephones and individuals using in their own residence
Fear of police response and the criminalization.	While limited within facilities, policing outside facilities may impact service usage.	More research is required, however, potential police response to overdose may result in criminal consequences.
Regulation of operations and service	Most SCSs and Overdose Prevention Sites are regulated by the government or health authorities	No regulation is required as of yet.
Safety and efficacy	SCSs are highly safe interventions reporting no deaths on site.	Safety and efficacy have yet to get determined. Further research is required.
Cost	Physical SCS and Overdose Prevention Sites can be costly because of location, building/capital costs, staffing	Concerns remain around response times from Emergency Medical Services in rural and remote communities. Costs could vary depending on the technology used, data safety costs, and staffing. Studies have yet to report the cost-effectiveness of services.
<b>SERVICE PROVISION ASPECTS:</b>		
Naloxone administration	On-site immediate naloxone administration is provided	Further research is required however, overdose responses may be delayed based on response times which may result in increased mortality
Information around Education and Prevention	Provided on site but may not reach hidden populations	Provided via app or peer to peer discussion and may reach hidden populations.
Access to Additional Resources including treatment	Referrals to additional support provided on-site	Referrals to additional support provided through peer-to-peer discussion or on the app interface including opioid agonist treatment
Access to social supports such as housing, income support, identification, and food security.	Access or referral is provided on-site by most SCS services.	Referral pathways around resources can be established through both phone and digital app-based platforms.
Testing of sexually transmitted blood-borne pathogens (HIV and Hep C) and access to additional resources such as wound care.	Provided on-site by most harm reduction services	Cannot be tested virtually but referral pathways can be established and leveraged.
Distribution of sterile supplies and naloxone kits	Distributed on-site and through outreach	Not easily distributed but referrals to where these can be obtained are provided.
Peer-based support	Is offered in most SCSs	Offered by select services including NORS and BRAVE and Never Use Alone.
Provision of wound care and onsite medical support	Offered by most SCSs	Referral to these services is required given the virtual platforms.

### Routes of administration

Access issues additionally extend to the preference of route of administration for people who use drugs. The vast majority of supports around substance use are geared towards injection routes of use. However, evidence from a harm reduction client survey suggests that approximately 69% of opioid users in British Columbia prefer to inhale or smoke their

substances (Parent et al., 2021). Despite this, only 2 out of 39 (5%) SCS are sanctioned for inhalation across Canada (Public Health Agency of Canada, 2022b). This is a large limitation for many substance users in Canada who require inhalational facilities. All VOMS support inhalational substance users in the privacy of their residences, with the National Overdose Response Service reporting upwards of 38.9% of their callers using the inhalational route of administration (Matskiv et al.,

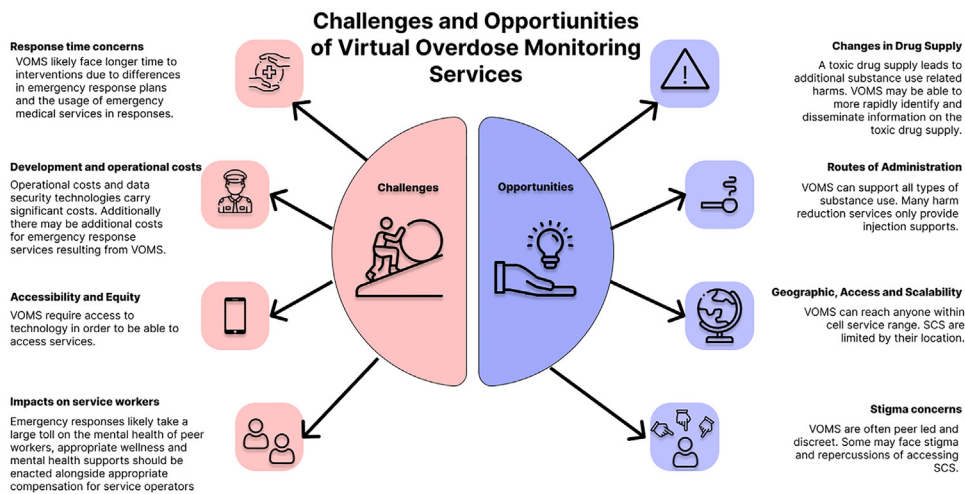


Fig. 3. Summary of opportunities and limitations of virtual overdose monitoring services.

2022). Therefore, VOMS can provide an important avenue to support individuals who use multiple routes of administration.

#### Stigma, gender, and political limitations

Another barrier to accessing harm reduction is the stigma and discrimination faced by people who use drugs. There continue to be perceived risks including stigma, loss of employment, and child custody which may dissuade individuals from accessing in-person services (Perri et al., 2022; Tsang et al., 2021). Physical SCS have offered gender minorities and other individuals a safer space to use substances compared to the streets where they face the risk of sexual assault and exploitation. However, they continue to face disproportionate rates of interpersonal violence and stalking behavior when accessing these facilities (Dunn et al., 2016).

Additionally, the implementation of physical harm reduction services or facilities often meets public opposition within neighborhoods (Yoon et al., 2022). There are significant political and legal issues surrounding North American differences in the implementation of harm reduction. This is secondary to “not in my backyard” mentalities and alignment with conservative government values (Allin & Manson-Singer, 2020). While these issues disproportionately affect North America, overdose deaths continue across the globe (Harm Reduction International, 2022). In many cases countries outside of North America and Western Europe have strict drug use policies, leaving little room for harm reduction strategies overall (Harm Reduction International, 2022).

Qualitative evidence indicates that VOMS may assist in overcoming barriers to supervised consumption on the basis of stigma and lack of comfort in using physical SCS (Perri et al., 2021). It can address current cultural and gender-based power imbalances through connection to appropriate peer and cultural supports (Perri et al., 2021; Tsang et al., 2021). Lastly, given the virtual nature of VOMS, there is likely to be less concern with political and public opposition in comparison to other harm reduction measures.

#### Changes in drug supply

Many harm reduction services grapple with an ever-changing drug supply. More recently, adulterants including benzodiazepines and xylazine have contaminated the drug supply, increasing the risk of overdose, especially for those using alone. There are additional consequences from these adulterants including soft tissue injury and fatal overdose deaths (Friedman et al., 2022). This reality has heightened the need for more innovative delivery of harm reduction, including virtual harm reduction supports with messaging regarding drug supply trends and consequences (Friedman et al., 2022).

The scalability and reach of VOMS may provide a unique opportunity to disseminate harm reduction education, particularly around changes to the drug supply, while also providing education on safer injecting and smoking practices. App-based services have been previously used to disseminate public health material, espousing education, and prevention materials, facilitating user decision-making self-efficacy, and providing guidance around naloxone use and other lifesaving interventions (Baldacchino et al., 2016). National harm reduction services also offer a unique opportunity to be able to monitor drug use trends from substance users themselves, while also transmitting drug alerts to clients in their jurisdiction in real-time across the country.

#### Limitations of VOMS and overdose prevention devices and their solutions

While one pilot study indicated that VOMS and overdose prevention devices may be an effective adjunct to current harm reduction services through their ease of accessibility (Matskiv et al., 2022), key limitations remain. Thus far literature in this field along with preliminary quantitative and qualitative research highlight constraints in accessibility, cost, equity, response times, quality assurance and safety, impacts on service workers, and legal and privacy barriers. These are all limitations of these services. A summary of the limitations and opportunities provided by VOMS in particular is illustrated in Fig. 3.

#### Accessibility, and equity barriers

One cross-sectional survey conducted within British Columbia’s harm reduction centers found that 45% (n=219) of people who use substances had reliable access to a cell phone, with 59% of those (n= 102) having access to the internet (Tsang et al., 2021). While VOMS may present an additional opportunity for some to access harm reduction services, nearly half would still not be able to access any overdose prevention services provided by either in-person or virtual overdose monitoring. Issues around cell reception in remote communities could also pose accessibility concerns. While this is a larger systems-based issue, investments in expanding mobile phone reception in smaller rural communities would help not only provide further support for substance users but also the general population, improving connectivity with their community. Phone use by proxy and word-of-mouth communication within communities may additionally offer an opportunity to connect with these services and their benefits.

There continue to be equity concerns around the costs of phones, data plans, and purchasing of equipment such as wearable devices, which could be prohibitive for much of the substance-using population. The provision of mobile phones, along with data cards would be one way

to support equity amongst vulnerable populations and consequently improve health equity (Kazevman et al., 2021). In addition to these costs of purchasing and maintaining buttons and reverse motion detectors can be equally expensive for various agencies which support substance-using populations to afford and implement.

#### *Response time concerns*

Discussions with current VOMS users and key community stakeholders suggest that issues related to emergency response times may be inadequate to prevent fatal overdoses, particularly in remote communities (Marshall et al., 2023; Perri et al., 2022). In some remote communities, emergency medical service responses are double those seen in urban centers (Mell et al., 2017). Given that these times may not be conducive to overdose resuscitations, service line workers and harm reduction services should examine alternative emergency response plans to allow for timely intervention such as nonmedical community-based naloxone responses by community-based organizations or by individuals such as family members or friends. For example, some services such as the National Overdose Response Service and Unity Philly utilize community responses involving friends, family members, or members of the general public to administer naloxone during an overdose (Ataia et al., 2021; Schwartz et al., 2020). In one study 59.5% of (n=74) lay-person interventions preceded interventions by emergency medical services by greater than 5 minutes (Schwartz et al., 2020).

#### *Development and operational costs*

While some aspects of VOMS can be cost-effective in regards to scalability, the developmental costs of smartphone-based services and overdose prevention devices can vary and pose challenges to their implementation. With data security being a large concern, encryption technology or other features to protect data collected from VOMS could in theory be costly, and appropriate measures would need to be taken to prevent online theft of sensitive information, especially for smart-phone based services. Phone line services such as the National Overdose Response Service and Never Use Alone Hotline, or physical devices such as reverse motion detectors do not require imputing personal information or data which helps circumvent some of these concerns.

Additionally, costs associated with false callouts by emergency medical services to overdose events could also be a hindrance to the implementation of these services. While early data from NORS indicates that only 2 false call-outs have occurred over the first two years of operation (Matskiv et al., 2022) continued monitoring should be undertaken to ensure that VOMS do not overburden emergency services.

Installation, maintenance, and recalibration costs for various fixed overdose prevention devices such as buttons and reverse motion detectors can also be continued barriers to their implementation. This is especially true when multiple devices are required per site. These costs may add up quickly reducing their affordability and scalability.

#### *Impact on service workers*

Lastly, some peer operators of VOMS who are responsible for supporting individuals using drugs (referred to as “spotters”) enact emergency action plans during an overdose event. These events result in a significant toll on the mental health of these individuals (Perri et al., 2021). While virtual burdens are described as less in comparison to physical overdose responses (Perri et al., 2021), operators should also be adequately emotionally and psychologically supported. Medical debriefings for adverse events and the provision of counseling and wellness supports can help avoid some of these concerns around mental wellness for service workers working and responding to both virtual overdoses and physical overdoses detected through technology. Given the complexity and responsibility of this work, proper worker compensation should also be provided to service operators. These considerations would likely be

limited to hotline-based VOMS (The National Overdose Response Service and Never Use Alone) in comparison to automatic timer-based services.

### **Controversies surrounding VOMS and overdose prevention technologies**

#### *Criminalization of substance use*

Criminalization of substance use has continued to contribute to barriers in accessing harm reduction services in addition to noncriminal societal repercussions. People who use drugs have raised concerns around the loss of child custody, loss of employment, confiscation of supplies and paraphernalia from authorities, as well as execution of arrest warrants which exclude individuals from the protection provided by the Good Samaritan Act (Marshall et al., 2023; Perri et al., 2022). These are continued themes that emerge from discussions around the feasibility VOMS (Perri et al., 2022; Tsang et al., 2021). Due to ongoing concerns around the criminalization of drug use, some VOMS users prefer to utilize their social connections instead of emergency medical services in the case of illicit drug overdose (Perri et al., 2021). Expanding legislation around the Good Samaritan Act to protect those with arrest warrants, as well as implementing legislation preventing police from attending overdose dispatches, and ultimately decriminalization of substance use could be key strategies to mitigate these concerns. For instance, a policy suggesting the prohibition of police from attending overdose events unless requested by emergency medical responders has been successfully implemented in Vancouver since 2006 and has contributed to a marked decrease in overall police call-outs to overdose events without increasing harm to medical responders (Mehta et al., 2021). Similar policies implemented in other jurisdictions could be helpful in furthering the impact of the Good Samaritan Act and would likely increase the utilization of VOMS. Other measures such as enshrined policy or signed contracts from police services recognizing VOMS as an essential health resource, and not charging individuals for using these services ensures continued protection of substance users and prioritizes their wellness.

Broadly, decriminalization would also reduce concerns around using VOMS. Decriminalization was recently passed in the Canadian province of British Columbia, allowing people to have personal possession of up to 2.5 grams of any illicit drugs, but has also been criticized for its low threshold (Ali et al., 2023). Portugal and Oregon, United States, have similar decriminalization policies in place (Rêgo et al., 2021; Russoniello et al., 2023). Through these actionable steps people who use drugs may be more likely to access VOMS and other harm reduction services without fear of criminalization.

#### *Quality assurance and safety*

With a variety of overdose prevention services and products being produced, formal mechanisms to ensure the quality of these services and their safety in case of technology failures are not yet in place. Much like other technology-based medical interventions, evaluation of their safety and ensuring appropriate standards are maintained is paramount to their long-term success. Technological failures with phone applications or other overdose prevention devices could have disastrous consequences for individuals using substances and cause liability concerns to agencies employing devices such as reverse motion detectors or buttons. Given the potential quality assurance and safety concerns with these devices and services, medical device licensing should be considered to ensure standards are in keeping with local laws and regulations. Undoubtedly, there may be additional legal concerns regarding responsibility and liability for these devices and services in case of product failures or adverse outcomes which could impact their utilization and broader implementation (Draanen et al., 2022). Additionally, with buttons and reverse motion detectors, false callouts, constant inappropriate

alarm ringing, or malfunctioning devices could lead to increased worker burden when responding to faulty devices.

### *Privacy, confidentiality, and data security*

Some VOMS require the addresses and locations of users to enact an overdose response. Given the criminality of substance use in some jurisdictions, there is strong concern about protecting this information. In health technology, there are additional barriers concerning how individuals will provide informed consent (Draanen et al., 2022). There are currently few guidelines around data collection for these services and how this data could be used or shared and may require regulation by the government or other regulatory bodies for these technologies similar to other healthcare devices and technology-based products. For instance, Electronic Medical Records in Canada are governed by the Personal Information Protection and Electronic Documents Act which ensures data protection. Extending this act to VOMS would be important in protecting this information from law enforcement and the judicial system, much like other health records. Ensuring data security and protection are optimized must be a key concern for every VOMS provider, to ensure they are adherent to local Health Information regulations. As VOMS are a life-saving device and service, other legislative opportunities include laws and policies that specifically protect VOMS users and their drug use information from police disclosures and charges. These laws should also be extended to attorneys who could use this knowledge to prosecute VOMS users as well. Mining this information for prosecution purposes undermines the service, and much like medical health records, this information is confidential, and explicit patient/user permission and informed consent must be provided before third-party access to this information is provided.

Other safety mechanisms like cloud storage could be helpful if phones go missing or are stolen to prevent information theft. This presents a unique challenge in the harm reduction space due to the decentralized storage of health information and the collection of sensitive personal information which could be misused or criminalized. Government and regulatory standards must be established regarding data collection, sharing, dissemination, and privacy protection for people who use drugs using these services.

Understanding the key elements of VOMS and establishing standards around service delivery, data collection, and privacy are additional areas left to be explored, but should follow existing medical and personal information privacy acts and standards.

### *Surveillance concerns*

While not as applicable with overdose prevention devices, some VOMS, given their national reach, have the potential to provide indirect epidemiological information on substance use trends regarding the geographic location of substance users and types of substances being used. VOMS services could be used as a surveillance tool for government officials, public health experts, and epidemiologists to determine substance use patterns, and to disseminate toxic drug alerts based on these patterns to relevant stakeholders. While it can be beneficial to expand our understanding of substance use in various communities, it could also be used as an indirect tool for policing and criminalization. Within North America, data privacy acts are already in place where organizations must obtain consent when they collect, use, or disclose an individual's personal information. This information must be used for the purposes for which they were collected, and any changes to its use will require reconsent. VOMS should adhere to these laws, and not disclose private information on individuals' locations, drug use, and identities without appropriate consent. Government agencies and regulatory watchdogs must be alerted to the existence of VOMS and be observant of VOMS activities to ensure they meet appropriate compliance and consumer protection and be willing to act if non-compliance or negligence

is seen. Improper surveillance could lead to serious alienation from substance users, as well as mistrust and non-use of these services by an already stigmatized and vulnerable population.

### **Future opportunities and directions**

#### *Research*

The lack of existing data on the effectiveness and safety of VOMS and other overdose prevention devices, contrasted by qualitative evidence of its potential to reduce intersecting healthcare inequalities indicates appropriate planning should be undertaken to further research in this field. Research on this subject matter should primarily focus on the effectiveness and safety of VOMS and other overdose prevention devices in reducing fatal drug overdoses.

Research should additionally focus on identifying the impact these services have on select populations who may differentially utilize VOMS such as gender minorities, and individuals in locations that do not have access to harm reduction resources. This can also extend to individuals with diverse routes of administration. Evaluation of the social and health implications of these services on a population level also remains to be explored. A quality improvement lens could be undertaken with these services examining their impact on service users, providers, health outcomes, and cost-effectiveness. Lastly, the potential harms of these devices and services need to be examined closely including emergency response times, criminalization, and quality assurance and safety concerns.

#### *Implementation, equity, and policy*

Information around VOMS and overdose prevention device efficacy and safety could positively impact future policy directions and public health messaging; potentially reducing solitary use of substances. An examination of how best to implement and reach key populations will need to be explored. Dissemination of materials and promotion of VOMS should target those who are most overrepresented within mortality statistics and underrepresented in harm reduction services access. For example, a disproportionate number of opioid overdoses occur among construction workers in North America (Gomes et al., 2022; Harduar Morano et al., 2018), however, they make up a small minority of those accessing in-person harm reduction sites (Lukac et al., 2022). Additional populations who do not necessarily engage with harm reduction resources include those from higher socio-economic statuses, youth, gender minorities, individuals in rural communities, and ethnic minorities mainly due to fear of repercussions including job loss and fear of stigma (Ivsins, 2022; Perri et al., 2022). The promotion of VOMS should be geared towards these groups to create a more equitable harm reduction landscape.

VOMS especially holds promise when being paired with other public health strategies such as naloxone kit distribution, sterile supply provision, harm reduction education, and supervised consumption. For example, information on VOMS via stickers or pamphlets could be paired with Naloxone kit distribution and sterile supply provision as an added tool to ensure safety (Safi et al., 2023). Given that naloxone kits are heavily promoted, adding VOMS messaging to these kits can increase awareness of these services. Other opportunities for sharing knowledge on VOMS could be at opioid agonist treatment (OAT) clinics, rehabilitation facilities, and at discharge from acute care/hospital sites, correctional facilities, and other programs where there is an increased risk of opioid intolerance from nonuse of illicit substances with a consequently high risk of death from relapse (Gan et al., 2021; Weiner et al., 2020).

Public health policy not only needs to focus on increasing awareness, penetration, and utilization of VOMS, but also needs to equally address the barriers to VOMS use. This includes advocating for expansion of the Good Samaritan Act, ensuring police do not come to overdose events,

and maintaining privacy and security around personal information individuals may disclose around their substance use with these services. Decriminalization of substance use is already being explored in various jurisdictions and would also further the impact of VOMS. There should also be expansion of policy and regulation around safety and quality of overdose prevention technologies in general.

Lastly, ensuring there is equity applied to the availability and affordability of these services is key as some of these devices may be cost-prohibitive for some individuals and organizations. As these services can negate potential overdose deaths, efforts should be made to improve their accessibility including ensuring the service is free for substance users and at minimum cost to organizations who may need to utilize them to keep their clients safe.

## Conclusion

VOMS and overdose prevention devices present unique strengths that may be able to address many of the current limitations seen within the harm reduction landscape and expand the reach of harm reduction interventions. Should there continue to be demonstrable effectiveness of these programs and devices, there would need to be increased support, funding, and implementation to increase their use in communities. Indeed, these services have the potential for rapid scalability which also facilitates access to harm reduction for many individuals currently facing healthcare inequalities. Future exploration on how to appropriately scale these interventions is warranted.

## Ethics approval

The authors declare that the work reported herein did not require ethics approval because it did not involve animal or human participation.

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## Declaration of Competing Interest

WR is an employee with the University of Alberta and receives a salary via the Canadian Institute of Health Research. MG is a co-founder and advisor for the National Overdose Response Service, receives funding from Health Canada's Substance Use and Addiction Program, and was a board member of the Canadian Society of Addiction Medicine. TM declares no conflicts of interest.

## CRediT authorship contribution statement

**William Rioux:** Writing – review & editing, Writing – original draft, Visualization, Project administration, Conceptualization. **Tyler Marshall:** Writing – review & editing. **S. Monty Ghosh:** Writing – review & editing, Writing – original draft, Funding acquisition, Conceptualization.

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