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Pre-exposure Prophylaxis State of the Science: Empirical Analogies for Research and Implementation

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Abstract Pre-exposure prophylaxis (PrEP) has the potential to become a powerful biomedical approach to HIV prevention; however, its success depends on behavioral and social factors that may determine its appropriate use. This article is designed to facilitate interdisciplinary empirical analogies relevant to PrEP implementation, reviewing behavioral and social science findings that may provide lessons critical to the success of PrEP as a biomedical-behavioral prevention strategy. As we prepare for the dissemination of new biomedical approaches to HIV prevention, integrating the state of the science across disciplines may result in innovative strategies for implementation that can enhance their success.

Keywords HIV · Pre-exposure prophylaxis (PrEP) · Adherence · Risk reduction · Decision-sciences · Risk analysis · Health communication

Introduction

Pre-exposure prophylaxis (PrEP) refers to daily or intermittent oral administration of antiretroviral drugs designed to protect high-risk HIV-negative individuals from infection. As a new biomedical approach to HIV prevention, PrEP has the potential to become a powerful tool. Simulation models indicate that an effective PrEP program could substantially reduce the incidence of HIV transmission both internationally and among high-risk populations in the United States [1, 2]. At present, clinical trials of PrEP are underway in 13 countries, and the US Centers for Disease Control and Prevention has called PrEP “one of the most important new prevention approaches being investigated today” [3].

Recent discussions of advances in biomedical prevention emphasize the importance of community participation and collaboration in the success of product development, testing, and dissemination [4, 5]. This focus on collaboration and participation must apply to the scientific community as well. Too often, progress is stymied by what might be called a “failure of analogy,” that is, a neglect of empirical findings from other research areas or disciplines that are relevant to emerging prevention strategies. The success of PrEP as a biomedical prevention strategy depends on behavioral and social factors that may determine its appropriate use. Consequently, scientific insights from behavioral and social research are crucial to PrEP success. This article is designed to facilitate interdisciplinary empirical analogies relevant to PrEP implementation, reviewing behavioral and social science findings that may

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provide lessons critical to the success of PrEP as a biomedical–behavioral prevention strategy.

Should PrEP prove effective in clinical trials, successful implementation will require support for three individual-level behaviors: 1) *adoption* of PrEP by high-risk individuals; 2) *adherence* to PrEP regimens by individuals who adopt it; and 3) *sustained risk reduction* practices by these same individuals. For each of these behaviors, we review the state of the science from neuroeconomics, decision-sciences, social and health psychology, health communication, and across other public health research areas that provide the most pertinent empirical analogies for PrEP as a prevention strategy (Table 1). We then make specific recommendations for the application of this evidence to PrEP-specific research and practice.

Adoption of PrEP

The introduction of new prevention technologies can be a challenging process, as high-risk individuals are often reluctant to adopt prophylactic treatment [6, 7, 8]. Similar concerns are likely to occur with the adoption of PrEP. In developing strategies to promote PrEP adoption, researchers and practitioners should consider findings from three areas of behavioral and social sciences research: 1) information processing regarding risk and probability; 2) framing effects; and 3) the role of stigma in determining health behavior. Findings from each area provide important insights into the decision making of potential PrEP adopters and their response to potential PrEP information campaigns.

Research on communication of risk and probability information emerges from the disciplines of behavioral economics and social psychology, which study the ways in which people encode, retain, and apply probability information to make choices that involve risk/benefit calculations. In this paradigm, probability information refers to individuals' understanding of the likelihood of particular outcomes—both positive and negative—associated with a given behavior. Risk refers to individuals' understanding of the probability of these outcomes, plus the *value* they ascribe to these outcomes. For example, decision-making around risky sexual behavior involves both probability information (ie, perceived likelihood of contracting HIV or another STD by engaging in this behavior) and risk information (ie, integration of these probabilities with both negative value placed on HIV/STD infection and the positive value placed on having unprotected sex). Effective communication regarding risk and probability will be essential to PrEP adoption because PrEP is unlikely to provide complete protection from HIV infection [9]. Public information and provider-based education about PrEP must

effectively communicate information about efficacy in a manner that allows high-risk populations to make informed decisions about its use. In a recent meta-analytic review of empirical findings on communication about risk and probability, Visschers and colleagues [10] make a series of specific recommendations regarding the most effective methods for presenting probability (eg, that a certain drug might confer only 60% protection) to insure that consumers are able to understand and apply it to their decision-making processes. For example, increasing the personal relevance of risk information by presenting probability estimates tailored to an individual's specific characteristics and context consistently results in more accurate comprehension and application of risk information. These and other findings from the literature on information processing [11] will be vital to the development of both public information campaigns and tailored personal messages to promote PrEP acceptability and adoption.

In addition to understanding the best strategies for presenting PrEP-related risk and probability information, it is important to understand factors that impact potential users' ability to comprehend this information and apply it to their decision-making. According to the heuristic-systematic information processing model, individuals process new information either systematically—ie, by conducting a deliberative, in-depth analysis—or heuristically—ie, by using simple inferential rules or shortcuts [12]. When individuals process information heuristically, they are more vulnerable to biases that might impair their decision-making. One of the challenges to the development of effective PrEP communication strategies will be maximizing the likelihood that patients and consumers use more deliberate, systematic decision-making as they consider PrEP adoption—eg, thoughtfully considering the pros and cons of PrEP use and the feasibility of regular self-administration of drugs in their daily lives—rather than more spontaneous, heuristic decision-making. Consistent with evidence from other similar social psychological models of communication and persuasion [13], the likelihood of systematic processing is determined by individuals' *capacity* for systematic processing (ie, cognitive capacity, attention, and time) and their *motivation* to engage in this type of processing (ie, interest, personal relevance). In constructing messages about PrEP adoption, it will be critical to consider ways to facilitate capacity and motivation among potential consumers. For example, providers must insure that PrEP information is presented to patients in a setting in which they have sufficient time and energy to engage with the message, and in a manner that optimizes personal relevance and motivation to attend to the message. Behavioral science also emphasizes characteristics of the messenger or communicator that maximize decision-making within the target or consumer [13]. Accordingly, research must examine health

Table 1 Empirical analogies to guide PrEP research and practice

Concept/topic	Discipline	PrEP relevance	Further reading
A. Adoption			
Risk communication	Decision-sciences; Risk analysis	PrEP adoption necessitates complex communication with patients regarding PrEP efficacy and its implications for relative risk reduction	Visshers et al. [10•], 2009: Meta-analysis of 45 empirical articles about probability in risk communication related to medical or health risk
Health numeracy	Medical decision-making; health communication	Some PrEP adopters may have limited ability to understand and apply numerical information, impacting both adoption and adherence to PrEP	Reyna et al. [11], 2009: Review of literature on health numeracy, detailing mechanisms through which it impacts health outcomes, treatment adherence, and risk perception
Heuristic vs systematic processing	Neuro-economics	Decision-making around PrEP adoption and sustained adherence will be impacted by the synergistic interaction of both deliberative and associative or affective factors; adequate support of patients must consider the influence of both types of processes	Sanfey and Chang [12], 2008: Review of evidence for the dissociation between automatic and controlled processing in decision-making from behavioral economics and neuroscience
Framing effects	Health psychology; health communication	Development of social marketing campaigns for PrEP must consider the influence of the framing of information about a new technology on perceptions of personal risk and patient decision-making	Edwards et al. [16], 2001: Review of literature on manipulation of risk and benefit information and framing effects in clinical settings
Stigma	Sociology; public health	HIV stigma is likely to be a significant barrier to PrEP adoption and adherence	Mahajan et al. [17•], 2008: Review of literature on HIV/AIDS stigma in theory, assessment, intervention, and policy analyses
B. Adherence			
Latent tuberculosis infection	Infectious disease	Prophylactic treatment taken daily; potential for side effects; difficult for patients to make the connection between treatment and risk reduction	Hirsch-Moverman et al. [6•], 2008: Review of 78 studies regarding predictors of latent tuberculosis infection medication adherence and intervention efficacy
Oral contraceptive pills (OCP)	Reproductive health	Pills taken daily to prevent sexual risk; similar challenges regarding sustained condom use; similar disconnect between pill-taking and the sexual act	Rosenberg et al. [27], 1995: Review of factors that predict poor OCP adherence and recommendations for improving OCP adherence
HIV ART	Public health/HIV	Lessons learned from use of similar medications in similar populations can inform PrEP adherence interventions	Stimatt and Gordon [30•], 2008: Review of three areas in which HIV treatment adherence literature can inform research on biomedical prevention strategies
Other biomedical approaches to HIV prevention	Public health/HIV	Experience with strategies such as microbicides, male circumcision, STD treatment can inform PrEP adherence and risk reduction	Padian et al. [32], 2008: Review of biomedical interventions to prevent HIV and discussion of challenges and recommendations for future work
Theories of health behavior	Behavioral sciences	Successes and failures in the application of existing behavioral theories to adherence interventions can inform selection of theoretical models for PrEP intervention development	Munro et al. [39••], 2007: Review of over 30 behavioral change theories applicable to long-term treatment adherence and assessment of the evidence for their effectiveness in predicting behavior change
C. Sustained risk reduction			
HIV prevention interventions	Public health/HIV	Lessons learned from past experience in the development of targeted prevention interventions can be adapted for the specific context of PrEP	Rotheram-Borus et al. [37], 2009: Review of evidence-based interventions to reduce HIV risk behavior and discussion of common factors and recommendations
Sexual risk-taking and HAART	Public health; health psychology	Understanding the impact of beliefs around viral suppression on condom use and the relationship between antiretroviral adherence and sexual risk can inform prevention messages targeting PrEP users, especially those in serodiscordant relationships	Crepaz et al. [40], 2004: Meta-analysis of the association between HAART and sexual risk behavior Kalichman et al. [41], 2010: Contrasts two models for understanding the association between adherence and HIV transmission risk
Risk compensation	Health psychology	Provides a framework for predicting the potential impact of PrEP adoption on sexual risk practices in different populations	Eaton and Kalichman [33], 2007: Review and meta-analysis of literature on risk compensation in response to HIV vaccines, microbicides, antiretrovirals, and circumcision

Table 1 (continued)

Concept/topic	Discipline	PrEP relevance	Further reading
Fuzzy Trace Theory (FTT)	Behavioral economics; decision research	Sustained risk reduction on PrEP requires ongoing risk assessment and its application to decision-making; FTT explains how individuals use both “gist” and “verbatim” information to inform risk perception and decision-making	Reyna [43•], 2008: Review of FTT and discussion of its relevance to health and medical decision-making; presentation of theory-based intervention strategies
Emotional systems in decision-making	Neuro-economics	Managing conflicting emotions and affective cues will be critical to sustained sexual risk reduction on PrEP	Gutnik et al. [47••], 2006: Reviews evidence of emotional aspects of decision-making and develops a model for applying these findings to understanding sexual risk
Identity	Social psychology; sociology	PrEP represents a unique opportunity to activate an HIV prevention role-identity to promote behavioral synergy; presenting PrEP adoption as part of a “prevention activist” identity may facilitate adherence and sustained risk reduction	Hagger et al. [49], 2007: Examination of the role of identity in determining intention and behavior for three health behaviors

HAART highly active antiretroviral therapy; *PrEP* pre-exposure prophylaxis

provider characteristics—such as communication style, clarity, and empathy—that facilitate attention and responsiveness among potential PrEP users.

The second major concept that can inform PrEP adoption campaigns involves research on framing effects. Framing effects are a central tenet of Prospect Theory [14], which argues that decision-making is significantly affected by the manner in which choices are presented. Because PrEP may show only partial efficacy in protecting against HIV infection, the communication and framing of the relative merits and limitations of this strategy are crucial. Behavioral science has shown that, when faced with an identical decision (eg, between a pill that protects 60% of the time versus one that fails to protect 40% of the time), individuals react differently when the choice is framed in terms of potential benefits (“gain” frame) compared to potential harm (“loss” frame) [15]. Research in the application of framing effects to decision-making regarding prevention behavior suggests that presentation of PrEP in either a gain frame (eg, “taking PrEP will help protect you against HIV”) or a loss frame (eg, “if you don’t take PrEP, you increase your risk of becoming infected with HIV”) may have significant effects on adoption [16], but it is currently unclear which may be more effective. More research is needed into the application of framing effects to the specific dynamics surrounding PrEP, but a nuanced understanding of framing effects is critical to the presentation of PrEP information to potential consumers.

Third, efforts to maximize PrEP adoption can be informed by research from social and health psychology on the impact of perceived stigma on health behavior [17•]. Research suggests that individuals may act in ways that might undermine their objective self-interests in order to reduce their association with a stigmatized condition [18]. For example, in order to differentiate themselves from high-risk groups, some individuals might underestimate their risk of having contracted a stigmatized illness, particularly HIV or other sexually transmitted diseases [19]. This underestimate of risk often translates into lower rates of testing and treatment for stigmatized conditions, and poses a significant barrier to uptake of vaccines or other prophylaxis [20]. Issues of HIV-related stigma are particularly relevant for PrEP adoption, as individuals may see taking PrEP as an admission that they are engaging in behaviors that put them at risk for infection. Normalization of testing or prophylactic treatment through opt-out policies, and carefully delivered PrEP education counseling, may lessen the negative impacts of stigma on potential user initiation of PrEP [21]. The success of PrEP as a prevention strategy will be impacted by ongoing structural and societal efforts to reduce HIV stigma, but the role of stigma must be considered in the development of strategies to encourage PrEP adoption.

Adherence to PrEP

Following adoption of PrEP, it will be critical to develop strategies to improve and support adherence to PrEP regimens. Nonadherence to prescribed regimens continues to be one of the most significant challenges to successful HIV treatment [22]. Suboptimal adherence is common among patients prescribed prophylactic regimens, and has been documented in other types of HIV-related prophylaxis [23, 24]. In recent PrEP trials, adherence rates approached only 70% [25, 26].

The most important analogies that provide lessons for PrEP adherence can be drawn from investigations of other types of drug treatment, including anti-malarial prophylaxis, treatment for latent tuberculosis infection (LTBI), and daily oral contraceptive pills (OCP), as well as the extensive literature on adherence to HIV medications themselves. Although the research is vast, three consistent findings emerge across almost all adherence investigations: 1) the importance of complete and detailed patient education at regimen initiation; 2) the role of structural issues in determining adherence behavior; and 3) the need for comprehensive approaches to adherence support. Each of these findings will be critical to the development of supportive interventions for PrEP users.

In multiple studies across prophylactic technologies, adherence is strongly associated with patients' understanding of drug information [24, 27]. At the most basic level, PrEP adherence will be dependent on clear and comprehensive messages regarding proper administration and mechanisms of action. In a large-scale review of factors affecting adherence to treatment for LTBI [6], perceived severity of TB, perceived susceptibility to TB, and perceived accuracy of LTBI diagnosis were all identified as correlates of LTBI adherence. While perceived severity of and susceptibility to HIV infection will be critical determinants of PrEP adoption, these factors must also be addressed as motivators of sustained adherence to a PrEP regimen. For example, if high-risk individuals taking PrEP for a relatively brief time remain HIV-negative at subsequent testing, they might perceive themselves at low personal susceptibility for HIV infection and, consequently, discontinue PrEP use. In the absence of continued reminders of personal susceptibility for and severity of HIV infection, target users may question the appropriateness of PrEP prescription and need for adherence. Lessons from the LTBI literature indicate that patient education regarding PrEP must address these issues directly, ensuring that patients have an accurate assessment of the severity of HIV infection, their personal risk for transmission, and the potential of PrEP to reduce this risk.

Drug-related toxicity and side effects have also been identified as critical factors in nonadherence across medi-

cations, including both prophylactic regimens [6•] and treatment of chronic illnesses [28]. Research suggests two factors are critical to patient education at drug initiation. First, providers should distinguish between particular side effects that a particular patient is willing to tolerate and those that he or she is not. Research indicates that patients often have a specific intolerable side effect that varies by individual [29], and this information can be used to select a particular PrEP regimen or to strategize about medication to mitigate specific effects. Second, providers should help patients think through specific action plans that can be initiated in the event that intolerable side effects are experienced, including strategizing about over-the-counter medication that could mitigate side effects in the time it takes to make a medical appointment, or discussing the importance of condom use in the event that PrEP is suspended.

A third finding relevant to patient education around PrEP initiation is the importance of discussing when, where, and how patients will take the new medication. In a large retrospective study of OCP compliance in the United States and Europe, integrating pill-taking into a regular routine was the strongest single factor associated with adherence [27]. Similar findings have been identified in the adherence literature across illnesses [28]. Sustained adherence to PrEP regimens will be possible only to the extent that high-risk individuals are able to incorporate the prophylactic treatment into their everyday lives. Adherence promotion strategies may need to differentiate between daily versus intermittent PrEP dosage regimes should both be proven effective, as each dosage regimen may be associated with unique adherence challenges.

In addition to these shared insights about patient education, a second set of findings from the larger adherence literature is the emphasis on structural—ie, societal and social—factors that influence adherence. Access to affordable, convenient, and culturally competent medical care emerges consistently as one of the most important determinants of medication adherence [30••]. Other structural issues, such as housing stability and access to mental health services for depression or substance use, are also critical factors that enable sustained adherence. These structural issues are important considerations for users in resource-deprived settings, where access to clinics and private places to store and administer pills may be lacking. As discussed above, stigma associated with HIV infection may negatively impact PrEP adoption, but even once adopted, HIV-related stigma may act as a structural barrier to adherence. Individuals with HIV and other stigmatized conditions report needing to hide medications and not wanting to take pills in front of other people, as well as difficulties managing or explaining side effects [31]. Stigma concerns will be important in deciding how broadly

to target PrEP; if PrEP is offered only to the highest-risk individuals, there is a potential for stigmatizing PrEP use itself. Providing systems that support PrEP adopters in managing societal and social factors must be considered in the promotion of PrEP adherence on a large scale.

Finally, adherence research has seen a call for a more integrated and comprehensive approach to intervention development. Recent reviews of advances in HIV medication adherence strategies for HIV [22, 30••] and LTBI [6•] emphasize the need for a multidisciplinary, multi-method, and multi-behavioral focus in adherence intervention development [32]. In addition, recent reviews draw attention to a mismatch between the relatively brief duration of most behavioral interventions versus the long-term time-frame in which patients are expected to maintain target behaviors. To provide ongoing reinforcement to PrEP users, behavioral supports and adherence counseling could be integrated into regular clinic visits that become standard of care for PrEP users. Underhill and colleagues (in this issue) argue for an expanded “implementation appropriate” definition of PrEP as a prevention strategy, including not only distribution of antiretroviral medications, but also provision of ongoing HIV testing, behavioral intervention, and integration of PrEP into an overall care platform. Similar to OCPs, PrEP is a prevention method that is not coitally dependent, as in the case of condom use, and has the potential to be sustained significantly longer than other prophylactic regimens such as LTBI or anti-malarial treatment. In developing supportive interventions for PrEP users over time, clinicians and researchers must consider the unique challenges of a prevention method that must be integrated into everyday life rather than associated with a specific sexual act. For example, women often report sporadic OCP use during periods of decreased sexual activity [27]. Although trials of intermittent PrEP are underway, little is currently known about the efficacy of periodic or selective PrEP use, and the potential consequences of PrEP discontinuation or “holidays,” as observed in the HAART literature. If PrEP is proven efficacious in clinical trial settings future research on periodic use will be essential, as it is almost certain to occur.

Risk Reduction

The third and perhaps most important behavior related to PrEP effectiveness is sustained sexual risk reduction among its users. Both clinicians and researchers have expressed concern about detrimental effects of PrEP adoption on other sexual risk reduction practices, due in part to increased HIV complacency and reduced perceptions of risk [33]. One ongoing concern in PrEP discussions is the potential for risk compensation, or an increase in HIV risk behavior

following PrEP initiation due to the perception that one is less susceptible to infection. Indeed, a behavioral economics analysis has shown that, at the population level, prevalence of sexual risk behaviors tends to increase following the introduction of new HIV prevention technologies [34]. Cost-effectiveness models conclude that the positive impact of PrEP may be offset by even modest increases in risk behavior [1, 2, 35]. For this reason, any positive long-term impacts of PrEP will be dependent on the delivery of behavioral interventions that support high-risk individuals in combining PrEP use with sustained risk reduction practices—including condom use, partner reduction, serostatus discussion, and repeat HIV testing.

The state of the science best applied to PrEP-focused behavioral interventions begins with over three decades of HIV prevention research and intervention development. Recent reviews of efficacious HIV and STI prevention interventions [36–38] and over 30 theories of behavior change that have most often guided intervention development [39••] can provide an important framework within which to develop PrEP-specific interventions and integrate PrEP into existing prevention efforts. In addition, it is important to consider findings regarding the association between beliefs about reduced infectiousness and increased risk behavior among HIV-positive individuals on HAART [40, 41]. These findings and the dynamics they uncover relate directly to PrEP use, both because of the number of PrEP adopters who may be in serodiscordant relationships with partners already taking HAART, and also because beliefs about reduced infectiousness may lead to behavioral disinhibition among PrEP users more broadly. In addition to lessons from HIV itself, two areas of research across behavioral sciences provide important empirical analogies to guide the development of PrEP-focused risk-reduction interventions: 1) research on dynamics of risk perception; and 2) examinations of the role of identity in intention and behavior.

Many theories of behavior change used to develop HIV prevention interventions begin with the idea that individuals need accurate information in order to make choices that will reduce health risks. However, few interventions have integrated empirical research on dynamics of risk perception into the creation of their informational components. Risk perception is likely to play a pivotal role in decisions about condom use on PrEP [42]. Research on mechanisms and processes of risk perception emerges from decision sciences and behavioral economics, focusing on the ways in which individuals understand both personal and societal-level risks and use this information to guide decision-making. According to Fuzzy Trace Theory (FTT), judgment and decision-making rely primarily on “gist” rather than “verbatim” representations of information [43•]. Gist representations are qualitative (eg, that PrEP is “good”);

they capture the gut-level meaning of information (eg, that PrEP protects against HIV), but are impacted heavily by emotion, past experience, culture, and level of development (eg, that using PrEP is similar to using ART). This reliance on gist representations is often associated with inaccurate risk perception [43], because it minimizes the important nuances, probabilities, and outcomes associated with the information. However, an overemphasis on verbatim, or quantitative, risk perception (eg, specific effect sizes from a PrEP trial) can also lead to inaccuracies. For example, individuals underestimate personal risk when they weigh the objective risks and benefits associated with a single act of unprotected sex, rather than focusing on gist perceptions that are linked to the cumulative risk of repeated unprotected acts [44].

Relatedly, PrEP intervention development may benefit from emerging research on the role of affect in risk perception and risky decision-making. Social psychological theories of emotion regard affect as a primary and dominant influence on attitudes, judgments, and behavior, often overriding or shaping cognition [45]. Other models focus on factors that determine the relative strength of “cold” cognitive systems and “hot” emotional systems in self-regulation and delay of gratification [46]. Cognitive neuroeconomics provides a model describing the roles of emotion and cognition specifically in decision-making under risk, and integrates external factors (eg, physical environment, culture, group norms) and temporal focus (ie, short-term vs long-term orientation) to explain the relationship between emotion, cognition, perceived risk, and behavior [47]. Managing conflicting emotions and affective cues will be critical to sustained sexual risk reduction on PrEP, and these models may contribute to a better understanding of the mechanisms through which PrEP availability and/or adoption impacts risk perception and behavior.

Finally, intervention development related to sustained condom use on PrEP may be well informed by research on the role of identity in predicting behavior, particularly habitual health-related behavior. For example, repeated behavior (eg, leafleting weekly for Greenpeace) may represent or signify an identifiable role (eg, volunteer; environmental activist), thereby becoming incorporated into self-concept as both an exemplar and reinforcer of a particular role-identity [48]. In many cases, role-identity has an effect on behavior that is stronger than, and independent of, an individual’s attitudes or perceived social norms. In empirical investigations, the more salient or central a particular role-identity is to an individual, the more predictive it is of both behavioral intentions [49, 50] and actual behavior [48]. Previous investigations in the field of HIV prevention have focused almost exclusively on the *negative* impact of role-identity on behavior, as evinced

in the focus on the role of a “barebacker” identity in predicting unprotected sex among men who have sex with men. PrEP provides an opportunity to capitalize on the *positive* impact of role-identity on behavior. Individuals who adopt PrEP may be able to see this behavior as reinforcing an identity as a “preventionist,” ie, “the type of person who cares about reducing my risk of HIV infection.” Construing PrEP as a reflection of a risk-reducing role-identity might have a positive impact on sustained risk reduction by replacing fatalistic attitudes associated with prevention fatigue with a new emphasis on prevention activism [4].

Conclusions

As we prepare for demonstrated efficacy of PrEP in upcoming clinical trial results, empirical analogies across research fields and scientific disciplines must be incorporated into the development of public education, behavioral interventions, and systems of care for PrEP. Here, we have outlined some of the most salient findings from behavioral and social sciences relating to PrEP adoption, adherence, and sustained risk reduction. Although this review is by no means comprehensive, the examples it supplies are meant to serve as a springboard for conceptualization of research and practice around PrEP within an existing wealth of relevant research. From the above review, we underscore three specific research areas most relevant to PrEP implementation.

First, communication to the general public and potential PrEP adopters will require a clear, focused understanding of the ways in which individuals process and apply probability and relative risk information to their own health decision-making. Behavioral economics, decision sciences, and health communication have much to teach us in developing both social marketing campaigns and patient–provider communication. Second, because of the uniquely nuanced risk reduction message inherent in PrEP—ie, that it must supplement traditional risk reduction efforts, rather than replace them; that it might be only partially effective when used alone—it is critical to understand the cognitive and emotional processes related to the perception of personal risk and its application to decision-making. Research summarized here will be useful to the development of support programs and risk reduction strategies for high-risk individuals in the context of PrEP. Finally, PrEP represents a unique opportunity to draw on empirical research regarding the role of identity in shaping behavior. Many behavioral interventions acknowledge the role of cognitive and affective processes in shaping motivation and behavior, but few have focused on the potential to shape risk reduction by encouraging the development of an individu-

al's identity as "the type of person who protects myself against HIV."

Presenting PrEP use as part of the expression of a true commitment to HIV prevention has the potential to promote engagement in all three target behaviors. Individuals who consider HIV prevention a critical part of their identity will want to be PrEP adopters, but will also be conscientious about adherence to PrEP and consistent condom use. This potential for behavioral synergy is rare in the field, but is important to consider in the development of PrEP-related programs at all levels. As we prepare for the dissemination of new biomedical approaches to HIV prevention, integrating the state of the science across disciplines may result in innovative strategies for implementation that can enhance their success.

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