



Optimizing Provider Preexposure Prophylaxis (PrEP) Training: A Cross-Sectional Analysis of Recommendations from Providers Across the PrEP Implementation Cascade

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Abstract

Expanding PrEP access necessitates training that supports healthcare providers' progression along the PrEP implementation cascade, moving from PrEP awareness to prescription. We surveyed 359 USA providers about PrEP training content and format recommendations. We examined the association between cascade location and training recommendations. Most providers were aware of PrEP (100%), willing to prescribe PrEP (97.2%), had discussed PrEP with patients (92.2%), and had prescribed PrEP (79.9%). Latent class regression analysis revealed that cascade location was associated with training recommendations. Although all providers recommended PrEP-specific content (e.g., patient eligibility), providers who were located further along the cascade also recommended more comprehensive content, including sexual history-taking and sexual and gender minority competence training. Providers further along the cascade were also more likely to recommend interactive training formats (e.g., role-playing). These insights from providers furthest along the cascade indicate the importance of including comprehensive content and interactive formats in future PrEP training initiatives.

Keywords Pre-exposure prophylaxis · HIV prevention · Healthcare providers · Training programs

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Introduction

There is a significant gap between the number of people who could benefit from pre-exposure prophylaxis (PrEP) to prevent HIV and the number obtaining prescriptions. In 2018, over 1.2 million Americans were eligible for PrEP according to the Centers for Disease Control and Prevention (CDC) criteria, but only an estimated 18.1% of those individuals were prescribed PrEP [1]. The gap between the number of people who could benefit from PrEP and the number for whom PrEP is prescribed is likely even larger, as federal criteria for PrEP eligibility do not adequately capture all individuals who are at risk for HIV and could thus benefit from PrEP [2]. In order to work towards improving PrEP access for all individuals who could benefit, more healthcare providers must be empowered with the necessary training to prescribe PrEP. The present research examined the relationship between providers' level of PrEP experience and PrEP content and format training recommendations in order to understand how to optimize PrEP training programs.

Increasing provider knowledge and skills through training programs may be an efficient method to increase PrEP prescription [3], particularly because lack of knowledge is one of the most frequently identified barriers to PrEP prescription among providers [4, 5]. Likewise, providers' PrEP knowledge has been associated with greater confidence in PrEP-related clinical activities [6], intention to prescribe PrEP in the future [7, 8], and actual PrEP prescription [8]. However, previous research has found that prescription rates remain low, despite providers expressing relatively high levels of awareness of and support for PrEP [9–12]. These findings suggest that expanding providers' knowledge of PrEP and associated sexual healthcare information beyond just simple awareness is essential in order to increase PrEP prescription. Healthcare providers have reported several gaps in PrEP-related knowledge as barriers to prescription, including knowledge about research establishing the efficacy of PrEP [13], guidelines and eligibility criteria for prescribing PrEP [10, 14], skills for monitoring patients who are prescribed PrEP [15], PrEP-related risk compensation and adherence [7], methods of integrating PrEP into clinical practice [16, 17], and insurance information [15, 17].

Addressing these commonly reported knowledge gaps through training may be helpful in motivating providers to prescribe PrEP, thus increasing PrEP access. As there is no dominant, standardized training program on PrEP, existing training programs that aim to address these knowledge gaps tend to be quite varied in the content and format of information delivered. For example, the AIDS Education and Training Center's (AETC) National HIV Curriculum

provides self-guided PrEP training modules for continuing education credits that cover basic information about PrEP clinical guidelines, skills for initiating and monitoring, PrEP efficacy and clinical trial evidence, and potential risks and side effects [18]. Another recent PrEP training program for family planning providers covered information related to HIV epidemiology and prevention, patient risk assessment and referral, and example case scenarios [19]. Finally, the Training and Technical Assistance Program (T-TAP) in New York City offers several day-long PrEP trainings on various subjects, including the basics of PrEP, best practices in PrEP education and counseling, and financial barriers and benefits navigation for PrEP [20].

Overall, a variety of training programs have been found to be effective at increasing provider willingness to prescribe PrEP [21] and actual PrEP prescription [4]. However, training programs may be most effective when they reflect provider recommendations for content, which could differ based on providers' level of experience with PrEP [22]. Provider recommendations may additionally vary according to the training formats that are perceived to be most helpful to their learning experience. While some providers may recommend lectures with anonymous audience response technology, others may favor medical case discussions or demonstrations of clinical strategies [17]. As with content recommendations, format recommendations may vary depending on level of PrEP experience.

Level of PrEP experience can be conceptualized as providers' location along the PrEP implementation cascade, which includes four stages: awareness of PrEP, willingness to prescribe PrEP, discussion of PrEP with patients, and actual prescription of PrEP [12]. Location along the PrEP implementation cascade reflects increasing PrEP knowledge and experience. Clearly, there is a need for more healthcare providers to be further along the PrEP implementation cascade in order to increase access to PrEP. However, to our knowledge, no prior research has mapped provider training recommendations onto the PrEP implementation cascade.

To better understand and address PrEP education needs among providers, we surveyed healthcare providers about their experiences with PrEP as well as PrEP training content and format recommendations. We then identified providers' position along the implementation cascade based on their experience with PrEP and analyzed their content and format training recommendations to identify specific response profiles. Ultimately, we aimed to identify distinct training content and format recommendation profiles and to determine how providers' location along the implementation cascade predicted training recommendation profiles. Based on these aims, we expected that: (1) distinct subgroups ("profiles") of training content and format recommendations would emerge among the sample of healthcare providers and (2) providers' position along the implementation cascade would be

associated with membership in specific training content and format recommendation profiles.

Methods

Participants and Procedure

This survey was conducted as part of a larger study to develop a group-based training program to increase provider knowledge about PrEP and promote equitable prescription practices. All study procedures were approved by George Washington University and Yale University institutional review boards prior to inception. Participants in this study included USA healthcare providers with prescription privileges recruited in 2016–2017 via emails sent out through the American Academy of HIV Medicine and other general medicine and HIV care-related professional email distribution lists. Recruitment via professional email distribution lists is consistent with recruiting strategies used for other PrEP-related studies with providers [3, 23].

Healthcare providers were eligible to participate in the survey if they were licensed to prescribe medicine in the USA and were currently practicing in an outpatient primary care or HIV care setting in the USA. Upon consenting and enrolling in the online survey study, participants reported their demographic characteristics; medical background; and PrEP awareness, attitudes, and experiences. They also indicated their recommendations for PrEP training content and format. Upon completion of the survey, participants could either receive a \$25 gift card or be entered into a drawing for an iPad mini. All participants were then directed to the CDC PrEP website [24]. The final analytic sample consisted of 359 healthcare providers in the USA with prescription privileges.

Measures

Location Along the PrEP Implementation Cascade

Participants' location along the PrEP implementation cascade was assessed based on the following pre-established criteria: (1) awareness of PrEP, (2) willingness to prescribe PrEP, (3) discussion with patients about PrEP, and (4) actual prescription of PrEP [12]. Location along the cascade was constructed from four single-item questions used to determine each point along the cascade. (1) Awareness of PrEP was measured by the item "How would you describe your current knowledge/familiarity with PrEP?" to which participants responded with "Not at all familiar/This is my first time hearing about PrEP," "A little familiar/I've heard of PrEP but don't really know what it is," "Somewhat familiar/I know what PrEP is and basic information

about it," "Very familiar/I know a lot of information about PrEP, including details such as recent clinical trial results," or "Extremely familiar/I have expert knowledge of PrEP." Responses were dichotomized as "Not at all familiar with PrEP" or "At least some familiarity with PrEP." (2) Willingness to prescribe was measured by the item "How likely is it that you will prescribe PrEP to one or more patients in the next year?" to which participants responded with "Not at all likely," "A little bit likely," "Somewhat likely," "Very likely," or "Extremely likely." Responses were dichotomized as "Not at all likely" or "At least some likelihood." Of note, in a separate question about patient characteristics described below, all participants reported seeing patients belonging to one or more high-priority populations for PrEP in their clinical practice (see Table 1). (3) Patient consultation was measured by the item "Approximately how many HIV-negative patients have you yourself ever discussed PrEP with (including patients who chose not to use it) when you were providing direct clinical care to these patients?" Participants provided a number between 0 and 1000. Responses were dichotomized as "None" or "At least one." Lastly, (4) actual prescription of PrEP was measured by the item "Approximately how many HIV-negative patients have you ever prescribed PrEP to when you were providing direct clinical care to these patients?" Participants provided a number between 0 and 1000. Responses were dichotomized as "None" or "At least one." Participants were considered to have progressed to the most advanced of the stages consecutively endorsed. Ten participants endorsed a more advanced stage (e.g., discussing PrEP with a patient) without endorsing an earlier one (e.g., PrEP awareness) and were thus excluded because of the illogical responding pattern. One participant was excluded because they did not endorse any steps along the cascade.

PrEP Confidence To assess PrEP confidence, participants were instructed, "We want to get a sense of your confidence and comfort carrying out various clinical activities related to PrEP. Please rate your confidence for each skill listed." Participants were asked how confident they were in their ability to (1) talk to a patient about their sexual history, (2) screen a patient to determine whether they were an appropriate candidate for PrEP, (3) answer a patient's questions about PrEP, (4) suggest PrEP to a patient, (5) counsel a patient about using other methods of protection (e.g., condoms) while on PrEP, and (6) effectively monitor a patient on PrEP. Participants rated their confidence by choosing "Not at all confident," "A little bit confident," "Somewhat confident," "Very confident," or "Extremely confident."

PrEP Implementation Cascade Location Measure Validity To examine the validity of our measure of PrEP implementation cascade location, we examined its association

Table 1 Provider sociodemographic and professional characteristics by current PrEP implementation cascade stage

Characteristic	Total sample (<i>N</i> =359)	Awareness of PrEP (<i>n</i> =10)	Willing to prescribe PrEP (<i>n</i> =18)	Discuss PrEP with patients (<i>n</i> =44)	Actual prescription of PrEP (<i>n</i> =287)
	<i>N</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)
Gender**					
Female	183 (50.97)	8 (80.00)	13 (72.22)	25 (56.82)	137 (47.90)
Men	172 (47.91)	2 (20.00)	5 (27.78)	18 (40.91)	147 (51.39)
Trans and gender nonbinary individuals ^a	3 (0.84)	0 (0.00)	0 (0.00)	1 (2.27)	2 (0.69)
Race					
White	274 (76.32)	6 (60.00)	17 (94.44)	37 (84.09)	214 (74.83)
Black/African American	26 (7.24)	1 (10.00)	1 (5.56)	2 (4.55)	22 (7.69)
Asian	43 (11.98)	2 (20.00)	0 (0.00)	3 (6.82)	38 (13.29)
Other	15 (4.18)	1 (10.00)	0 (0.00)	2 (4.55)	12 (4.20)
Ethnicity					
Latinx/Hispanic identity	26 (7.24)	0 (0.00)	3 (16.67)	6 (13.64)	17 (5.94)
Sexual orientation**					
Heterosexual	257 (71.59)	6 (60.00)	18 (100.00)	37 (84.09)	196 (68.29)
Sexual minority	90 (25.07)	3 (30.00)	0 (0.00)	3 (6.82)	84 (29.27)
Prefer not to disclose	12 (3.34)	1 (10.00)	0 (0.00)	4 (9.09)	7 (2.44)
Country of birth					
USA	309 (86.07)	7 (70.00)	15 (83.33)	39 (88.64)	248 (86.41)
Other	50 (13.93)	3 (33.33)	3 (16.67)	5 (11.36)	39 (13.59)
Medical title(s)/degree(s)*					
Doctorate degrees (e.g., MD, DO)	239 (66.57)	7 (70.00)	16 (88.89)	34 (77.27)	182 (63.41)
Nursing degrees (e.g., APRN, NP)	83 (23.12)	2 (20.00)	2 (11.11)	9 (20.45)	70 (24.39)
Physician's assistant degree	37 (10.31)	1 (10.00)	0 (0.00)	1 (2.27)	35 (12.20)
HIV specialist status***					
Primary care provider	116 (32.31)	8 (80.00)	16 (88.89)	32 (72.73)	60 (20.91)
HIV specialist	243 (67.69)	2 (20.00)	2 (11.11)	12 (27.27)	227 (79.09)
Medical setting**					
Community health center only	87 (24.23)	1 (10.00)	4 (22.22)	7 (15.91)	75 (26.13)
Hospital setting only	18 (5.01)	1 (10.00)	2 (11.11)	1 (2.27)	14 (4.88)
University academic setting only	58 (16.16)	3 (30.00)	7 (38.89)	13 (29.55)	35 (12.20)
Other single healthcare setting	63 (17.55)	0 (0.00)	1 (5.56)	6 (13.64)	56 (19.51)
Two or more healthcare settings	133 (37.05)	5 (50.00)	4 (22.22)	17 (38.64)	107 (37.28)
Region of practice**					
West	89 (24.79)	0 (0.00)	3 (16.67)	3 (6.82)	83 (28.92)
Midwest	41 (11.42)	3 (30.00)	5 (27.78)	4 (9.09)	29 (10.10)
Northeast	143 (39.83)	3 (30.00)	6 (33.33)	24 (54.55)	110 (38.30)
South	86 (23.96)	4 (40.00)	4 (22.22)	13 (29.55)	65 (22.65)
Geographic setting of practice					
Urban	277 (77.16)	9 (90.00)	15 (83.33)	35 (79.55)	218 (75.96)
Suburban	66 (18.38)	1 (10.00)	2 (11.11)	6 (13.64)	57 (19.86)
Rural	16 (4.46)	0 (0.00)	1 (5.56)	3 (6.82)	12 (4.18)
Patient characteristics^b					
Men who have sex with women	350 (97.49)	10 (100.00)	15 (83.33)	42 (95.45)	283 (98.61)
Men who have sex with men	355 (98.89)	10 (100.00)	17 (94.44)	43 (97.73)	285 (99.30)
Women who have sex with men	356 (99.16)	10 (100.00)	16 (88.89)	43 (97.73)	287 (100.00)
Women who have sex with women	304 (84.68)	10 (100.00)	13 (72.22)	36 (81.82)	245 (85.37)
Transgender woman	301 (83.84)	7 (70.00)	11 (61.11)	24 (54.55)	259 (90.24)
Transgender men	205 (57.10)	4 (40.00)	4 (22.22)	17 (38.64)	180 (62.72)

Table 1 (continued)

Characteristic	Total sample ($N=359$)	Awareness of PrEP ($n=10$)	Willing to prescribe PrEP ($n=18$)	Discuss PrEP with patients ($n=44$)	Actual prescription of PrEP ($n=287$)
	N (%)	n (%)	n (%)	n (%)	n (%)
Patients who exchange sex for money, drugs, or other goods	329 (91.64)	9 (90.00)	13 (72.22)	36 (81.82)	271 (94.43)
Patients who inject drugs	343 (96.66)	9 (90.00)	16 (88.89)	41 (93.18)	281 (97.91)

* $p < .05$ ** $p < .01$ *** $p < .001$ ^aExcluded for comparative analyses^bRepresents the number of providers with 1 + current or former patients who they perceived as belonging to the specified group

with confidence in PrEP-related clinical activities and HIV specialization. Location along the cascade was significantly positively correlated with providers' reported confidence providing different types of PrEP related services, including talking to a patient about sexual health history ($r=0.28$), screening a patient for PrEP ($r=0.57$), answering a patient's PrEP-related questions ($r=0.64$), suggesting PrEP to a patient ($r=0.62$), counseling a patient on other protection methods while being on PrEP ($r=0.32$), and monitoring a patient on PrEP ($r=0.65$) (see online supplemental material).

To assess PrEP specialization, participants reported whether they identified as an HIV specialist ([0] no or [1] yes). Providers' location along the cascade varied significantly by providers' HIV specialist status: Examined using the Mann–Whitney U test, HIV specialists were significantly further along the cascade than primary care providers ($U=8146.00$, $p < 0.0001$).

PrEP Training Recommendations

Participants' recommendations for future PrEP training programs were prefaced with the information, "We would like your input on a few things related to the PrEP training program that we are developing for providers like yourself. This will be a 1 h, single-session training offered as part of continuing medical education."

PrEP Training Content Recommendations A list of topics for PrEP training was developed based on review of past literature and earlier formative work with USA early adopting PrEP providers regarding their insight into content and strategies for PrEP training [17]. Participants were asked, "What PrEP-related topics would be most useful for us to cover in order to make primary care providers feel more comfortable prescribing PrEP? Check all that apply." Participants then endorsed recommended training topics from the pre-established list of options, such as HIV background, efficacy

of PrEP, and clinical trial evidence of PrEP (See Table 2). Participants were also provided with a free response field to recommend any content that had not been included on the list. The content recommendation option of "Other," associated with the free response field, was excluded from analyses. Idiosyncratic responses from nine participants were excluded from latent class analysis as these unique categories did not contribute to broader classifications (e.g., a response about the cost of PrEP versus a response about managing potential lab abnormalities).

PrEP Training Format Recommendations A list of activities for PrEP training was also developed based on earlier formative work [17]. Participants were asked, "What activities do you think would be most helpful for learning in the 1 h training with providers? Check all that apply." Participants then indicated their preferred activities from the pre-established list of options, such as informational lecture, case presentation of actual PrEP patient, and full group discussion of hypothetical patient case (See Table 2). Participants were also provided with a free response field to add formats that they would prefer that had not been included on the list. The format recommendation option of "Other," associated with the free response field, was excluded from analyses. This was done because only one participant endorsed this option (participant recommended having existing PrEP patients conduct some training for providers). Further, the format recommendation option of "Open Q&A opportunity for audience to ask trainers any questions" was excluded from analyses because only two of the providers in the sample endorsed this option (see Table 2).

Sociodemographic Characteristics

Participants reported their gender, race, ethnicity, sexual orientation, and country of birth. For comparative inferential analyses, gender was dichotomized as (1) female or (2) male. Gender non-binary individuals were excluded from

Table 2 Providers' PrEP training content recommendations and format preferences relative to current PrEP implementation cascade stage

Providers' PrEP training needs	PrEP implementation cascade			
	Awareness of PrEP (<i>n</i> = 10)	Willing to prescribe PrEP (<i>n</i> = 18)	Discuss PrEP with patients (<i>n</i> = 44)	Actual prescription of PrEP (<i>n</i> = 287)
	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)
Training content recommendations				
HIV background	2 (20.00)	2 (11.11)	12 (27.27)	130 (45.30)
Efficacy of PrEP	7 (70.00)	11 (61.11)	34 (77.27)	245 (85.37)
Risks/side effects of PrEP	9 (90.00)	14 (77.78)	35 (79.55)	239 (83.28)
Clinical trial evidence for PrEP	9 (90.00)	11 (61.11)	32 (72.73)	223 (77.70)
Biological mechanisms of PrEP	4 (40.00)	3 (16.67)	12 (27.27)	127 (44.25)
Clinical protocol for initiating and monitoring patients on PrEP	9 (90.00)	15 (83.33)	39 (88.64)	257 (89.55)
How to take sexual history	4 (40.00)	5 (27.78)	14 (31.82)	190 (66.20)
How to talk about sex with a patient who is a sexual minority	4 (40.00)	5 (27.78)	17 (38.64)	173 (60.28)
PrEP adherence and drug resistance	7 (70.00)	10 (55.56)	27 (61.36)	183 (63.76)
Clinical guidelines for determining patient eligibility for PrEP	8 (80.00)	15 (83.33)	36 (81.82)	243 (84.67)
Other content recommendations ^a	0 (0.00)	0 (0.00)	0 (0.00)	9 (3.14)
Training format preferences				
Informal lecture with PowerPoint slides	7 (70.00)	12 (66.67)	20 (45.45)	178 (62.02)
Case presentation of actual PrEP patient	6 (60.00)	8 (44.44)	32 (72.73)	216 (75.26)
Full group discussion of hypothetical patient case	3 (30.00)	4 (22.22)	12 (27.27)	116 (40.42)
Small group breakout sessions to discuss hypothetical patient case	2 (20.00)	2 (11.11)	12 (27.27)	76 (26.48)
Multiple trainers role playing how to talk to patients about PrEP	6 (60.00)	6 (33.33)	25 (56.82)	169 (58.89)
Audience members role playing how to talk to patients about PrEP	2 (20.00)	7 (38.89)	17 (38.64)	124 (43.21)
Question and Answer sessions with trainers using anonymous handheld devices	3 (30.00)	0.00 (0.00)	12 (27.27)	113 (39.37)
Open Question and Answer sessions with trainers ^a	0.00 (0)	0.00 (0)	0.00 (0)	2 (0.70)
Other format preferences ^a	3 (30.00)	4 (22.22)	19 (43.18)	136 (47.39)

^aExcluded from analyses

comparative inferential analyses because of the small subsample size (*n* = 3). Race was recoded into (1) White, (2) Black, (3) Asian, or (4) other.

Professional Characteristics

Participants reported various characteristics of their medical background and practice.

Medical Title(s)/Degree(s) Participants indicated their medical titles and degrees by choosing all that applied from the following list: (1) doctor of medicine (MD), (2) doctor of osteopathic medicine (DO), (3) advanced practice registered nurse (APRN), (4) nurse practitioner (NP), (5) registered nurse (RN), (6) certified nurse midwife (CNM), (7) physician assistant (PA), (8) student, and (9) other. For inferential analyses, medical title(s)/degree(s) were recoded into (1) doctoral degree (e.g., MD, DO), (2) nursing degree (e.g., APRN, NP, RN, CNM), or (3) Physician's Assistant degree.

Medical Setting In addition to reporting HIV specialization, participants indicated the setting in which they practiced medicine by choosing all that applied from the following list: (1) community health center, (2) hospital, (3) physician practice group, (4) sexually transmitted infection (STI) clinic or AIDS Service Organization, (5) health department, (5) university/academic setting, (6) corporation, (7) Veteran's Affairs healthcare setting, and (8) other setting. For inferential analyses, practice characteristics were recoded into (1) community health setting only, (2) hospital setting only, (3) university academic medical setting only, (4) other single healthcare setting, or (5) two or more healthcare settings.

Region of Practice Participants indicated the region of the USA in which they currently practiced medicine by choosing (1) west, (2) midwest, (3) northeast, or (4) south.

Geographic Setting of Practice Participants indicated the geographic setting in which they currently practiced medicine by choosing (1) urban, (2) suburban, or (3) rural.

Patient Characteristics Participants indicated, to the best of their knowledge, whether any of their current or former patients had been (1) men who have sex with women; (2) men who have sex with men; (3) women who have sex with men; (4) women who have sex with women; (5) transgender men; (6) transgender women; (7) individuals who exchange sex for money, drugs, or other goods; or (8) people who inject drugs.

Analysis

The analytic sample for this study was restricted to respondents who completed the survey, as indicated by responding to the last item of the survey, as well as those healthcare providers with prescription privileges and whose location along the PrEP implementation cascade could be accurately identified. Gender non-binary individuals were excluded from comparative inferential analyses because of the small sub-sample size ($n=3$). Differences in PrEP cascade location by provider characteristics were assessed through Mann–Whitney U tests and Kruskal–Wallis tests. Associations between participants' confidence with PrEP and cascade location were tested using Pearson correlations. To test our primary aims, latent class analysis was first performed to identify PrEP training content recommendation classes and PrEP training format recommendation classes [16, 25]. Various models that emerged from the data were assessed and selected based on a maximum likelihood solution $> 60\%$ [26]. Model fit statistics were then evaluated using established criteria [i.e., G-squared fit statistics, Akaike Information Criterion (AIC), and Bayesian Information Criterion (BIC)] as well as interpretability. For both of these indicators, a lower value indicated a better fit. Content and format recommendations were determined to be characteristics of a latent class using a cut-off of 0.50, with probabilities closer to one indicating a greater likelihood that individuals in that class endorsed that recommendation [26]. We then performed latent class regression analyses to identify the association between participants' cascade location and class membership for content and format recommendations separately. Covariates for the regression analyses were selected based on statistically significant association ($p < 0.05$) with the predictor variable (i.e., PrEP implementation cascade location) as well as outcomes (recommended training content or format classes). All analyses were performed using IBM SPSS v. 26 and a PROC LCA macro in SAS 9.4 [27].

Results

Overall Sample Characteristics

Seven hundred and one participants responded to the survey. Of the 701 responses, 325 (46.36%) were excluded because of incomplete survey responses, 11 (1.57%) were excluded because of inconsistent/illogical response pattern to the cascade measure (e.g., discussing PrEP with a patient without endorsing PrEP awareness), 4 (0.57%) were excluded because of possibly fraudulent response patterns, and 2 (0.29%) were excluded because participants did not endorse medical degrees with prescription privileges. The final analytic sample of healthcare providers ($N=359$) included 50.97% women, 47.91% men, and 0.84% transgender and nonbinary individuals.

Providers' Location Along the PrEP Implementation Cascade

A total of 359 providers were categorized according to the four stages of the PrEP implementation cascade. Eleven participants were excluded because their location along the implementation cascade could not be accurately identified. Most providers endorsed all four stages of the cascade, including awareness (100%), willingness to prescribe (97.21%), discussion with patients (92.20%), and actual prescription (79.94%). Reframed according to providers' location along the cascade, 2.79% of the sample endorsed only being aware of PrEP, 5.01% had progressed to willingness to prescribe, 12.26% had progressed to discussing PrEP with their patients, and 79.94% had progressed to prescribing PrEP to their patients. Provider's location along the cascade varied significantly by providers' gender, sexual orientation, region of practice, and HIV specialist status. Providers who identified as men were significantly further along the cascade than providers who identified as women, $U=13,961.00$ ($p=0.008$). Providers who identified as sexual minorities were further along the cascade when compared to providers who identified as heterosexual as well as providers who chose not to disclose their sexual orientation ($H=14.60$, $p=0.001$). Providers' location along the cascade differed significantly by their region of practice ($H=14.16$, $p=0.003$), medical degree ($H=7.93$, $p=0.019$), and setting of medical practice ($H=19.88$, $p=0.001$). The implementation cascade mean rank of providers who practiced medicine in the Western region of the USA was higher when compared to providers who practiced medicine in the Midwest, Northeast, and South. Providers with nursing or physician's assistant degrees had a higher mean rank for their position along

the implementation cascade when compared to those with doctorate degrees. Finally, providers who worked in community health settings only, other single settings, or two or more settings had a higher mean rank for their position along the implementation cascade when compared to those working in hospital settings only or university academic settings only.

PrEP Training Content Recommendations

Providers’ PrEP training content recommendations and format recommendations at each step of the cascade are presented in Table 2. A three-class model was identified as optimal for providers’ PrEP training content recommendations using established fit criteria for latent class analysis (see Table 3) [26]. The item-response probabilities for each profile, which indicates the conditional probability of reporting

each recommendation given membership in a latent class, are presented in Table 4.

The first profile (Class 1: *PrEP clinical implementation only*; 23.65% of the sample) was characterized by recommendations to cover a clinical protocol for initiating and monitoring patients on PrEP and clinical guidelines for determining patient eligibility for PrEP. These two recommendations were probable for all three profiles. In addition to the clinical protocol and clinical guidelines, the second profile (Class 2: *PrEP clinical implementation and PrEP background*; 43.75% of the sample) was also characterized by recommendations to cover the efficacy of PrEP, risks/side effects of PrEP, and clinical trial evidence for PrEP. All recommendations characteristics of Class 2 were also probable for the third profile (Class 3: *PrEP clinical implementation and comprehensive sexual health background*; 32.60% of the sample). Additionally, the third profile was characterized by recommendations to include content on HIV background

Table 3 Fit statistics for competing latent class models of providers’ PrEP training content recommendation profiles with two to four classes and PrEP training format preference profiles with three to five classes ($N=359$)

	Number of classes	Solution percentage	G^{2*}	df	Log-likelihood	AIC	BIC
PrEP training content recommendations	2	100%	607.87	1002	-1788.32	649.87	731.42
	3	83%	500.89	991	-1734.82	564.89	689.15
	4	71%	436.22	980	-1702.49	522.22	689.20
PrEP training format preferences	2	100%	179.29	112	-1548.94	209.29	267.54
	3	91%	141.24	104	-1529.92	187.24	276.55
	4	70%	118.89	96	-1518.75	180.89	301.27

G^{2*} likelihood-ratio chi-square statistic, *df* degrees of freedom, *AIC* Akaike’s information criterion, *BIC* Bayesian information criterion

Table 4 Item-response probabilities for three PrEP training content recommendation profiles reported by healthcare providers ($N=359$)

Class prevalence	Class 1	Class 2	Class 3
	PrEP clinical implementation only	PrEP clinical implementation and PrEP background	PrEP clinical implementation and comprehensive sexual health background
	23.65%	43.75%	32.60%
Content recommendation	Item response probabilities		
HIV background	0.12	0.23	0.87
Efficacy of PrEP	0.44	0.91	1.00
Risks/side effects of PrEP	0.41	0.93	1.00
Clinical trial evidence for PrEP	0.43	0.81	0.95
Biological mechanism of PrEP	0.15	0.25	0.80
Clinical protocol for initiating and monitoring patients on PrEP	0.62	0.98	0.97
How to take sexual history	0.41	0.42	0.97
How to talk about sex with sexual minority patients	0.42	0.32	0.96
Adherence and drug resistance	0.31	0.57	0.95
Clinical guidelines for determining patient eligibility for PrEP	0.50	0.95	0.94

information, biological mechanisms of PrEP, training on how to take a sexual history and how to talk about sex with sexual minority patients, and adherence and drug resistance.

Content Recommendation Class Association with Providers' Location Along the PrEP Implementation Cascade

Providers' location along the PrEP implementation cascade was tested as a predictor of training content recommendation class membership using latent class regression analysis [26]. Providers' location along the cascade was predictive of class membership when the regression model was run without adjusting for any background characteristics ($p < 0.001$) and after adjusting for providers' gender, sexual orientation, medical setting, and region of practice ($p = 0.0013$). Providers who were further along the cascade were more likely to recommend *PrEP clinical implementation and comprehensive sexual health background* (Class 3) than *PrEP Clinical Implementation Only* (Class 1) or *PrEP clinical implementation and PrEP background* (Class 2).

PrEP Training Format Recommendations

A three-class model was identified as optimal for providers' PrEP training format recommendations using similarly established fit criteria (see Table 3) as well as interpretability [26]. The item-response probabilities for each format recommendation by latent class are presented in Table 5.

The first profile (Class 1: *Informational lecture only*; 17.35% of the sample) was characterized solely by recommendation of informational lectures. The second profile (Class 2: *Non-interactive diverse formats*; 73.44% of the sample) was characterized by recommendation of informational lectures, case presentation of actual patient on PrEP,

and trainers role-playing how to talk to patients about PrEP. The third profile (Class 3: *Interactive diverse formats*; 9.20% of the sample), which was the most expansive profile, was characterized by recommendation of diverse, interactive training formats: informational lecture, case presentation of actual patient on PrEP, full group discussion of hypothetical patient case, small group sessions to discuss hypothetical patients, trainer and audience role-play for best practices to talk to patients about PrEP, and opportunity to respond to trainers' questions anonymously using handheld devices.

Format Recommendation Class Association with Providers' Location Along the PrEP Implementation Cascade

Providers' location along the PrEP implementation cascade was tested as a predictor of training format recommendation class membership using latent class regression analysis [26]. Providers' location along the cascade was predictive of class membership when the regression model was run without adjusting for any background characteristics ($p = 0.0016$) and after adjusting for providers' gender, sexual orientation, medical setting, and region of practice ($p = 0.0034$). Providers who were further along the cascade were more likely to prefer *diverse interactive formats* (Class 3) and *diverse non-interactive formats* (Class 2) than *informational lecture only* (Class 1).

Discussion

Results of the current study illuminate healthcare providers' perspectives on the content and format that could optimize future PrEP training programs for providers. We identified three profiles for PrEP training content recommendations,

Table 5 Item-response probabilities for four PrEP training format preference profiles reported by healthcare providers ($N = 359$)

Class prevalence	Class 1 Information lecture only	Class 2 Non-interactive diverse formats	Class 3 Interactive diverse formats
	17.35%	73.44%	9.20%
Format preference	Item response probabilities		
Informational lecture	0.93	0.52	0.71
Case presentation of actual PrEP patient	0.42	0.77	1.00
Trainer-led full group discussion of hypothetical patient case	0.00	0.39	0.98
Small group breakout session to discuss hypothetical patient cases	0.00	0.22	0.96
Multiple trainers role-playing how to talk to patients about PrEP	0.26	0.60	0.94
Audience members role-playing how to talk to patients about PrEP	0.16	0.41	0.94
Audience members responding anonymously via handheld devices to trainers' questions	0.00	0.37	0.91

including *PrEP clinical implementation only*, *PrEP clinical implementation & PrEP background*, and *PrEP clinical implementation & comprehensive sexual health background*, which varied in terms of the comprehensiveness of recommended content. We additionally identified three profiles for training format recommendations, including *informational lecture only*, *diverse non-interactive formats*, and *diverse interactive formats*, which differed in scope and degree of trainer-learner interaction. The most frequently endorsed profile for content recommendations was *PrEP clinical implementation & PrEP background* (43.7% of providers) and for format recommendations was *diverse non-interactive formats* (73.4% of providers).

Providers' location along the PrEP implementation cascade was associated with membership in specific training content and format recommendation profiles. With regard to content recommendations, providers further along the cascade were more likely to recommend the most comprehensive training content (i.e., *PrEP clinical implementation & comprehensive sexual health background*) than the other two content recommendation profiles. Providers earlier on the cascade were more likely to recommend *PrEP clinical implementation only* compared to *PrEP clinical implementation and comprehensive sexual health background*. While providers earlier in the cascade were more focused on the logistics of PrEP clinical implementation, insight from providers further along the cascade indicates that comprehensive training on sexual health in addition to PrEP-specific information may be essential to increasing PrEP prescription and access. For format recommendations, providers further along the cascade were more likely to prefer more applied and interactive formats (i.e., *diverse interactive formats*) compared to the other two format recommendation profiles. These results suggest that PrEP-experienced providers tend to recognize that more applied and interactive format options offer additional learning value that would be beneficial within the context of PrEP training.

Implications

Our findings provide further support for research that has previously identified comprehensive training content beyond PrEP-specific guidelines as important for supporting providers' location along the implementation cascade. Petroll et al. found that primary care providers showed large drop-offs between awareness of PrEP and discussion of PrEP with patients [3], indicating that more expansive training is needed to equip these providers with the necessary skills and knowledge to progress along the PrEP implementation cascade. Previous literature has also identified several knowledge gaps [7, 10, 13–17, 21] that align with the content recommendations of providers in this study who were more advanced in their location along the PrEP cascade. For

example, beyond PrEP-specific information, early-adopting providers endorsed sexual history taking and sexual minority competence as essential topics to discuss in PrEP training programs [17], thus providing further support for the expansion of existing PrEP training programs to include comprehensive sexual health background information.

PrEP training format recommendations from providers later in the cascade suggest that applied and interactive formats, such as case applications, role-plays, or group discussions, may additionally help providers to progress along the implementation cascade. Although limited research has previously focused on PrEP training format recommendations, Broekhuis et al. found that providers were more likely to prescribe PrEP if they had prior experience with counseling patients on PrEP-related decisions [21]. This suggests that applied/interactive training formats where providers can learn how to engage patients in discussions about PrEP and practice counseling skills could be effective in increasing provider comfort and readiness to prescribe PrEP. Furthermore, a qualitative study examining provider reactions to various training formats found that providers with PrEP prescription experience consistently recommended medical case discussion and application but expressed mixed reactions to audience role-plays or small group break-out sessions [17]. Although these findings seem partially contradictory to our results, the discrepancy may merely reflect the variability and nuance in format recommendations showcased by qualitative research and not captured as readily in the current quantitative findings, which represent average recommendations across a large sample.

When comparing the training content and format recommendations of PrEP-experienced providers to those with less experience, there appears to be a mismatch between what providers earlier in the cascade perceive as needed and what more experienced providers recognize as necessary to optimize training programs. Specifically, providers with less PrEP experience tend to recommend PrEP-focused training content and prefer lecture- and presentation-based formats, while PrEP-experienced providers tend to recommend more comprehensive training content and more applied and interactive formats. This finding is consistent with the fact that lack of knowledge is one of the most frequently identified barriers to PrEP prescription [4, 5], and may suggest that lack of knowledge may itself act as a barrier to knowing what kind of training is necessary to progress to the latter end of the PrEP implementation cascade. Put simply, PrEP-inexperienced providers may not know what they do not know (and need to know). Although this disconnect between what PrEP-inexperienced providers want and what they need in training programs may impact provider receptivity to training, existing research suggests that matching instructional methods and curricula to the discipline itself rather than

to learner preferences may be more effective in promoting student learning [28]. Thus, insight from PrEP-experienced providers, who may be more capable of identifying and recommending the optimal types of training content and format for this discipline, can play a crucial role in designing effective PrEP training programs.

Ultimately, PrEP training is essential to address commonly reported knowledge gaps and support providers' progression along the PrEP implementation cascade [4, 14, 21]. Providers earlier in the cascade, who may be less aware of the content required to progress to the end of the cascade, should be targeted with comprehensive PrEP training programs in order to increase PrEP prescription. Comprehensive training may also remain an ongoing process for PrEP-experienced providers to stay up to date on the latest information and to work on other factors, like cultural competence, that influence prescription [2]. Additionally, current research points towards disparities in clinical judgments and PrEP prescription practices among practitioners. Although certain minority communities, such as Black and Latinx men who have sex with men (MSM), are at heightened risk for HIV [29, 30], PrEP prescriptions are disproportionately provided to White individuals [1, 31]. This information suggests a need for training that addresses biases among providers at all locations along the implementation cascade [32, 33]. However, training alone may not be sufficient to produce enduring change. System-level and clinic-level factors are also important and can limit or facilitate the effectiveness of training. For example, training programs may be particularly effective at increasing PrEP prescription when implemented in tandem with other interventions that address key system-level and clinic-level barriers to prescription, including lack of funding for sustainable PrEP programming, lack of insurance coverage, lack of tools to facilitate PrEP implementation and delivery, and lack of local champions who can serve as a role model or clinical resource [34–36].

Beyond the intended goals of our study, we were also able to provide preliminary evidence for the validation of our measure of provider location along the PrEP implementation cascade. Although previous research had established criteria for the PrEP implementation cascade [12], no agreed-upon measure existed for provider location along the cascade. Using our measure, we found a significant positive association between provider location along the implementation cascade and confidence in PrEP-related clinical activities, which is consistent with existing literature [6]. Additionally, HIV specialists were more likely than PCPs to be farther along the implementation cascade, which is expected given that HIV specialists have been found to be more likely to have previously prescribed PrEP compared to PCPs [12, 37]. While future research should continue to explore the psychometric properties of this measure, the findings from this study are promising.

Limitations and Future Directions

There are several limitations to the current study. The majority of providers in the sample practiced medicine in urban areas in the Northeast region of the USA, limiting the generalizability of our findings. Recruitment of healthcare providers for research purposes can be challenging [38], and our recruitment of a convenience sample is consistent with the sampling strategies of other studies seeking to assess provider knowledge of and experience with PrEP [3, 23]. The sample for this study also showed limited variability in cascade location, with the majority of participants positioned toward the later end of the PrEP implementation cascade. In addition, likely because participants in our sample were recruited through the American Academy of HIV Medicine listserv, PrEP awareness and willingness to discuss or prescribe PrEP were higher than those obtained in previous research [12], which generally sampled providers more broadly. Moreover, even within the providers we attempted to recruit, those who were already familiar with or interested in PrEP may have been more likely to volunteer to participate in a survey about PrEP, thus creating a more experienced and more interested sample that was farther along the implementation cascade. Because our sample is comprised of a more PrEP-experienced and possibly more PrEP-interested group of providers, the results may not be representative of providers earlier on in the cascade or providers who are less interested in learning about PrEP. Furthermore, the limited variability in the cascade variable may have limited our ability to identify other significant differences between training content and format with regard to location along the implementation cascade. However, our sample of PrEP-experienced providers was able to offer greater wisdom about training content and format recommendations than we likely would have captured with a less experienced sample.

With regard to items used to measure providers' location along the implementation cascade, we operationalized the second stage—willingness to prescribe PrEP—as providers' likelihood of prescribing PrEP. Adams and Balderson [15] examined providers' likelihood of prescribing PrEP to patients, which was included by Zhang et al. in their systematic review when calculating the pooled prevalence of willingness to prescribe PrEP [12]. However, there may be a conceptual distinction between them. Willingness to prescribe PrEP may primarily reflect one's inclination to behave in a certain way, whereas likelihood to prescribe PrEP may involve that inclination but also be further influenced by contextual variables (e.g., clinic-level or system-level factors such as lack of insurance coverage or PrEP implementation tools) that could preset barriers to actually being able to prescribe PrEP. Overall, the items comprising providers' location along the cascade were developed for this survey.

Given that they were not piloted prior to survey distribution, we checked the validity of our measure of PrEP implementation cascade location by examining its association with providers' confidence in PrEP-related clinical activities and HIV specialization. Consistent with our expectations, a further location along the cascade was associated with providers' reported confidence in offering different types of PrEP-related clinical services. HIV care specialists were also significantly further along the cascade than primary care providers.

Future research could expand insights from the current study by creating a PrEP training program that integrates comprehensive content and applied/interactive training formats and evaluating how effective it is at moving providers further along the PrEP implementation cascade compared to existing PrEP training programs. Specifically, this research could evaluate the acceptability and the differential impact of this new program for providers starting at different steps along the PrEP implementation cascade. Given the context of the current COVID-19 pandemic, additional research could explore the acceptability of in-person versus online training formats. Learner engagement and interaction may be easier to facilitate through in-person training than through online training [39, 40]. However, online training opportunities can reach a wider audience and are not limited by pandemic-related health restrictions. Further, online trainings for healthcare providers on motivational interviewing or evidence-based psychotherapies led to similar gains in skills and knowledge in comparison to in-person training, indicating that this may be a promising avenue for PrEP training as well [41, 42]. Finally, considering the disconnect between the structure of the proposed comprehensive training program and the recommendations and preferences of providers earlier in the implementation cascade, further research should investigate receptivity to and engagement in this training program among PrEP-inexperienced providers in order to ensure that the program is indeed appropriate for this population.

Conclusions

The current study identified distinct profiles for training content and format recommendations, which reveal the presence of varied priorities. Insight from providers further along the cascade provides evidence that PrEP training programs with more expansive content and applied and interactive formats may improve existing training programs. The findings from this study are particularly relevant for continuing medical education, a key opportunity for intervention with practicing providers with regard to expanding overall knowledge as well as patient care.

Alternatively, PrEP training programs could be embedded within the broader medical training that is required for licensure in order to ensure that all healthcare providers are adequately knowledgeable about PrEP. By modifying PrEP training programs to reflect the training content and format recommendations from PrEP-experienced providers, we can support providers' location along the PrEP implementation cascade, thereby increasing the number of providers offering PrEP and ultimately increasing access to PrEP, which is an important step towards health equity.

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Data Availability Data are currently not included in a public repository.

Declarations

Conflict of interest Sarah K. Calabrese received partial support from Gilead Sciences to attend a research conference. Douglas S. Krakower has been a consultant to Fenway Health for research studies funded by Gilead Sciences and has received personal fees to develop medical education content for Medscape, MED-IQ, DKBMed, and UpToDate, Inc. Kenneth H. Mayer has conducted research with unrestricted project support from Gilead Sciences and Merck.

Ethical Approval All study procedures and instruments were approved by the Institutional Review Boards at George Washington University and Yale University.

Informed Consent Informed consent was obtained from study participants.

Consent to Publish The authors affirm that human research participants provided informed consent for publication of de-identified data. No identifying information is included in the manuscript.

References

- Harris NS, Johnson AS, Huang YA, et al. Vital signs: status of human immunodeficiency virus testing, viral suppression, and HIV preexposure prophylaxis—United States, 2013–2018. *MMWR Morb Mortal Wkly Rep.* 2019;68(48):1117–23. <https://doi.org/10.15585/mmwr.mm6848e1>.
- Calabrese SK, Willie TC, Galvao RW, et al. Current USA guidelines for prescribing pre-exposure prophylaxis (PrEP) disqualify many women who are at risk and motivated to use PrEP. *JAIDS.* 2019;81(4):395–405. <https://doi.org/10.1097/QAI.00000000000002042>.
- Petroll AE, Walsh JL, Owczarzak JL, McAuliffe TL, Bogart LM, Kelly JA. PrEP awareness, familiarity, comfort, and prescribing experience among USA primary care providers and HIV specialists. *AIDS Behav.* 2017;21(5):1256–67. <https://doi.org/10.1007/s10461-016-1625-1>.
- Clement ME, Seidelman J, Wu J, et al. An educational initiative in response to identified PrEP prescribing needs among PCPs in the Southern USA. *AIDS Care.* 2018;30(5):650–5. <https://doi.org/10.1080/09540121.2017.1384534>.
- Seidman D, Carlson K, Weber S, Witt J, Kelly PJ. United States family planning providers' knowledge of and attitudes towards preexposure prophylaxis for HIV prevention: a national survey. *Contraception.* 2016;93(5):463–9. <https://doi.org/10.1016/j.contraception.2015.12.018>.
- Walsh JL, Petroll AE. Factors related to pre-exposure prophylaxis prescription by USA primary care physicians. *Am J Prev Med.* 2017;52(6):165–72. <https://doi.org/10.1016/j.amepre.2017.01.025>.
- Blackstock OJ, Moore BA, Berkenblit GV, et al. A cross-sectional online survey of HIV pre-exposure prophylaxis adoption among primary care physicians. *J Intern Med.* 2017;32(1):62–70. <https://doi.org/10.1007/s11606-016-3903-z>.
- Blumenthal J, Jain S, Krakower D, et al. Knowledge is power! increased provider knowledge scores regarding pre-exposure prophylaxis (PrEP) are associated with higher rates of PrEP prescription and future intent to prescribe PrEP. *AIDS Behav.* 2015;19(5):802–10. <https://doi.org/10.1007/s10461-015-0996-z>.
- Karris MY, Beekmann SE, Mehta SR, Anderson CM, Polgreen PM. Are we prepped for preexposure prophylaxis (PrEP)? Provider opinions on the real-world use of PrEP in the United States and Canada. *Clin Infect Dis.* 2014;58(5):704–12. <https://doi.org/10.1093/cid/cit796>.
- Krakower D, Ware N, Mitty JA, Maloney K, Mayer KH. HIV providers' perceived barriers and facilitators to implementing pre-exposure prophylaxis in care settings: a qualitative study. *AIDS Behav.* 2014;18(9):1712–21. <https://doi.org/10.1007/s10461-014-0839-3>.
- Smith DK, Mendoza MC, Stryker JE, Rose CE. PrEP awareness and attitudes in a national survey of primary care clinicians in the United States, 2009–2015. *PLoS ONE.* 2016;11(6):e0156592. <https://doi.org/10.1371/journal.pone.0156592>.
- Zhang C, McMahon J, Fiscella K, Przybyla S, Braksmajer A, LeBlanc N, Liu Y. HIV pre-exposure prophylaxis implementation cascade among health care professionals in the United States: implications from a systematic review and meta-analysis. *AIDS Patient Care STDS.* 2019;33(12):507–27.
- Desai M, Gafos M, Dolling D, McCormack S, Nardone A. Healthcare providers' knowledge of, attitudes to and practice of pre-exposure prophylaxis for HIV infection. *HIV Med.* 2016;17(2):133–42. <https://doi.org/10.1111/hiv.12285>.
- Edelman EJ, Moore BA, Calabrese SK, et al. Preferences for implementation of HIV pre-exposure prophylaxis (PrEP): results from a survey of primary care providers. *Prev Med Rep.* 2020;17:101012. <https://doi.org/10.1016/j.pmedr.2019.101012>.
- Adams LM, Balderson BH. HIV providers' likelihood to prescribe pre-exposure prophylaxis (PrEP) for HIV prevention differs by patient type: a short report. *AIDS Care.* 2016;28(9):1154–8. <https://doi.org/10.1080/09540121.2016.1153595>.
- Castel AD, Feaster DJ, Tang W, et al. Understanding HIV care provider attitudes regarding intentions to prescribe PrEP. *J Acquir Immune Defic Syndr.* 2015;70(5):520–8. <https://doi.org/10.1097/QAI.0000000000000780>.
- Calabrese SK, Magnus M, Mayer KH, et al. Putting PrEP into practice: lessons learned from early-adopting USA providers' firsthand experiences providing HIV pre-exposure prophylaxis and associated care. *PLoS ONE.* 2016;11(6):e0157324. <https://doi.org/10.1371/journal.pone.0157324>.
- Spach DH, Kalapila AG. Lesson 5. Preexposure Prophylaxis (PrEP). Farley JE, reviewer. National HIV Curriculum. AIDS Education and Training Center; 2020. Available at: <https://www.hiv.uw.edu/go/prevention/preexposure-prophylaxis-prep/core-concept/all#citations>. Accessed 30 June 2021.
- Sales JM, Cwiak C, Haddad LB, Phillips A, Powell L, Tamler I, Sheth AN. 2019 Impact of PrEP training for family planning providers on HIV prevention counseling and patient interest in PrEP in Atlanta, Georgia. *J Acquir Immune Defic Syndr.* 1999;81(4):414. <https://doi.org/10.1097/QAI.0000000000002057>.
- New York City Department of Health. T-TAP Training Course Directory [Internet]. NYC Health Training. Available from: <https://nychealthtraining.org/ttap-training-course-directory>. Accessed 30 June 2021.
- Broekhuis JM, Scarsi KK, Sayles HR, et al. Midwest pharmacists' familiarity, experience, and willingness to provide pre-exposure prophylaxis (PrEP) for HIV. *PLoS ONE.* 2018;13(11):e0207372. <https://doi.org/10.1371/journal.pone.0207372>.
- Bleasdale J, Wilson K, Aidoo-Frimpong G, Przybyla S. Prescribing HIV pre-exposure prophylaxis: a qualitative analysis of health care provider training needs. *J HIV AIDS Soc Serv.* 2020;19(1):1–7. <https://doi.org/10.1080/15381501.2020.1712291>.
- White JM, Mimiaga MJ, Krakower DS, Mayer KH. Evolution of Massachusetts physician attitudes, knowledge, and experience regarding the use of antiretrovirals for HIV prevention. *AIDS Patient Care STDS.* 2012;26(7):395–405. <https://doi.org/10.1089/apc.2012.0030>.
- Pre-exposure prophylaxis (PrEP). Centers for Disease Control and Prevention website. <https://www.cdc.gov/hiv/risk/prep/index.html>. Updated 13 March 2020. Accessed 30 June 2021.
- Turner D, Lockhart E, Wang W, Shore R, Daley EM, Marhefka SL. PrEP implementation behaviors of community-based HIV testing staff: a mixed-methods approach using latent class analysis. *JAIDS J Acquir Immune Defic Syndr.* 2020;83(5):467–74.
- Collins LM, Lanza ST. Latent class analysis and latent transition analysis: with applications in the social, behavioral, and health sciences. Hoboken: Wiley; 2010.
- Lanza ST, Dziak JJ, Huang L, Wagner A, Collins LM. PROC LCA & PROC LTA user' guide version 132. University Park: The Methodology Center; 2015.
- Pashler H, McDaniel M, Rohrer D, Bjork R. Learning styles: concepts and evidence. *Psychol Sci Public Interest.* 2008;9(3):105–19.
- Finlayson T, Cha S, Xia M, et al. Changes in HIV preexposure prophylaxis awareness and use among men who have sex with men—20 Urban Areas, 2014 and 2017. *MMWR Morb Mortal Wkly Rep.* 2019;68:597–603. <https://doi.org/10.15585/mmwr.mm6827a1>.
- Kanny D, Jeffries WL IV, Chapin-Bardales J, et al. Racial/ethnic disparities in HIV preexposure prophylaxis among men who have sex with men—23 Urban Areas, 2017. *MMWR Morb*

- Mortal Wkly Rep. 2019;68:801–6. <https://doi.org/10.15585/mmwr.mm6837a2>.
31. Huang YA, Zhu W, Smith DK, Harris N, Hoover KW. HIV preexposure prophylaxis, by race and ethnicity—United States, 2014–2016. *MMWR Morb Mortal Wkly Rep*. 2018;67:1147–50. <https://doi.org/10.15585/mmwr.mm6741a3>.
 32. Calabrese SK, Earnshaw VA, Underhill K, Hansen NB, Dovidio JF. The impact of patient race on clinical decisions related to prescribing HIV pre-exposure prophylaxis (PrEP): assumptions about sexual risk compensation and implications for access. *AIDS Behav*. 2014;18(2):226–40. <https://doi.org/10.1007/s10461-013-0675-x>.
 33. Calabrese SK, Earnshaw VA, Krakower DS, Underhill K, Vincent W, Magnus M, Hansen NB, Kershaw TS, Mayer KH, Betancourt JR, Dovidio JF. A closer look at racism and heterosexism in medical students' clinical decision-making related to HIV pre-exposure prophylaxis (PrEP): implications for PrEP education. *AIDS Behav*. 2018;22(4):1122–38. <https://doi.org/10.1007/s10461-017-1979-z>.
 34. Pinto RM, Berringer KR, Melendez R, Mmeje O. Improving PrEP implementation through multilevel interventions: a synthesis of the literature. *AIDS Behav*. 2018;22(11):3681–91. <https://doi.org/10.1007/s10461-018-2184-4>.
 35. Liu A, Cohen S, Follansbee S, Cohan D, Weber S, Sachdev D, Buchbinder S. Early experiences implementing pre-exposure prophylaxis (PrEP) for HIV prevention in San Francisco. *PLoS Med*. 2014;11(3):e1001613. <https://doi.org/10.1371/journal.pmed.1001613>.
 36. Edelman EJ, Gan G, Dziura J, Esserman D, Morford KL, Porter E, Chan PA, Cornman DH, Oldfield BJ, Yager J, Muvvala SB, Fiellin DA. Readiness to provide medications for opioid, alcohol and tobacco use disorder in HIV clinics: a multi-site mixed-methods formative evaluation. *J Acquir Immune Defic Syndr*. 2021;87(3):959–970. <https://doi.org/10.1097/qai.0000000000002666>
 37. Carter MR, Aaron E, Nassau T, Brady KA. Knowledge, attitudes, and PrEP prescribing practices of health care providers in Philadelphia. *PA J Prim Care Community Health*. 2019;10:2150132719878526. <https://doi.org/10.1177/2150132719878526>.
 38. Hysong SJ, Smitham KB, Knox M, Johnson KE, SoRelle R, Haidet P. Recruiting clinical personnel as research participants: a framework for assessing feasibility. *Implement Sci*. 2013;8(1):1–7.
 39. Vaccani JP, Javidnia H, Humphrey-Murto S. The effectiveness of webcast compared to live lectures as a teaching tool in medical school. *Med Teach*. 2016;38(1):59–63. <https://doi.org/10.3109/0142159X.2014.970990>.
 40. Khalil R, Mansour AE, Fadda WA, Almisnid K, Aldamegh M, Al-Nafeesah A, Alkhalifah A, Al-Wutayd O. The sudden transition to synchronized online learning during the COVID-19 pandemic in Saudi Arabia: a qualitative study exploring medical students' perspectives. *BMC Med Educ*. 2020;20(1):1.
 41. Mallonnee S, Phillips J, Holloway K, Riggs D. Training providers in the use of evidence-based treatments: a comparison of in-person and online delivery modes. *Psychol Learn Teach*. 2017;17(1):61–72. <https://doi.org/10.1177/1475725717744678>.
 42. Mullin DJ, Saver B, Savageau JA, Forsberg L, Forsberg L. Evaluation of online and in-person motivational interviewing training for healthcare providers. *Fam Syst Health*. 2016;34(4):357–66. <https://doi.org/10.1037/FSH0000214>.
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