



Naloxone vending machines in county jail

Grant Victor^{a,b,*}, Bethany Hedden-Clayton^c, Danielle Lenz^c, Peyton R. Attaway^d, Bradley Ray^d

^a School of Social Work, Rutgers, The State University of New Jersey, 390 George St, Suite 710, New Brunswick, NJ 08901, USA

^b Rutgers Addiction Research Center, The State University of New Jersey, 671 Hoes Lane West, Piscataway, NJ 08854, USA

^c Center for Behavioral Health and Justice, School of Social Work, Wayne State University, 5447 Woodward Ave, Detroit, MI 48202, USA

^d RTI International, Division for Applied Justice Research, 3040 Cornwallis Road, Research Triangle Park, NC 27709, USA

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ABSTRACT

Introduction: The overdose epidemic in the United States has intensified following the introduction of illicitly manufactured fentanyl to drug markets with recent estimates indicating 110,000 deaths in 2022 and longer-term trends adversely impacting national life expectancy. A period of incarceration has been identified as a critical touchpoint for overdose prevention given its strong association with risk of overdose. In this paper we describe efforts funded by the Centers for Disease Control and Prevention (CDC) Overdose Data to Action (OD2A) grant to design and implement naloxone vending machines that provide free naloxone within county jails to returning citizens and those visiting county jail facilities.

Methods: This study utilized three sources of data. First, we describe the results of a pre-implementation survey administered by technical assistance providers to 18 jails across the state of Michigan. Second, among the 6 jail facilities that accepted a naloxone vending machine we examine administrative data from Michigan Department of Health and Human Services on naloxone orders to look at changes 6-months before and after implementation. Third and lastly, we conducted semi-structured interviews ($N = 6$) with jail administrators (i.e., County Sheriffs) on the barriers and facilitators to implementing a naloxone vending machine.

Results: Six facilities indicated they would accept a vending machine to distribute free naloxone. Overall, the total number of naloxone box orders that were distributed across all jail sites increased by 63.5 % from 4104 boxes pre-naloxone vending machine to 6708 boxes post-naloxone vending machine implementation. Qualitative interviews revealed that prior naloxone distribution efforts and foundational knowledge about opioids, overdose, and naloxone emerged as facilitators for vending machine implementation.

Conclusion: This study illustrates the utility of policy-driven funding strategies aimed at mitigating accidental overdose deaths among a high-risk population while building community naloxone saturation efforts.

1. Introduction

The overdose epidemic is a major contributing factor to the declining overall life expectancy in the United States (U.S.), with estimates suggesting accidental overdose deaths accounted for >100,000 deaths in 2022 (Ahmad et al., 2023; Harper et al., 2021). Most overdose deaths are opioid-related, though the type of opioid and corresponding mortality rates varies over time, with fentanyl and its analogs currently driving the fatality count in rural (Victor et al., 2023) and urban areas (Friedman & Hansen, 2022). Individuals who return to using opioids following an incarceration stay are at an elevated risk of experiencing an overdose owing to the lack of evidence-based treatment within correctional institutions to treat opioid use disorder (OUD), lowering opioid tolerance

during incarceration, and the volatility of the current unregulated drug market (Joudrey et al., 2019; Palamar et al., 2022).

Prior research has consistently demonstrated that the risk of experiencing a fatal overdose is considerably greater in the immediate post-release period (Binswanger, 2013; Binswanger et al., 2011; Brinkley-Rubinstein et al., 2018; Ranapurwala et al., 2022; Ray et al., 2023; Shefner et al., 2020). For instance, findings from a recent study indicated that approximately one in five overdose deaths in a major metropolitan area were attributed to someone recently released from incarceration during a four-year period (Victor, Sights, et al., 2021; Victor, Zettner, et al., 2021). This vulnerability is compounded when overdose prevention supports (e.g., naloxone and drug checking technologies) and evidence-based agonist medication treatment are not readily accessible

* Corresponding author at: 390 George St., suite 710, New Brunswick, NJ 08901, USA.

E-mail address: gv200@ssw.rutgers.edu (G. Victor).

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(Davidson & Rowe, 2008; Ray et al., 2021; Victor et al., 2020).

In response to the mounting impacts of overdose mortality, the U.S. Department of Health and Human Services' comprehensive Opioid Strategy, released in 2017, includes aims to.

"Target the availability and distribution of overdose reversing drugs to ensure broad availability of these medications to people likely to experience or respond to an overdose, [...] and identify effective public health interventions to reduce opioid related harms" (Johnson et al., 2018).

The Centers for Disease Control and Prevention's Overdose Data to Action (OD2A) is one stream of policy-driven funding to reduce drug overdose-related harms. The OD2A supports overdose prevention programming and surveillance by evaluating drug use and overdose trends and etiology, identifying barriers and facilitators of overdose prevention efforts, and assessing their efficacy (Centers for Disease Control and Prevention, 2023).

Expanding access to naloxone, an opioid overdose antidote, is an evidence-based public health strategy for those at high risk of opioid-related overdose leaving incarceration facilities (Chimbar & Moleta, 2018; Wenger, Showalter, Lambdin, et al., 2019). Some correctional facilities in the U.S. have implemented take-home-naloxone programs that provide naloxone training while people are incarcerated and distribution of naloxone via property room boxes (boxes containing an individual's belongings that are returned at release), often among those who have been identified as having symptoms that are consistent with OUD (Showalter et al., 2021; Wenger, Showalter, Lambdin, et al., 2019). This distribution process is limited given that it requires coordination between correctional officers and health staff to facilitate opportunities for training and distribution prior to release.

Prior research on naloxone saturation has demonstrated that nearly no US state is currently distributing an adequate amount of naloxone to reach community saturation (Irvine et al., 2022), and there is a need to develop distribution practices that target individuals most at risk of experiencing an overdose – people who use drugs and those leaving jail (Sugarman et al., 2023). One method of reaching this population may be to achieve an in situ (i.e., static) passive distribution of naloxone. In situ refers to naloxone distribution methods in which naloxone is conveniently positioned in a fixed location within communities for access without the need to interact with another person (Meyerson et al., 2021). To improve naloxone saturation among individuals leaving incarceration, naloxone vending machines offer an in situ delivery method in which naloxone is strategically placed in a jail, does not require interaction with another person to obtain, is less burdensome to correctional staff, and less restrictive than targeted delivery. In addition, vending machines may hold promise as a low-barrier naloxone distribution conduit, because vending machines provide an anonymous mechanism for access (Sugarman et al., 2023).

The Los Angeles County jail implemented a novel program in 2019 to provide naloxone through a vending machine. During the first nine months of 2020, >20,000 doses of naloxone were distributed through this free, self-serve vending machine (Alene Tchekmedyian & Hamilton, 2020). However, research regarding the impact of naloxone vending machines in jail settings is limited (Russell et al., 2023). In this paper we report on a mixed-methods study of naloxone vending machine implementation across multiple jail facilities in Michigan. We detail implementation efforts and outcomes, as well as barriers and facilitators towards this novel naloxone distribution strategy.

2. Material and methods

2.1. Funding and vending machine design

Funding from the Centers for Disease Control and Prevention (CDC) Overdose Data to Action (OD2A) grant was provided to the Michigan Department of Health and Human Services (MDHHS) to provide ongoing technical assistance that expanded substance use disorder treatment in

correctional settings throughout the state. The correctional facilities included in this study were all jails and therefore these facilities were primarily designed for short-term confinement – for those awaiting trial, sentencing, or those serving short sentences. This funding provided the opportunity to identify potential sites for implementation of vending machines to distribute naloxone provided by the MDHHS. The vending machines were identified by university researchers as a novel means of distributing naloxone to a population at high-risk of overdose (Wenger, Showalter, Wheeler, et al., 2019). These researchers identified a vending machine manufacturer and customized the coils to vend 360 Narcan® nasal spray boxes that each contained two single doses (4 mg each) of naloxone. Machines were further customized to have the payment mechanism removed and replaced with word "free" across the interface (Fig. 1). Each of machines were implemented in a publicly accessible area within or near the jail facility so that visitors and those who were recently released could access naloxone. At the time of implementation (2021), the cost of new machines was approximately \$4000USD but included delivery and retrieval if needed.

2.2. Data sources

This study of naloxone vending machine implementation in county jails examines three sources of data. First, we describe the results of a pre-implementation survey administered by technical assistance providers to 18 jails across the state in December 2020 (21 jails were contacted with an 85.7 % response rate). The survey inquired about jail capacity, current naloxone distribution efforts, and interest in initiating or expanding naloxone distribution with a vending machine. Next, among the 6 jail facilities that accepted a naloxone vending machine we examine administrative data from MDHHS on naloxone orders to look at changes 6-months before and after implementation (July 2021 to December 2021). Finally, among those who implemented we conducted semi-structured interviews on barriers and facilitators. This study was considered exempt and approved by the Wayne State University Institutional Review Board (protocol number 21-03-3342).

2.3. Semi-structured interview data

To further understand the barriers and facilitators to implementing jail-based naloxone vending machines in these newly adopted sites, semi-structured interviews were conducted with a cohort of jail administrators (i.e., County Sheriffs; $N = 6$) from each site. Interviews were conducted (December 2021) by a member of the research team (PA) who is a public health analyst with expertise in qualitative interviewing with law enforcement. The research team used purposive sampling methods to recruit jail administrators in each of the sites that implemented a vending machine by email with an invitation to participate in the study. The introductory e-mail included a brief study description, the types of questions that would be asked, and confirmation about the site's naloxone vending machine program. Interviews were conducted remotely using Zoom technology (Zoom Video Communications, San Jose California) with each interview lasting between 45 and 60 min to complete. The study transcribed and coded interview transcripts (PA, BR, & GV) to assess themes regarding attitudes to expanding naloxone distribution in jail facilities.

The interview guide included a total of 14 questions, although the interviewer encouraged a fluid conversation, therefore not all questions were asked in some cases, or the prompts that were asked varied between interviewees. These interviews began by inquiring about the interviewee's role in implementing a naloxone vending machine, the process of acquiring approval for a machine in the jail, and barriers and facilitators that impacted implementing a vending machine.

Examples of semi-structured questions and prompts are as follows:

Question: "Why did your facility decide to implement naloxone vending machines?"

Prompts: If they were offered the machine, why did they accept?

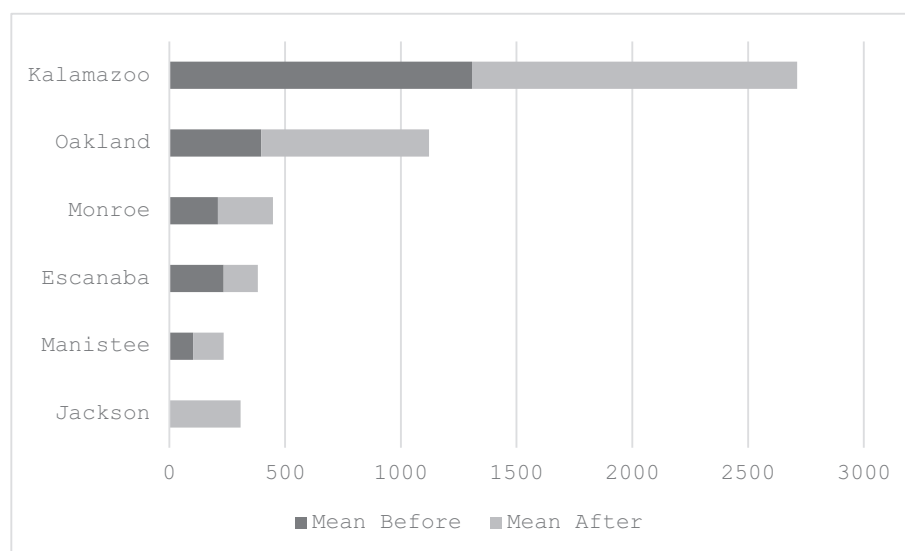


Fig. 1. Average change in naloxone box orders pre/post vending machine implementation

Note: Averages are of naloxone box orders consisting of two atomizers for intranasal administration in each naloxone kit.

What are the potential benefits? Inquire about alternatives (fishbowl) and offsetting strengths of vending machine. Have you or someone you know ever had to administer naloxone?

Question: “What barriers or support did you encounter internally in your organization?”

Prompts: Has that been consistent since implementation, if not, how has it changed? What barriers or support did you encounter from stakeholders external to your organization?

Question: “What materials, besides naloxone, are distributed through the vending machine?”

Prompts: Are there other items you would like to see stocked in the vending machine? What are the barriers towards including these materials?

2.4. Analytic approach

Pre-implementation survey data were collected via an online survey platform (Qualtrics). We provide descriptive analysis of the survey and administrative naloxone distribution data from MDHHS and use a paired *t*-test to determine significant overall changes in naloxone distribution with the cut-off for statistical significance of $p < 0.05$. Administrative data from MDHHS was filtered to only include jail sites that had elected to implement a vending machine. The date of naloxone vending machine implementation at each site was used to anchor the 6-month pre- and post-period. Transcribed interviews were coded using a grounded thematic analysis (Braun & Clarke, 2014) in which co-authors used an established code construction process that was refined at each reading

Table 1

Overall jail characteristics and naloxone distribution (NVM) ($N = 18$).

County	Jail capacity ^a	Naloxone pre-NVM	Jail naloxone provider	Naloxone eligibility	Naloxone delivery	Accepted NVM
Kalamazoo	400	Yes	Jail medical staff	By request	Property at release; Referral to local harm reduction	Yes
Oakland	1664	No	–	–	–	Yes
Monroe	383	Yes	Jail medical staff	Those with suspected OUD	Property at release	Yes
Escanaba	156	Yes	Corrections staff	By request	Property at release	Yes
Manistee	52	Yes	Jail medical staff	Those with suspected OUD	Property at release	Yes
Jackson	460	Yes	Corrections staff	By request	Property at release	Yes
Washtenaw	404	Yes	Community organization	By request	Property at release	No
Muskegon	264	Yes	Jail medical staff	Those with suspected OUD	Property at release; Referral to local harm reduction	No
Wayne	2981	No	–	–	–	No
Ogemaw	144	No	–	–	–	No
Kent	1533	Yes	Corrections staff	Those with suspected OUD	Property at release; Referral to local harm reduction	No
Grand	168	No	–	–	–	No
St. Joseph	165	No	–	–	–	No
Livingston	411	Yes	Jail medical staff	Those with suspected OUD	Property at release; Referral to local harm reduction	No
Berrien	341	No	–	–	–	No
Cheboygan	103	No	–	–	–	No
Charlevoix	195	Yes	Jail medical staff	Those with suspected OUD	Property at release	No
Livingston	411	No	–	–	–	No

Note.

^a Number of beds per jail facility.

interval, with subsequent readings conducted to refine our construct operationalization (Charmaz, 2017). Quantitative data were examined using IBM SPSS Statistics (Version 26) while qualitative data were coded using NVivo (Lumivero, 2023).

3. Results

3.1. Prior naloxone distribution efforts

In the ten facilities that provided naloxone and completed the survey before vending machine implementation, six programs distributed naloxone as determined by the in-jail medical provider, three were distributed naloxone by correctional staff, and one distributed naloxone through community partners (Table 1). Although one-third of jails (34 %; $n = 3$) provided naloxone to anyone who requested it, 70 % ($n = 7$) only distributed naloxone to those who exhibited opioid use disorder symptoms at booking or by jail medical staff. Among the jails that provided naloxone pre-vending machine implementation, most made it available in property boxes that detainees accessed at release while others provided only a referral to where naloxone could be obtained. Six facilities elected to implement a vending machine to distribute free naloxone.

3.2. Changes in naloxone distribution after vending machine implementation

The study filtered administrative data from MDHHS to examine the naloxone ordering patterns by responsible agencies 6-months before and after vending machine implementation. The average number of naloxone box orders that were distributed across all jail sites increased by 63.5 % from 4104 boxes pre-naloxone vending machine to 6708 boxes post-naloxone vending machine implementation ($t(1) = 3.67, p = 0.03$). Of note, one of the stocking organizations was a jail facility that went from distributing no naloxone to over 1000 kits in the six-months following naloxone vending machine implementation. The total number of naloxone boxes ordered from pre- to post-naloxone vending machine implementation increased among five jail sites, with the greatest total increases observed among larger jail facilities (see Table 2 and Fig. 1). There were little to no observed increases in the total number of naloxone box orders among the smaller counties in the 6-month follow-up period.

3.3. Barriers and facilitators to implementation

3.3.1. Knowledge about opioid overdose and naloxone distribution

Foundational knowledge about opioids, overdose, and naloxone emerged as facilitators for machine implementation. The jail facilities included in this study had already been working with technical assistance providers to implement OUD medications (buprenorphine, methadone, or naltrexone), and this existing partnership may have enhanced understanding about the importance of naloxone among jail administrators. Relatedly, jail administrators stressed the importance of

having a collaborative relationship with their in-jail medical providers and noted they had a positive impact on their decision to implement a machine.

Jail sites which did not have existing relationships with community agencies (e.g., harm reduction organizations and community mental health providers) expressed that they had a limited understanding of the local- and state-naloxone distribution landscape and were hesitant to implement a naloxone vending machine. Some cited a perceived legal liability related to the storage and distribution of naloxone (i.e., whether a jail facility is permitted to distribute naloxone to the public), while others focused on potential adverse outcomes when distributing naloxone without direct training or providing treatment referral. These concerns were allayed through technical assistance providers and collaborating harm reduction organizations who explained to the jail administrators that Michigan's Administration of Opioid Antagonists Act (House Bill 4367, 2019) allows a governmental agency to purchase and distribute naloxone without the risk of legal liability.

3.3.2. Coordination, logistics, and sustainability

“Easy” was the overwhelming expression used among jail administrators regarding the coordination, delivery, and stocking of the naloxone vending machine. Technical assistance providers facilitated the design, ordering, and delivery of machines, and identified the local stocker of the machine, minimizing burden on jail staff and resources during implementation. One jail administrator stated, “outside of doing some of the legwork to get the machine in, it's self-operated. You know what I mean? There's really very little oversight.”

Approval processes for implementing the free naloxone vending machines varied by jurisdiction and more intensive processes often acted as barriers to implementation. For instance, some jail administrators noted that they required county board approval to implement a naloxone vending machine, while others disclosed that the process to implement their machine was more streamlined and only required approval from a County Sheriff or from themselves as the jail administrator. Lengthier approval processes and timelines posed challenges to implementing a naloxone vending machine. Additionally, some jail administrators noted delays in naloxone deliveries from supply-chain shortages caused by the COVID-19 pandemic and worried about machines sitting empty.

3.3.3. Community perceptions and messaging

Several jail administrators endorsed public support for the naloxone vending machines, citing increasing “positive messaging against social stigma within the community.” Many agreed that harm reduction organizations aided to reduce misconceptions about stigma and liability relative to naloxone distribution. Most felt positively about provision of naloxone to their own community, with one stating, “it's nice to have [the vending machine] out in a major release area, you never know when you could save someone's life with it.” Another described how family and acquaintances visiting the jail would access the machine, “We don't have any restrictions. It's free – just walk up and punch the number – like you want a can of soda. No questions asked, and no criteria, anybody can come into our lobby and get it.”

Conversely, stigma regarding drug use and misconceptions about naloxone were salient obstacles to naloxone vending machine implementation. Several jail administrators noted a negative reception of the machines on social media. In one setting in which naloxone vending machine implementation required approval from a board of county-level officials, one county commissioner expressed opposition, suggesting naloxone “enabled” drug use and that the county, “should not be giving drug offenders a pass on their next overdose.” This board meeting resulted in a no-vote from the county officials.

4. Discussion

County jail facilities represent an important overdose prevention

Table 2
Pre-post vending machine implementation change in naloxone distribution.

Jail facility	Naloxone per bed ^a	Pre-post change	
		Total	Average
Kalamazoo County	5.8	192	96
Oakland County	0.8	1056	330
Monroe County	2.6	528	27
Escanaba County	2.8	−24	−86
Manistee County	2.5	−72	30
Jackson County	2.1	924	308

Note.
^a Amount of naloxone per jail bed in the post-period.

touchpoint (Ray et al., 2022). Many people leaving jail facilities are reincarcerated (Blank Wilson et al., 2014), face considerable stigmatization (Berryessa & Krenzer, 2020; Brinkley-Rubinstein & Cloud, 2020; Hartwell, 2004), and have limited access to evidence-based treatment options (Ducharme et al., 2021; Ray et al., 2022). Overdose Data to Action (OD2A) funding that supported this naloxone vending machine program, provided by the Centers for Disease Control and Prevention (CDC), was a critical resource aimed at combating the overdose epidemic by enhancing naloxone access among a population at high risk of experiencing or witnessing an overdose. As evidenced in the current study, this funding facilitated collaboration between various stakeholders and jail facilities, jail medical providers, harm reduction organizations, and MDHHS – with the goal of increasing the availability of naloxone and supporting innovative distribution approaches. Our findings suggest that OD2A and related funding mechanisms can be used to develop a low-threshold naloxone distribution strategy for vulnerable population groups who are at acute risk of fatal overdose.

We found that prior naloxone distribution efforts may have facilitated the implementation of a vending machine, as approximately half of all jails that received technical assistance for OUD management and overdose prevention elected to implement a machine. However, prior to implementing a vending machine, the naloxone distribution methods in these jails were done in a select way, such that distribution was limited to the amount of naloxone provided and was often only provided to those who were flagged as being at elevated overdose risk. The funding that supported the current naloxone vending machine project featured grant conditions that required program evaluators to include naloxone distribution and saturation plans. These jails were able to enhance their capacity to distribute low-barrier naloxone by leveraging O2DA funding, which covered the procurement, customization, and delivery of vending machines, as well as the purchase of naloxone.

This study may provide a framework for the implementation of an in situ passive naloxone distribution to improve naloxone saturation among a subgroup that is more likely than the general population to experience or witness an overdose, and in a location (i.e., jail) where pharmacists and harm reduction services are limited or absent. Furthermore, there is evidence suggesting that those most in need of naloxone receive it from non-retail environments and anonymously (Sugarmen et al., 2023). This study is congruent with established best practices in that these naloxone vending machines were cost-free, and naloxone was dispensed anonymously. To the latter point, it is important to acknowledge that although person-to-person interaction was not needed to receive a naloxone from the vending machine, the degree of comfort and perceived anonymity may have been hindered, given that these machines were placed within county jails. Prospective adopters of naloxone vending machines may question the necessity of the machine to distribute naloxone. That is, a table with naloxone sitting on it might be sufficient or placing naloxone in an individual's personal items prior to their release. However, it is a medication with stigma among those within the criminal/legal system (Kruis & Merlo, 2021; Showalter et al., 2021) and the vending machine may provide a sense of regulation and legitimacy towards how this medication is dispensed.

Our analysis of changes in naloxone distribution in jails after vending machine implementation suggests that this in situ passive dispersal method may be an effective means of providing naloxone in the community, potentially increasing its distribution to a high-risk group. We found that agencies stocking vending machines with naloxone, particularly those in large cities, significantly increased their distribution following implementation. One jail facility, Jackson County, was not distributing naloxone prior to implementing a vending machine, and our estimate suggests that this facility is now distributing approximately two naloxone kits per jail bed in the 6-months after post-implementation. However, the second-smallest facility and most rural areas did not exhibit increases after implementation. Those who were incarcerated in rural and smaller jail facilities may have had concerns about stigma and the potential social and legal consequences of obtaining naloxone via a

vending machine, which are often smaller and more close-knit, and the lack of perceived anonymity can deter individuals from seeking overdose prevention services out of concern that their drug use will become public knowledge. Moreover, a recent study by Hoover et al. (2023) found that rural individuals with recent incarceration histories were not more likely to currently carry naloxone than those without prior detainment.

Although the current project did not collect primary data on naloxone vending machine consumers, we demonstrate that state agency administrative data is a viable methodology for monitoring naloxone purchase requests and distribution in lieu of more technologically advanced public health vending machines. Future research should extend the findings of the current study to understand whether the implementation of naloxone vending machines in jails impacts the incidence of recently released individuals carrying and refilling naloxone, who are accessing naloxone in jail vending machines (e.g., outside visitors to individuals who are detained), and whether local reductions in overdose mortality are observed. Emerging evidence suggests that implementing naloxone vending machines – otherwise referred to as “harm reduction vending machines” or “public health vending machines” – in a syringe service program setting may reduce the occurrence of fatal overdoses in the county in which these machines are located. For instance, Allen et al. (2022) found that naloxone dispensation via a vending machine was associated with 41 fewer overdose fatalities than a forecasted estimation. Similar findings were reported by Arendt (2023), where the implementation of vending machines was associated with increased provision of harm reduction products (e.g., naloxone, safer injection/smoking kits) and was associated with a lower incidence of human immunodeficiency virus (HIV) and overdose mortality.

A 2016 study of ten U.S. states found that salient barriers to implementing policies targeting the overdose epidemic included a lack of coordinated law-making efforts, concerns about sustainable funding for take-home naloxone, and concerns about legal liability for adverse outcomes related to naloxone distribution, despite state standing orders and Good Samaritan Laws protecting naloxone distribution efforts (Whitmore et al., 2018). Interview responses from jail administrators support some of these prior findings related to legal liability concerns. These concerns resulted from the stigma and misconceptions about naloxone. Often, resistance arose from the jail administrator's concerns about providing naloxone to people who used opioids via a vending machine. Existing relationships and partnerships with local harm reduction stakeholders and technical assistance providers help mitigate the impact of stigma. Of note, the jail administrators in counties installing vending machines overwhelmingly supported installation, and once their concerns about legal liability dissipated, their support helped overcome institutional stigma.

The funding support for the current project may have eased the burden of naloxone availability and stocking machines for community agencies and jails. The MDHHS Narcan Direct naloxone ordering portal was established in 2020 and provides free 4 mg nasal naloxone to community organizations. In the fiscal year 2024, \$5 million of opioid settlement dollars will be allocated towards the purchase of naloxone to sustain this initiative broadly, as well as for the current naloxone vending machine program. Another facilitator that emerged in the interview data was that the jails that had implemented opioid use disorder medications had a stronger understanding of naloxone safety and the need for this medication to address overdose. This is likely a result of the ongoing technical assistance provided to these jail facilities, which centered on building community partnerships with harm reduction organizations and overdose prevention education that may have mitigated misconceptions about naloxone (Wagner et al., 2016; Wenger, Showalter, Lambdin, et al., 2019; Wenger, Showalter, Wheeler, et al., 2019).

Several factors should be considered for the future expansion and sustainability of these efforts. Local governments, public health organizations, and community harm reduction groups can collaborate with

vending machine companies to implement plans for offering free naloxone kits. This collaboration would involve identifying suitable vending machines in public spaces such as transport hubs, shopping centers, and public restrooms, where the risk of opioid overdoses may frequently occur. Another way to expand this mode of naloxone distribution is by repurposing older vending machines, as one such harm reduction organization has done in the state of Michigan (Gustafson, 2023). In this case, harm reduction organizations that may face financial constraints could repurpose discarded vending machines for naloxone distribution. Similarly, communities may consider modifying their machines to accommodate a single row dedicated to naloxone kits to ensure that the naloxone boxes are accessible and visible to the public. This modification could involve adjusting the configuration, labeling, and dispensing mechanisms of the machine to facilitate the distribution of free naloxone kits. These modifications can also facilitate the addition of other types of public health materials to vending machines, such as sterile syringes, alcohol swabs, condoms, fentanyl test strips, safe inhalation supplies, educational materials, and referral information. However, some of these modifications may be better suited to vending machines that are in public settings, given the relatively restrictive policies and procedures in most jail facilities.

4.1. Limitations

Although this study represents one of the most thorough assessments of naloxone vending machines in jail settings, there are several limitations that should be considered. The vending machines described in this paper were customized only to provide free naloxone, which is in contrast to the few harm reduction vending machines that have been implemented in the U.S. in recent years (Allen et al., 2022). For example, public health vending machines in the U.S. and abroad offer various resources such as feminine hygiene, safer sex, sterile syringes, and naloxone (Russell et al., 2023). Data on naloxone kit distribution and usage as well as feedback from the community can be used to make important decisions related to program adjustments and improvements. However, it was beyond the scope of this study to examine the effectiveness of in-jail naloxone vending machines in reducing fatal overdose. This was an intentional choice because we did not create any additional barriers to accessing naloxone; therefore, we did not ask the jails, stocking agencies, or clients for any additional data. The offsetting strength of this approach was that there was a relatively low threshold of operating costs related to distribution technologies because they were provided by state funds and data collection was collected through secondary administrative sources. We encourage county jails and program evaluators who wish to implement naloxone vending machines to consider whether program evaluation efforts impede or deter individuals from accessing naloxone (Abouk et al., 2019; Chimbar & Moleta, 2018; Doe-Simkins et al., 2014). Qualitative interview data were also limited to talking with early adopters, not non-adopters, and not with consumers, which may bias the themes discussed in the current study. Finally, the jails that implemented naloxone vending machines were already receiving technical assistance for opioid use disorder medications, making them an outlier to most correctional facilities in the U.S. Therefore, the generalizations of the current findings should not be broadly applied to all correctional facilities.

5. Conclusion

This study illustrates the usefulness of policy-driven funding strategies aimed at mitigating accidental overdose deaths among high-risk populations, while building community naloxone saturation efforts. Jail facilities are not designed for treatment, and incarcerating people with OUD can exacerbate symptoms and lead to other adverse health outcomes. Unregulated opioids continue to be responsible for most overdose deaths in the U.S., and communities need to consider opportunities for naloxone distribution to individuals at risk of overdose, such

as those exiting incarceration settings. This study examined the use of vending machines to achieve an in-situ naloxone distribution in jails and found that this technique aligned well with this setting, but more research is needed to understand why individuals utilize a naloxone vending machine in a jail setting and whether the distribution method is associated with reductions in overdose deaths.

Author agreement statement

We declare that this manuscript is original, has not been published before and is not currently being considered for publication elsewhere. We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us. We understand that the Corresponding Author is the sole contact for the Editorial process.

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CRediT authorship contribution statement

Grant Victor: Writing – review & editing, Writing – original draft, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Bethany Hedden-Clayton:** Writing – review & editing, Writing – original draft, Conceptualization. **Danielle Lenz:** Writing – review & editing, Project administration, Conceptualization. **Peyton R. Attaway:** Writing – review & editing, Conceptualization. **Bradley Ray:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

None.

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