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MAJOR ARTICLE

Six Moments of Infection Prevention in Injection Drug Use: An Educational Toolkit for Clinicians

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Background. Injection drug use–associated bacterial and viral infections are increasing. Expanding access to harm reduction services, such as safe injection education, are effective prevention strategies. However, these strategies have had limited uptake. New tools are needed to improve provider capacity to facilitate dissemination of these evidence-based interventions.

Methods. The "Six Moments of Infection Prevention in Injection Drug Use" provider educational tool was developed using a global, rather than pathogen-specific, infection prevention framework, highlighting the prevention of invasive bacterial and fungal infections in additional to viral pathogens. The tool's effectiveness was tested using a short, paired pre/post survey that assessed provider knowledge and attitudes about harm reduction.

Results. Seventy-five respondents completed the paired surveys. At baseline, 17 respondents (22.6%) indicated that they had received no prior training in harm reduction and 28 (37.3%) reported discomfort counseling people who inject drugs (PWID). Sixty respondents (80.0%) reported they had never referred a patient to a syringe service program (SSP); of those, 73.3% cited lack of knowledge regarding locations of SSPs and 40.0% reported not knowing where to access information regarding SSPs. After the training, 66 (88.0%) reported that they felt more comfortable educating PWID ($P < .0001$), 65 respondents (86.6%) reported they planned to use the Six Moments model in their own practice, and 100% said they would consider referring patients to an SSP in the future.

Conclusions. The Six Moments model emphasizes the importance of a global approach to infection prevention and harm reduction. This educational intervention can be used as part of a bundle of implementation strategies to reduce morbidity and mortality in PWID.

Keywords. harm reduction; infection control; infection prevention; medical education; PWID.

People who inject drugs (PWID) are at high risk for blood-borne viral infections and invasive bacterial infections. Recent outbreaks of human immunodeficiency virus (HIV) and hepatitis B virus (HBV) [1–9], and the increasing incidence of hepatitis C virus, infectious endocarditis, and other complications of injection drug use (IDU) are linked to the ongoing opioid epidemic and overdose crisis [10–12].

In addition to blood-borne viral infections, which have traditionally been the major focus of infection prevention efforts, recent data suggest that the incidence of bacterial endocarditis among PWID increased >12-fold over a 5-year period [13]. Emerging data also suggest that infection prevention efforts for bacterial infections in PWID has been more limited, which has led to gaps in care and increased long-term cardiovascular morbidity and mortality in this patient population [12–14]. PWID who develop IDU-associated endocarditis have significantly worse outcomes at 5 and 10 years as compared to non-IDU-associated endocarditis, despite surgical intervention [15]. However, anecdotal evidence suggests that surgeons are hesitant to operate on PWID who develop endocarditis due to poor long-term outcomes, including high rates of recurrent substance use and limited linkage to care, which can lead to repeated episodes of endocarditis and limit options for reoperation [16].

A major contributor to the increase in invasive bacterial infections is the increasing prevalence of fentanyl and other short-acting synthetic opioids. Fentanyl use is associated with higher injection frequency and with increased rates of receptive needle and syringe sharing [17]. In contrast to heroin injection, which typically occurs 3–4 times per day, many patients who inject fentanyl inject up to 6–10 times per day [18]. The impact of higher frequency of injection is several-fold. First, every additional injection represents an additional at-risk moment for

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transmission of infection, as 6–10 injections per day is 6–10 potential infection transmission events. Frequent injections may also lead to higher rates of needle reuse, which in turn leads to increased use of blunt needles, which cause more skin injury and impart a higher risk of introduction of skin flora and other potential pathogens into the soft tissues and bloodstream [19, 20]. Infectious risk is additionally increased if needles and other injection preparation equipment are shared between individuals.

Harm reduction strategies, such as syringe service programs (SSPs) [21], safe injection facilities [22], immunizations [23], skin cleaning and safe injection strategies [24], and HIV preexposure prophylaxis (PrEP) [25] are important tools for preventing infections in PWID. Safe injection techniques can reduce incidence of infectious endocarditis by over 90%, significantly higher than is achievable with a reduction in injection frequency alone [26]. SSPs reduce disease transmission by decreasing the rate of needle and syringe sharing, reducing needle reuse and the length of time that used injection materials are in circulation [21, 27].

Traditionally, infection prevention efforts within the harm reduction framework primarily targeted specific blood-borne viral infections, rather than adopting a generalized approach. However, there has been increasing interest in a more comprehensive, global approach to infection prevention [28, 29]. Hospital-based infection control models are beginning to implement horizontal infection control strategies, which target many different types of infections, rather than vertical strategies, which are interventions aimed at preventing a single pathogen or group of pathogens [30]. A similar philosophical approach can be adapted to expand prevention of infections associated with IDU.

Despite clear evidence of the increasing incidence of invasive bacterial complications of IDU, as well as the associated morbidity and mortality, we identified gaps in healthcare providers' knowledge and experience with harm reduction strategies, including limited knowledge about SSPs, a lack of familiarity with the injection process, and discomfort providing infection prevention counseling related to specific injection practices [31]. Thus, to address this implementation barrier, we adapted an existing infection control model [32] to identify moments of potential infectious risk during the injection process, link these moments with a corresponding infection control strategy, and collect data regarding the effectiveness of an educational curriculum for improving provider comfort and knowledge about infection prevention strategies for PWID.

METHODS

Derivation and Development of the Six Moments Model

The Five Moments for Hand Hygiene was developed by the World Health Organization (WHO)'s *Guidelines on Hand Hygiene in Health Care* [32]. The model is designed to highlight specific "at risk" moments and interactions that can contribute to the spread of nosocomial infection and specifies time points when hand hygiene is appropriate to break the "chain of infection." The concept is presented simply and applies to a wide range of patient care activities and healthcare settings. Likewise, the material is presented graphically as well as narratively to reduce potential language and literacy barriers.

Given the success of this model, we adapted this approach and created the "Six Moments of Infection Prevention in Injection Drug Use" education tool. The "Six Moments" tool highlights 6 potential sources of infection during the injection process, connects each activity to potential infections that can occur at each step, and specifies interventions that can be applied at each step to reduce risk of transmission (Table 1). While the model is designed to apply infection prevention strategies, it can also be used in reverse—if a patient presents with an injection-related infection, the model can be used to identify the likely underlying procedural etiology of the specific infection and can be used to help focus harm reduction counseling to specific patient behaviors associated with the acquisition of the pathogen.

The Six Moments model is presented in Figure 1; a complete curriculum and instructions for viewing a recorded version of the presentation are included in the Supplementary Materials.

Table 1. Six Moments of Infection Prevention in Injection Drug Use

Moment	Potential Pathogens	Intervention
Contaminated needle (prior to filling)	HIV, HCV, HBV, delta agent	• Use new needle for every injection • One needle for each person injecting • Vaccination against HBV • HIV PrEP
Contaminated water or acid	*Candida* and other fungal infections	• Use sterile water • Use single-use sachet of citric or ascorbic acid
Contaminated cooker	HIV, HCV, HBV, delta agent	• Use clean cooker • One cooker for each person injecting • Vaccination against HBV • HIV PrEP
Contaminated filter	"Cotton fever"—endotoxin from gram-negative bacteria	• Use clean, single-use cotton filter • One cotton for each person injecting
Unclean skin	MRSA and skin flora	• Wash hands • Wash area to be injected
Contaminated needle (after filling)	*Streptococcus* and oral flora	• Avoid contact with mouth or other surfaces after needle filled • Use of sharps bin

Abbreviations: HBV, hepatitis B virus; HCV, hepatitis C virus; HIV, human immunodeficiency virus; MRSA, methicillin-resistant *Staphylococcus aureus*; PrEP, preexposure prophylaxis.

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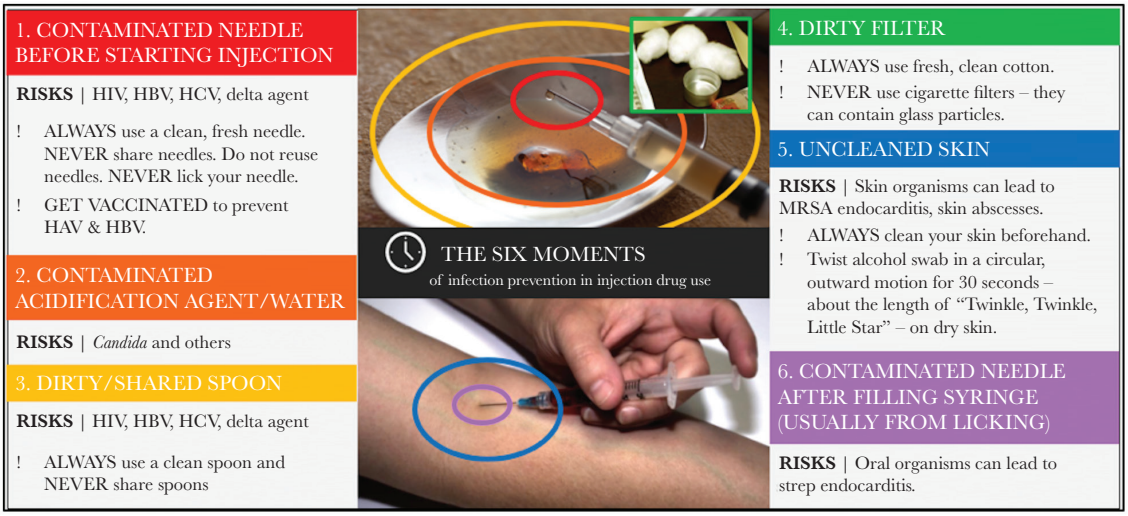

Figure 1. Six Moments of Infection Prevention in Injection Drug Use Model. Abbreviations: HAV, hepatitis A virus; HBV, hepatitis B virus; HCV, hepatitis C virus; HIV, human immunodeficiency virus; MRSA, methicillin-resistant *Staphylococcus aureus*.

Sample

Multiple medical centers, including several Veterans Affairs (VA) medical centers, were invited to participate in the "Six Moments of Infection Prevention in Injection Drug Use" curriculum through purposive sampling. The research team identified and recruited VA sites through an infectious disease provider network and via word of mouth. The tool was presented during existing educational forums, such as grand rounds or resident conferences. Individuals invited to participate in the trainings included clinicians, medical students, mental health providers, clinical researchers, nurses, pharmacists, and case managers.

Procedures/Measures

During the initial study period, presentations were delivered in person, although the remaining 6 presentations were delivered virtually using Microsoft Teams or a similar video conferencing platform in order to adhere to safety restrictions put in place during the coronavirus disease 2019 pandemic. All presentations took place between March 2020 and March 2021.

To assess and compare pre- and postpresentation knowledge of harm reduction principles, audience members at each site were asked to complete short pre- and postpresentation surveys. The prepresentation survey consisted of 9 questions and assessed respondents' prior experience with harm reduction, knowledge of infections associated with IDU, comfort counseling PWID, and whether they had previously referred patients to an SSP and, if not, why not. The postpresentation survey was administered immediately after the presentation and asked respondents to re-rate their harm reduction knowledge and comfort counseling PWID, reassessed knowledge of injection-associated infections and of harm reduction practices, and asked respondents to evaluate the model's efficacy. In addition, the postpresentation survey included a question about whether providers planned to use the Six Moments model in their own practice and included an open-ended question for respondents to provide comments and suggestions. (Supplementary Materials). In-person presentations used paired paper surveys. Surveys for virtual presentations were administered using VA REDCap, an online data management software, which allows for anonymous linkage of responses.

Data Analysis

Only responses with paired pre- and postpresentation data from respondents who completed the entire training were included in the data analysis. The aim of the initial analysis was to describe characteristics of presentation respondents, including their professional roles, prior training in harm reduction, and prior experience referring patients to an SSP. Surveys also assessed perceived changes in harm reduction knowledge and comfort educating patients with a history of intravenous drug use (PWID) and measured changes in subject-matter knowledge. The distribution of participant responses was described using bar charts and histograms.

One-sided, nonparametric sign tests were used to examine median differences in paired pre- and postpresentation perceptions of harm reduction knowledge and comfort educating PWID ($\alpha = .05$). Knowledge check questions were scored, counting 1 point per checkbox for 2 questions totaling 11 possible points. A nonparametric, one-sided Wilcoxon signed-rank test was used to examine differences between paired scores before and after the Six Moments training ($\alpha = .05$). All analyses were completed using Microsoft Excel version 2008 software.

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RESULTS

After excluding nonpaired responses and responses from individuals who did not complete the training (n = 67), 75 survey respondents representing >10 different medical facilities across the United States completed the paired pre- and posttraining survey. Due to medical center relocations and renovations that took place as part of the pandemic surge, some of the early paper responses were unable to be collected and thus were not recorded or included in the analysis.

Twenty respondents (26.6%) identified themselves as interns or residents, 11 (14.6%) as midlevel practitioners (nurse practitioner or physician assistant), 7 (9.3%) as attending physicians, 4 (5.3%) as medical students, and 33 (44.0%) as other, which included case managers, pharmacists, social workers, and peer specialists.

Harm Reduction Knowledge

At baseline, 17 respondents (22.6%) indicated that they had received no prior training in harm reduction. Forty-nine (65.3%) reported that they had received at least one previous harm reduction training and 8 (10.6%) reported they had received at least 5 harm reduction trainings.

Sixty respondents (80.0%) reported they had never referred a patient to an SSP and 14 (18.7%) reported that they had. Among respondents who had not previously referred patients to an SSP, 70.0% reported lack of knowledge regarding locations of SSP, 38.3% reported not knowing where to access information regarding SSPs, 11.7% did not think SSP referral was part of their role, and 11.7% reported a discomfort counseling PWID as the reason(s) for not referring patients previously.

Comfort Educating PWID

The Six Moments training improved respondents' comfort with educating PWID about reducing risk of infection during the injection process. Prior to the training, 28 respondents (37.3%) reported that they were either very or somewhat uncomfortable educating PWID and 17 (22.6%) reported neutral feelings. After the training, 66 (88.0%) reported that they felt either somewhat or very comfortable educating PWID (Figure 2). A one-tailed nonparametric paired sign test suggested significant median differences between comfort level educating PWID before and after Six Moments training, indicating increased comfort following the harm reduction curriculum ($P < .0001$).

Infection Prevention Knowledge

Respondents perceived that the Six Moments tool improved respondents' knowledge of strategies to reduce the risk of infection transmission during the injection process. Prior to the training, 40 respondents (53.3%) reported either no or low knowledge of harm reduction strategies and 35 (46.6%) reported moderate or extensive knowledge. After the training, 72 respondents (96.0%) reported either moderate or extensive knowledge. Seventy-one respondents (97.3%) reported that the Six Moments model helped them to understand risks of infection with the injection process and infection prevention strategies. Specifically, respondents were tested regarding their knowledge of infectious risk associated with IDU before and after the training. The mean and median scores prior to the training were 8.3 and 8.0, respectively, out of a possible 11 points (minimum = 5, maximum = 11). The mean and median scores after the training were 8.9 and 9.0, respectively (minimum = 4, maximum = 11) (Figure 3). A one-tailed Wilcoxon signed-rank test demonstrated significant mean differences between paired responses of pretest and posttest scores, indicating that individuals' scores were found to be significantly higher on the posttest compared to the pretest ($P < .05$).

After the Six Moments training, more respondents correctly identified bloodstream infections and/or endocarditis as among the most common infections for PWID (68.5% of respondents on the posttest vs 63.9% on the pretest). Overall, more

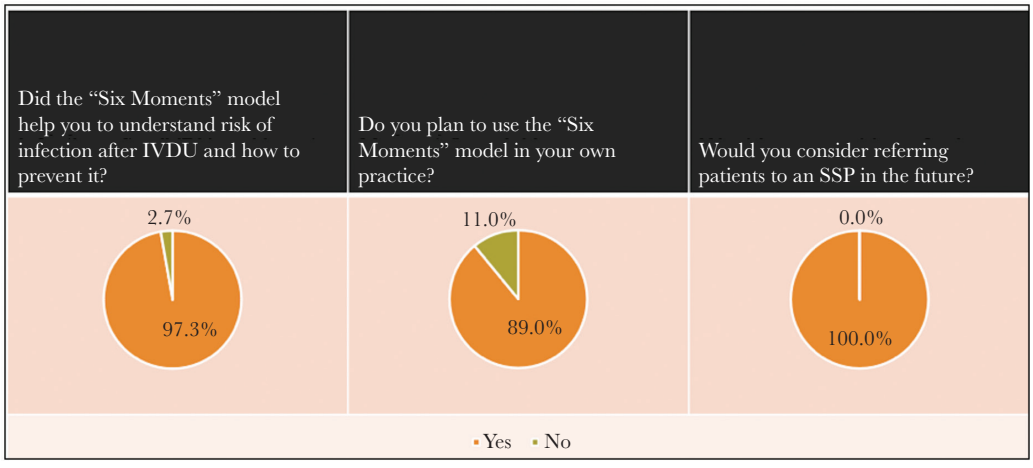

Figure 2. Knowledge of infectious risk associated with injection drug use before and after the training. Abbreviation: SD, standard deviation.

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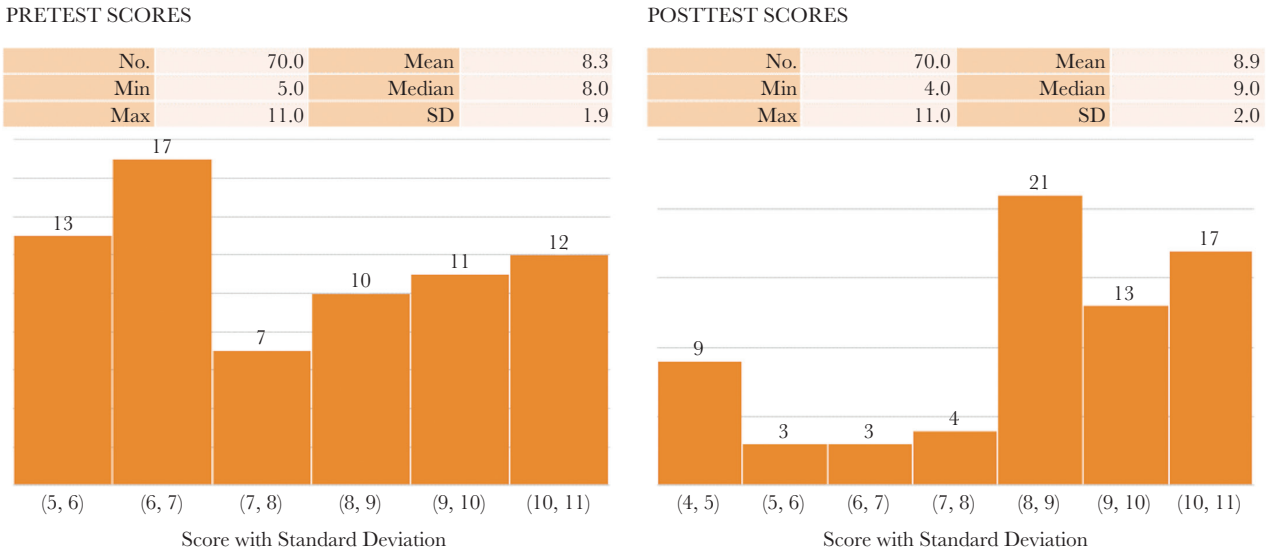

Figure 3. Respondents' reactions to the "Six Moments" model. Abbreviations: IVDU, intravenous drug use; SSP, syringe service program.

respondents were able to correctly identify each of the proven harm reduction strategies: SSPs (96.0% identified on posttest vs 86.7% on the pretest), vaccination against infectious diseases that can be transmitted through intravenous drug use (76.0% vs 46.7%), skin cleaning prior to injection (78.7% vs 52.0%), use of sterile needles (85.3% vs 84.0%), and avoiding needle contamination (72.0% vs 58.7%). More respondents incorrectly identified "sharing needles" as a proven harm reduction strategy on the posttest (8.0% vs 4.0%). After the training, 65 respondents (89.0%) reported that they planned to use the Six Moments model in their own practice and 100% said they would consider referring patients to an SSP in the future (Figure 2).

Qualitative Feedback

Nearly all survey respondents reported that the Six Moments model helped them to understand risks of infection associated with IDU and how to prevent these infections. The majority also reported that they planned to adapt the model to their own clinical practices. Respondents also highlighted that "the visual model made it easy to remember" and that identifying the pathogens and types of infections associated with each step of the process was particularly informative. Fifteen of the 75 respondents provided substantive comments and/or feedback on the Six Moments training; of those, the majority expressed appreciation for the training. Specific qualitative comments about how to better incorporate harm reduction services into the care of PWID are included in Table 2.

DISCUSSION

The Six Moments of Infection Prevention in Injection Drug Use is an adaptation of a generalized model of infection control, the WHO's Five Moments for Hand Hygiene, that has been shown to improve the practice of hand hygiene in a clear, user-centered format. Both models are intended to bridge the gap between clinical practice and scientific evidence, improving health outcomes and reducing interuser variability of a specific practice [30]. Moreover, these models are adaptable to a wide variety of clinical settings and applicable to both clinicians and nonclinical staff. The Six Moments model takes a horizontal approach to infection control strategy, rather than targeting individual pathogens with specific strategies [33]. While specific strategies, particularly those targeting blood-borne viral infections, have led to decreases in HBV [34] and HIV [35] transmission in the setting of IDU, the rising rates of disseminated bacterial

Table 2. Comments From Survey Respondents

Survey Open Question	Comment
Do you have comments about your response to "Do you plan to use the 'Six Moments' model in your own practice?"	"We can do better in the targeted outreach and engagement to Veterans and providers to improve education and break down communication barriers."
Any additional comments, feedback, or suggestions for improvement	"Incorporating Peer Support Specialists with lived experience will improve targeted outreach and engagement while supporting the liaison and advocacy work needed to improve provider education and understanding. Cultural competency matters for successful implementation of Harm Reduction. This means holding value and understanding of the experiences among those who may be engaged in intravenous drug use, sex work, or other risky behaviors (ie, 'drug culture'). We must ensure those with lived experience have a voice in the development and implementation of policies and programs."

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and fungal infections highlight the need for more global infection prevention strategies. Another benefit of the model is that it can be used to link infections to specific activities, facilitating targeted harm reduction education about certain behaviors and processes that contribute to risk of infection.

This model was developed in response to providers' reports of limited experience and comfort surrounding infection control strategies for reducing infections related to IDU [31]. In one recent survey of provider knowledge and beliefs, only 38.4% of providers reported that they had counseled PWID on infection prevention and nearly half stated that the reason for lack of counseling was a lack of knowledge and resources [31]. After this educational intervention, respondent surveys demonstrated increased knowledge and comfort around these harm reduction practices and interest in adopting infection prevention education into respondents' own clinical practice. The intervention was primarily offered to infectious disease physicians and internal medicine residents, who would be expected to have some experience in this area and potentially higher baseline knowledge and a lower potential for improvement. These results suggest that the intervention could potentially have a greater impact on participants with lower baseline knowledge. While this model focuses on provider education, additional research is needed to adapt and develop innovative educational tools for patients, ideally to be paired with other harm reduction strategies, including SSPs, immunization against hepatitis A virus and HBV, and access to PrEP.

The increasing incidence of infectious endocarditis associated with IDU particularly emphasizes the need for expanded patient education around safe injection practices [36]. Although it was not a specific goal of this curriculum, respondents noted that the mapping of infection type to specific injection practice was particularly helpful for better informing their own practice of counseling patients. Many respondents indicated that they did not have experience or knowledge about the specific steps involved in drug injection and thus did not feel prepared to counsel their patients about safer injection practices. In the future, consideration should be given to specific training on the process of injection, rather than just the infectious risks associated with IDU, so that providers are able to provide comprehensive harm reduction counseling to their patients.

This study focused on the development and validation of an educational intervention for providers designed to improve knowledge and comfort with counseling around infection prevention and represents a critical first step toward expanding infection prevention services to PWID. However, for improvements in care to be realized, provider-focused educational strategies need to be paired with other evidence-based implementation strategies, such as patient-facing education and facilitation, to promote comprehensive practice change and to improve health outcomes for these vulnerable patients.

Limitations

Harm reduction knowledge check scores showed modest yet significant improvement after respondents received the Six Moments training, although some knowledge gaps persisted; more data and trainings are needed to ensure the sustainability of the educational intervention. We did not assess long-term changes in knowledge; thus, it is possible that the impact of the training on provider knowledge and attitudes was short-lived. Likewise, it is unclear how generalizable this training would be to physicians with less experience working with this population. Additionally, we did not measure whether the knowledge and comfort changes translated into real-world practice change; prior work suggests that provider education is an essential element implementation strategy but that provider education is not a stand-alone implementation strategy; to improve adoption and achieve sustainable change, additional implementation strategies are necessary.

CONCLUSIONS

We present an adapted infection control model that emphasizes the importance of a global approach to infection prevention as part of a larger harm reduction model to providing care to PWID. This educational intervention can be used as part of a bundle of implementation strategies to improve morbidity and mortality in PWID.

Supplementary Data

Supplementary materials are available at *Open Forum Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Notes

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Patient consent. This anonymous survey was not considered to be human subjects research and therefore institutional review board approval was not required.

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All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

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