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Treatment-related Optimistic Beliefs and Risk of HIV Transmission: A Review of Recent Findings (2009–2012) in an Era of Treatment as Prevention

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Abstract

The promising outlook for HIV treatment as prevention (TasP) offered by the recent success in clinical trials has highlighted the need for effort against over-optimism toward anti-retroviral therapy (ART). It has been of a central concern that such optimistic beliefs may fuel an increase in risk behaviors to counter the protective effect of ART on reducing overall transmissibility of HIV. The current review was conducted to provide an updated look at the potential impact of treatment-related optimistic beliefs on the risk of HIV transmission. The review yielded a total of 14 studies published during the past 4 years that have examined the role of treatment-related optimistic beliefs in changing people's adoption of sexual risk behaviors. Findings from quantitative studies were largely in support of an association between optimistic beliefs and risk of HIV transmission. Results from qualitative studies discovered additional information concealed under the numerical associations, and pointed to the need of more rigorous and comprehensive examination of the relationship between optimistic beliefs and HIV transmission risk. Gaps in the current literature were identified and suggestions for future research were provided.

Keywords

HIV/AIDS; treatment-related optimistic beliefs; highly active anti-retroviral therapy (HAART); HIV treatment as prevention (TasP); HIV transmission; anti-retroviral therapy (ART); sexual risks; systematic review

Introduction

HIV treatment-related optimism has been of interest in the field of HIV prevention since highly active anti-retroviral therapy (HAART) became available in mid-1990s [1]. In recent years there has been a surge of optimism for HIV treatment following studies showing the biological plausibility for antiretroviral therapy (ART) to reduce HIV transmission through viral suppression [2]. Although improvement in ART has been quite astonishing during the past two decades, the ability to cure HIV infection is still beyond our reach. Therefore as HIV remains a life-threatening infectious disease, an increasing concern has been expressed toward whether optimism surrounding the medical improvement in HIV treatment would be misinterpreted or received in a way that could decrease people's adoption of preventative behaviors, such as condom use, and in turn counterbalance the benefit of treatment or even lead to an increase in HIV transmission [3][4].

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Managing public perceptions about how much protection HIV treatment can offer in preventing transmission is becoming a crucial aspect of the overall HIV prevention effort [5]. However, the urgency to address this issue is escalating in light of the recent release of findings from the HIV Prevention Trials Network 052 (HPTN 052) [2]. As the first randomized controlled trial ever to test the efficacy of early use of ART as an HIV prevention strategy, the HPTN 052 trial confirmed findings from previous observational studies by showing a large decrease in sexual transmission of HIV among HIV sero-discordant couples through early use of ART. On the one hand, the compelling evidence from HPTN 052 in support of treatment as prevention (TasP) has fundamentally changed attitudes toward the scale-up of ART and the possibility of halting the epidemic [6], but on the other hand, a large-scale ART roll-out is likely to bring out some of the hidden problems in the field of HIV prevention, with one of them being the potential of over-optimism from the public toward the effect of HIV treatment in reducing HIV transmission [7].

Treatment optimism has been considered one of the most salient factors to influence people's adoption of sexual risk behaviors [8]. Repeated findings of an association between treatment-related optimistic beliefs, including beliefs regarding reduced infectivity and sexual risks have aroused a fair amount of attention, despite the absence of evidence on a causal link. Moreover, several modeling studies have shown that the prevention benefits of HIV treatment can be offset by increases in risk behaviors [9–14], and even modest levels of reduced concern about HIV risk can result in significant increases in HIV transmission [15]. The scenario of increased risk compensation and a weaker commitment to safer sex has exceeded the scope of biological mechanisms that support early treatment as prevention. Given the amount of resources that will be invested in the roll out of early ART with the aim of prevention, there will be little room for any offsetting effect brought by increased risk behaviors. It is therefore essential for the field of public health to proactively tackle the potential impact of treatment-related beliefs on risk of HIV transmission in order to optimize the effect of TasP on a population level.

In light of the findings from the HPTN 052 and the corresponding calls for TasP, this review examines recent findings about the impact of treatment-related optimistic beliefs on the HIV transmission risk. and summarized some of the most commonly studied treatment-related optimistic beliefs and their relationships with risk of HIV transmission among specific populations. Based on available information, the review will also point out limitations to current research on treatment optimism and offer suggestions and directions for future studies.

Literature Search Strategies and Inclusion Criteria

For this review, I searched PubMed, Medline, PsycInfo, Scopus, and Google Scholar for English-language papers published in any countries, with the following search terms: "HIV", "treatment optimism", "treatment beliefs", "beliefs", "transmission", "vulnerability", "susceptibility", "infectivity", "attitudes", "reduced concern", "discordant", "sexual behavior", "unprotected sex/intercourse", "viral/HIV-RNA load", "correlates of unprotected sex/intercourse", and "HIV complacency". Different combinations of terms were used to maximize sensitivity and specificity for relevant studies and the term "HIV" was included in every searching attempt. I also conducted a manual search for references of each relevant paper. As studies conducted in the current time frame may be more informative to the corresponding policy changes and public health efforts initiated by the findings from HPTN 052, only studies published between Jan 1, 2009 and July 31, 2012 were included in this review. Since the purpose of the review was to evaluate the impact of treatment-related beliefs on risk of HIV transmission, only studies that included both elements and assessed either directly or indirectly the relationship between the two were included. A total of 14

studies met our criteria for inclusion with 10 of them to be quantitative, 3 qualitative and one mixed-method study.

Results

The main results of the review are presented according to research methodologies and a brief recap of the measurements used in those studies is provided.

Findings from quantitative studies

The study characteristics and major findings are presented in Table 1. All measurements used in quantitative studies in Table 1 were abbreviated for precision, with more detailed description in Table 2. Nearly all of the quantitative studies were cross-sectional with only one study using prospective data [16]. A majority (7 out of 10) of the available studies were conducted among HIV positive people [5, 16–21]. In addition, there is a heavy concentration of studies (5 out of 10) among men who have sex with men (MSMs) [17, 18, 22-24]. The pool of studies also appeared to be dominated by those from developed countries with only two studies from developing countries. Self or interviewer-administered questionnaires were the most commonly used data collection strategy, and only two studies from the U.S. have adopted audio computer assisted self-interview (ACASI). A majority of the studies assessed the direct associations between treatment-related beliefs and sexual risks. In contrast, only two studies [23, 24] performed mediation analyses and therefore drew somewhat more complex relationships between treatment-related beliefs and sexual risks. In view of a strong saliency of beliefs in reduced HIV infectiousness in the context of TasP, quantitative findings were further classified by this standard to enhance pragmatic value of the results.

Optimistic beliefs centered on reduced HIV infectiousness

All studies among HIV positive people have included beliefs in reduced HIV infectiousness (including transmissibility/infectivity of HIV, and susceptibility to HIV infection) given effective treatment and/or undetectable viral load. Some studies have used single-item measures that were exclusively about the beliefs or attitudes regarding HIV infectiousness given treatment or undetectable viral load, while some others have adopted composite measures with multiple items but overall were weighted more toward beliefs with respect to HIV infectiousness. Despite the heterogeneity, these belief measures appeared to be directly associated with HIV risks across studies, with HIV risks being defined as unprotected sex in most of the studies, or sexually transmitted infection in one study.

In two studies of HIV positive MSMs, one used single-item measures [22] and one used a comprehensive scale [18]. Both studies found support for the relationship between beliefs in reduced HIV transmissibility/infectivity and unprotected anal sex. Yet some distinctions also need to be noted. In the first study, two single items were used to measure beliefs in reduced HIV transmissibility/infectivity due to undetectable viral load, or due to ART, respectively. Only the belief that was specific about the role of undetectable viral load in reducing HIV transmissibility/infectivity was associated with discordant unprotected anal sex. In addition, this association appeared to be moderated by medication-taking behaviors. Belief in reduced HIV infectiousness due to undetectable viral load was associated with sexual risk among people who reported missing ART doses intentionally, but not among those who did not intentionally skip medications. The other study measured treatment-related beliefs and attitudes with a comprehensive scale that included three components: HIV susceptibility, condom motivation, and overall health of people on treatment. One of the components – lowered HIV susceptibility because of effective treatment – turned out to be the only attitudinal element associated with unprotected discordant anal sex.

Similarly, a study among PLWHA found that beliefs about undetectable viral load leading to lower HIV infectiousness were associated with a higher likelihood of contracting a new STI infection [19]. A unique contribution of this study is that it used STI as a measure for HIV risk. Since contracting STIs may increase infectiousness of an HIV positive person, recent STI infection, in addition to unprotected sex, could be another particularly relevant indicator for risk of HIV transmission, even when viral load in blood plasma is undetectable. Findings from this study suggested that PLWHA who believed in reduced HIV transmissibility/ infectivity given undetectable viral load were likely to be more infectious than those who did not hold the belief due to their contraction of new STIs.

In 2008, the Swiss Health Ministry released what has become known as the Swiss Statement, which stated that PLWHA who were on HIV treatment and have an undetectable viral load for over 6 months with no other STIs were non-infectious and could safely practice unprotected sex with their HIV negative partners. Two studies, one from Swiss and one from France, specifically tested the influence of the Statement on sexual risk behaviors.

The strongest evidence regarding the association between Swiss Statement and sexual risk, by virtue of the study design, was from the Swiss Cohort Study. In this study researchers used prospective data on sexual behaviors before and after the publication of the Statement [16]. The study found a progressive increase in unprotected sex with stable partners among all participant groups including MSM, heterosexual men and women, current injected drug users (IDUs) over the years. And there was a significant association between the time period after the publication of the Swiss statement and an increase in the odds of unprotected sex across all sub-groups, with the association being stronger among people having undetectable viral load. In the other study of the Swiss Statement, however, only descriptive data was reported with no apparent implication regarding the impact of the Statement on people's sexual risk. It was shown in the study that a large proportion (65%) of PLWHA who were aware of the statement declared being less afraid of sexually transmitting HIV, and among the 80% of sexually active PLWHA in the survey, 11% declared using condom less often, 65% reported no change in condom use, while the rest 10% reported using condom more often [20]. No further hypothesis testing was performed on the relationship between the Statement and changes in condom use.

While a direct association between beliefs in reduced HIV infectiousness and sexual risks were consistently reported in most studies, we found two exceptions. One of the studies was conducted among HIV clinical patients on ART from Thailand [21]. No association was identified between unprotected sex and beliefs about HIV infectiousness in relation to undetectable viral load or ART. But it was mentioned in the study that the data were collected in 2007 when less evidence was available regarding ART and HIV transmission. The authors also pointed out that the cohort of HIV patients in the study were mostly low income people with little access to information regarding the latest HIV news.

The other exception was a study conducted among non-HIV positive MSM [24]. This study evaluated a plausible causal model consisting of two belief-constructs: beliefs in reduced HIV severity due to HAART, and beliefs in reduced HIV susceptibility due to undetectable viral load, as well as two attitudinal (complacency) constructs: reduced concern for HIV susceptibility due to treatment and low viral load, and reduced overall concern for HIV infection and sexual risks. The model posits that the pathway between the two belief constructs and sexual risks would be mediated by the two attitudinal constructs consecutively. Consistent with its proposed model and in contrast with studies among HIV positive people, results showed no direct association with sexual risks for beliefs in reduced HIV infectivity/transmissibility due to undetectable viral load, but this belief appeared to have an indirect effect on sexual risk behaviors through reduced concerns for HIV.

Other optimistic beliefs and general HIV optimism

Several studies have evaluated treatment optimism covering a range of underlying optimistic beliefs including reduced concern for HIV/AIDS, beliefs in reduced severity of HIV, improved outlook on treatment, etc. These belief measures were generically defined without specific emphasis on reduced HIV infectiousness as a result of suppressed viral load and/or treatment availability. Some more inclusive measures such as the optimism-scepticism scale [1] may encompass a single item on beliefs in reduced HIV transmissibility associated with undetectable viral load, which however have no dominating effect on shaking the conceptual underpinning of the measure as a general assessment of treatment optimism. A few studies evaluated general HIV optimism alongside beliefs in reduced HIV transmissibility/ infectivity, providing a valuable opportunity for comparison.

Two of the three available studies [23, 25] among non-HIV positive participants both used more generic beliefs measures that require less prior knowledge about ART and viral load. One study from Kenya performed a population based survey in Kisumu [25]. The study measured ART-related attitudes and beliefs which were later separated into two components: beliefs that ART makes HIV more controllable and the belief that more risk sexual behaviors can be taken (risk compensation). Additionally the study used a single item to measure the belief that ART cures HIV. The two components derived from ART-related attitudes and beliefs were not relevant to sexual risks. Nevertheless, the belief that ART cures HIV were associated with a greater lifetime number of sexual partners and a younger age at sexual debut among women, a higher odds of reporting exchange of gifts or money for sex in the past 12 months and a lower odds of condom use during last sex among men.

In the other study among non-HIV positive MSM, the author measured overall optimism toward HIV treatment, and included it as a mediator in a proposed conceptual model to explain disengagement coping with HIV risk [23]. It was found that treatment optimism was a strong mediator of the association between anxiety and unprotected anal sex, indicating a potential for people to adopt treatment optimism as a coping strategy when facing anxiety incurred by their engagement in sexual risk behaviors. Mediation analysis was also performed in a previously described study among non-HIV positive MSM [24], in which the only factor with a direct effect on sexual risks in the proposed causal model was reduced overall concern for HIV and sexual risks, and this variable also mediated the association between sexual risk behaviors and other belief and attitudinal measures (including beliefs in reduced HIV severity due to HAART, beliefs in reduced HIV transmissibility/infectivity due to undetectable viral load, reduced concern for HIV susceptibility due to treatment and low viral load).

The role of general HIV optimism was also studied in another two studies [17, 19]. One of the studies from Kalichman et al. was described above, as it included both a measure specifically about the beliefs on reduced HIV infectiousness and a measure of general optimism toward HIV treatment. Contrary to other findings of general treatment optimism among non-HIV positive populations, treatment optimism was not associated with HIV risk in this sample of PLWHA. Failure to find an association was also in contrast with the study's own finding of an association between beliefs in reduced HIV infectiousness and risk of HIV transmission. The absence of an association between general treatment optimism and HIV risk was also observed in another study among HIV positive MSM from Begley et al. [17]. In the study a scale of optimism-scepticism was used to measure treatment-related optimistic beliefs. Despite being highly specific about types of sexual risk behaviors, including insertive and receptive anal intercourse either with ejaculation or without, the scale was not associated with any types of unprotected anal sex.

Findings from qualitative studies

There are three qualitative studies [26–28] which provided implications on how treatmentrelated optimistic beliefs may be connected with sexual behaviors. All three studies focused on sexual risks in HIV sero-discordant relationships. The findings obtained from interviews and focus groups to some extent supported an association between treatment-related optimistic beliefs and HIV risks, at the same time, these qualitative findings also implied that a more complex "story" may be at work under the apparent association observed in quantitative studies, as suggested by the following themes:

Adoption of optimistic beliefs as a post-hoc rationalization for sexual risk behaviors

A common highlight from qualitative studies is the potential that optimistic beliefs about HIV treatment may be used as a justification for sexual risk behaviors among people who are more likely to engage in sexual risk behaviors regardless of the information on reduced HIV transmissibility given ART and undetectable viral load. In other words, optimistic beliefs may rationalize rather than predict sexual risk behaviors. Such a possibility also corresponds to quantitative findings from the study by Yi et al. in which treatment optimism was involved in the process of disengagement coping with anxiousness brought by unprotected sex.

One of the qualitative studies was related to the experience of conception with an HIV negative partner among HIV positive women [26]. It was found that these HIV positive women usually justified their unprotected sex, a behavior considered as being careless and irresponsible, by constructing accounts around minimum risk of women-to-men transmission, and the reduced infectivity due to undetectable viral load. Similar findings were observed in a study that looked at barriers for consistent condom use among HIV+ MSM [28]. Overall only a small proportion of participants in the study perceived HIV treatment to reduce infectivity, but among those who held such a belief, undetectable viral load was referred to as a rationalization for engaging in sexual risk behaviors. Additionally there was a general consensus among the participants that effective treatments had led to a reduced fear for HIV and, by association, a shift in community norms regarding the acceptability of unprotected sex.

Desire for social validation overrides the consideration of risk

In the study of women's conception experience, social discrimination, and self-imposed stigma of HIV infection appeared to have triggered participants' desire to deny the influence of HIV on their lives through the action of normalizing sexual behaviors such as non-condom use or natural conception [26]. These actions were often supported by their HIV negativemale sexual partner who disliked condomuse. It appeared that infectivity beliefs were synchronized with the relationship needs of these women and the decision to use condoms was shaped less by treatment optimism than by emotional needs to normalize social identity.

A study by Persson also provided similar implications [27]. This study was conducted to evaluate whether information from the Swiss Statement would lead to a departure from condom use. Findings showed that beliefs in reduced transmissibility may have increased people's adoption of unprotected sex or alternatively reassured people of what they have already been doing. The needs to normalize sexual lives and to minimize the influence of HIV on their relationship were mentioned by several sero-discordant couples in the study. Sexual decision-making seemed to be shaped less by calculation of risk, than by complex dynamics around a range of emotional and relationship priorities such as intimacy, stigma, gender, and reproduction.

Findings from a mixed-method study

One study with a mixed-method approach echoed previous results from both quantitative studies and qualitative studies [29]. In the quantitative analysis, the study identified two components – HIV transmission optimism, focused on optimism toward sexual transmissibility of HIV due to effective treatment, and HIV Health Optimism related to optimism toward overall severity of HIV. It was found that HIV transmission optimism, but not HIV health optimism, was associated with unprotected anal intercourse with casual partners regardless of HIV sero-status.

In the qualitative analysis, the study found parallel existence of both types of optimisms across different themes (concerned, unconcerned, irrelevant, and fearful) generated to categorize attitudes toward HIV. Meanwhile people who recently engaged in unprotected anal sex expressed greater optimism overall, and were more likely to conceptualize the treatment optimism as "permission" for them to engage in unprotected sex, indicating that such optimism might have been adopted among participants who had more sexual risk behaviors in the first place because it is in concordance with their desire to have sex without a condom.

Variations in measurement

Measurements of treatment-related beliefs and attitudes varied across studies with some of them relying on a single item while others adopted a more comprehensive measurement with multiple items. Overlap in items was common across studies, but no study appeared to have used exactly the same set of items or questions to measure beliefs and attitudes. Overall these measures cover a range of concepts that underlie HIV treatment optimism, including beliefs in reduced infectivity and transmissibility, reduced concern for HIV infection, and positive outlook on HIV treatment. Others used proxy measurement such as knowledge about content in the Swiss Statement, and time point that divides the period before and after the Swiss Statement.

In contrast, there is not much variation in the outcome measures. Unprotected sex or noncondom use was consistently used across most of the studies as measures of HIV risk. Two studies also accompanied unprotected sex with other measures such as number of sexual partners and age of sexual debut in measuring HIV risk. Recent diagnosis of STIs was used in one study as an outcome measure.

Discussion

The purpose of this review was to provide an updated summary of the scientific evidence for the relationship between treatment-related optimistic beliefs and risk of HIV transmission. Current findings from quantitative studies support a hypothesized association between various optimistic beliefs and risk of HIV transmission, but findings from qualitative studies revealed greater depth that may bring into question a direct association between optimistic beliefs and sexual risk behaviors. An integration of these findings suggests an urgent need for research using a more comprehensive approach to assess the relationship between treatment-optimism and HIV risks.

One of the major methodological issues in current literature is the lack of consistency in measuring treatment-related optimistic beliefs. With every study using a unique set of measures, results cannot be lined up across studies. Such a wide variation in measures may not only interfere with the effort to compare results, but also raise concern regarding the validity of different measures. Many studies appeared to be measuring the same underlying belief, but a deep look into the measurement reveals considerable variability in the choice of items. The need to tailor measures to the study setting or target populations should be

balanced against a standardized measure. Moreover, most studies did not provide an adequate rationale for the choice of certain belief measures. As measures are at the core of producing valid study results, future researchers should give serious consideration to the theoretical soundness of belief measures and provide justification of the choice of measures or items that form a certain measure.

Results from the current literature suggest a potential difference between HIV-positive people and non-positive people regarding the influence of optimistic beliefs on sexual risks. General treatment optimism which was not associated with HIV risks in studies among HIV positive people appeared relevant to sexual risk behaviors in studies of non-HIV positive people. Although we cannot rule out the possibility that this contrast may be due to insufficient controls of confounders, the difference may highlight the obvious distinction between risks for being infected versus the risk of infecting a partner. More studies are needed to explore this issue so that relevant policies and intervention programs may be better tailored to both HIV positive and non-positive populations.

Qualitative findings and one quantitative study [23] indicated a potential for treatment optimism to be endorsed as a post-hoc coping strategy or rationalization for unprotected sex. These findings are in contrast to the widely held views that treatment-related optimism acts as an antecedent of sexual risk behaviors. The possibility that treatment optimism is adopted by people to rationalize their risk behaviors casts doubt on the assumed directionality of the relationship between treatment optimism and HIV risk. The correlational nature of the available quantitative studies has prevented us from excluding such a possibility. Therefore, longitudinal studies are needed to determine if interventions are targeted to treatment-related beliefs or toward individuals prone to engage in risk behaviors.

The current review also underscores findings from MSM that warrant attention given the high risk nature of sexual behaviors and high HIV incidence rates among this population. Nevertheless it is necessary to expand the dimension of studies on treatment-related beliefs to other populations, especially as TasP is promoted across all people infected with HIV. Most studies on treatment optimism were conducted in developed countries. However, studies are needed across different cultural settings and/or among less developed countries to broaden understanding of the potential impact of treatment optimism. Finally research is needed to delineate the interaction between optimistic beliefs and other critical elements such as treatment adherence, which when combined together, may have a synergy effect on the overall performance of TasP.

Conclusion

Findings from recently published studies were in support of a relationship between treatment-related optimistic beliefs and increased HIV risks. However, a lack of high quality evidence undermines the strength of the findings and precluded definitive recommendations geared toward minimizing the potential impact of treatment optimism on HIV transmission. More careful examinations of the relationship between treatment-related optimistic beliefs and risk of HIV transmission are warranted. It is foreseeable that with prospective study designs, there will be clearer implications not only regarding the role of specific types of beliefs on HIV risk, but also about the mechanism underlying the effect of optimistic beliefs.

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Table 1

Studies published between 2009–2012 with information on relationships between treatment-related HIV optimistic beliefs and sexual risks

Chen

QUANTITAT	IVE STUDIES						
Studies	Study design	Sample	Location	Methods of data collection	Treatment-related beliefs & attitudes	Risk of HIV transmission	Results
Joseph et al. (2009)	cross-sectional	HIV+ MSM (n=842)	USA	Audio computer assisted self- interview (ACASI)	PeP-Infectivity Belief, UVL- Infectivity Belief, & ART- Infectivity Belief	Discordant unprotected (insertive) anal intercourse (DUAI) & (DUIAI)	UVL-infectivity belief was associated with DUIAI & DUAI with casual partners. Intentional ART dose- missing moderated the association. No association was found for PeP- or ART- infectivity beliefs.
Begley et al. (2009)	cross-sectional	HIV+ MSM (n=109)	Australia	Self-administered questionnaire	O-S Scale	Unprotected receptive/insertive anal intercourse with/without ejaculation	No association between O-S Scale and all types of sexual risk behaviors.
Brennan et al. (2010)	cross-sectional	HIV+ MSM (n=346)	NSA	Self-administered questionnaire	Trt-O Scale (susceptibility, condom motivation, & severity)	DUAI	Susceptibility in Trt-O Scale is associated with DUAI.
Smith et al. (2011)	cross-sectional	General population aged 15-49 (men=749, women=906)	Kenya	Interviewer- administered pre- programmed questionnaire in a personalized digital assistant (PDA)	ART-Cure Belief, ART-Severity Belief, & ART-Risk Compensation	Unprotected intercourse (UI), life-time partners, age of sex debut, & engaging in sexual transaction	ART-Severity belief is associated with more casual sex, more life-time partners, younger debut age among women; ART-Cure belief is associated with younger debut age among women, UI at last sex, and sex transaction among men. No association was found for ART-risk compensation.
Hasse et al. (2010)	prospective	HIV+ persons aged 16 who attended clinics and hospitals (n=7,309)	Swiss	Standard data collection by physicians and study nurses & interviewer-administered questionnaire on condom use	Publication of the Swiss Statement	IJ	Time period after the publication of the Swiss Statement is associated with UI with stable partners across different groups of samples including MSM, current DDUs, heterosexual men & women. A positive interaction was observed between the time period and UVL.
MacKellar et al. (2011)	cross-sectional	HIV-MSM, or MSM not tested for HIV before (n=1.593)	USA	Self-administered questionnaire	Belief Construct: HAART- Mitigation Belief, UVL- Susceptibility Belief & Complacency Construct: HAART/UVL- Concern, HAART/UVL-	Having 10 male sex partners within 6 months, unprotected anal intercourse with 1 HIV+/	HIV/AIDS complacency construct mediated the effects of the belief construct, and predicted statistically significant variance in HIV acquisition behaviors.

Studies	Study design	Sample	Location	Methods of dat	a collection	Treatment-related attitudes	l beliefs &	Risk of HIV transmission	Results
						Reduced Susceptibil during D	ity Concern I	unknown status male partners, & HIV infection in the past year	
Kalichman et al. (2010)	cross-sectional	People living with HI AIDS (PLWHA) (n=190)	V/ USA	ACAS	SIS	ART-Infectiousnes ART Optim	s Belief,& ism	Diagnosis of a non-HIV STI within 6 months	ART-Infectiousness beliefs are associated with a recent diagnosis of an STI. No difference was found for ART optimism between people with or without STI diagnosis.
Castro et al. (2012)	cross-sectional	Sexually active PLWF who has knowledge about the Swiss Statement (n=977)	A France	Self-administered	questionnaire	Swiss Statement A	wareness	Change in condom use	11% of participants declared using condoms less than before since the awareness, 65% of participants reported no change in condom use, & 10% reported more condom use.
Yi et al. (2010)	cross-sectional	HIV negative MSM (n=285)	NSA	Self-administered	questionnaire	HAART Opti	mism	UAI	Optimism mediated the association of anxiety and UAI, and may be used as a coping strategy to reduce UAL-related anxiety.
<i>Clarke et al.</i> (2012)	cross-sectional	HIV+ patients on AR (n=512)	T Thailand	Self-administered	questionnaire	ART-infectivity Bel infectivity B	ief & UVL- elief	IJ	No association was found between the beliefs and UI.
QUALITATIV	E STUDIES								
Studies	Stu	ıdy design ^a	Sample	Location	Methods of	f data collection	Interpretation	1 of findings	
McDonald (20	<i>111)</i> E	γ xploratory	Vomen diagnosed HIV during years childbearing (n=3	with of Australia 4)	In-depth i	nterview (IDI)	Women in the likelihood of fi their effort of 1 partners.	study often resort to emale-to-male trans natural conception th	o low viral load and low mission as a justification for hrough unprotected sex with
Persson (201	(0) Longitudi	had + Exploratory the	HV+ heterosexual sir HIV-partners (r	s & 1=47) Australia	In-depth semi-s	tructured interviews	It was unclear unprotected se doing. Sexual calculation of 1 relationship pr	if beliefs in undetec x or merely reassure decision-making wa risk than by comple: iorities.	table viral load drove ed people of what they had been is shaped less by consistent x dynamics of emotions and
Vanable et a (2012)	u. E	xploratory	HIV+ MSM (n=5	2) USA	Focus g	group & IDI	There was a ge importance of ART. Some pa more like a rat	eneral consensus on safer sex among gay urticipants considere ionalization for peol	a shift in noms regarding the y communities due to effective ed undetectable viral load to be ple who disliked condom use.

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QUANTITATIVE STUDIES

Interpretation of qualitative findings	Beliefs do not necessarily predict sexual risk behaviors. Men who engaged in unprotected sex could be optimistic simply because such beliefs were in accord with their desires.
Quantitative results	UAI with casual partners was associated with a higher score on ART-transmission optimism but not ART-severity optimism among both HIV+ & HIV-MSMs.
Risk of HIV transmission	UAI with casual partners
Treatment-related HIV infectivity beliefs & attitudes	ART-Transmission Optimism, ART- Severity Optimism
Methods of data collection	Online survey & IDI
Location	Australia
Sample	MSM (n=2,306 for surveys, n=40 for IDIs)
Study design	Mixed-methods (cross-sectional + exploratory)
Studies	Prestage et al. (2012)

^aStudy design for qualitative studies was usually not clearly specified and thus was generally summarized as "exploratory" studies.

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MIXED-METHODS STUDIES

	Table 2
Measures of treatment-related optimistic beliefs	
SINGLE-ITEM MEASUREMENT	
PeP-Infectivity Belief (Joseph et al.)	HIV transmission can be prevented by post-exposure prophylaxis.
Undetectable viral load (UVL)-Infectivity Belief (Joseph et al. & Clarke et al.)	People with undetectable viral load are unlikely to transmit HIV.
ART-Infectivity Belief (Joseph et al & Clarke et al.)	People on HIV anti-retroviral therapy are unlikely to transmit HIV.
ART-Cure Belief (Smith et al.)	Belief that ART cures HIV/AIDS.
Swiss Statement Awareness ^a (Castro et al.)	Being aware of the Swiss Statement and its content.
Post-Swiss Statement Period td (Hasse et al.)	Time period after the publication of the "Swiss statement".
MULTIPLE-ITEM FACTORS/CONSTRUCTS ^b	
ART-Severity Belief <i>(Smith et al.)</i>	Belief that HIV/AIDS is a more controllable and less serious disease due to ART availability (4 items).
ART-Risk Compensation (Smith et al.)	ART availability makes HIV infection less of a concern so that people are more willing to engage in sexual risk behaviors (7 items).
ART-Transmission Optimism (Prestage et al.)	ART makes HIV transmission unlikely, reduced concerns for infection, and increased willingness to engage in sexual risks (4 items).
ART-Infectiousness Belief (Kalichman et al.)	ART makes HIV+ people with UVL less infectious and people can relax and not worry about unsafe sex (4 items).
ART Optimism (Kalichman et al.)	Treatment for HIV brought hope for a cure in the near future and will soon make HIV a more controllable disease like chronic illness (3 items).
ART-Severity Optimism (Prestage et al.)	HIV is no longer a death sentence and has become less serious and more controllable like a chronic illness (3 items).
HAART Optimism ($Yi et al.$)	HAART makes HIV infection more manageable, reduced concerns for HIV infection, and having more freedom to have sex without condoms (7 items).
Belief Construct (Hasse et al.)	
HAART-Mitigation Belief	Belief that HAART makes HIV a more manageable disease by preventing infection from progressing into AIDS (4 items).
UVL-Susceptibility Belief	Belief that people are less likely to be infected by HIV-positive partners with undetectable viral load (3 items).
Complacency Construct (Hasse et al.)	
HAART-Reduced HIV/AIDS Concern	HAART makes people being less concerned about HIV infection, unsafe sex or having sex with unknown HIV status partners (4 items).
HAART/UVL-Reduced Susceptibility Concern during discordant intercourse	People are less worried about getting infected by HIV+ partners if the partners were on HAART or have UVL (2 items).
COMPREHENSIVE SCALE	
O-S Scale (Begley et al.)	HIV optimism-scepticism scale (8 items).

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Chen .

Trt-O Scale for MSM (Brennan et al.)

A three-component scale including treatment-related susceptibility (10 items), condom motivation (5 items), and severity for HIV positive gay and bisexual men (4 items).

^aProxy measures of beliefs and attitudes.

 $b_{
m There}$ is substantial overlap of items across factors and constructs, but each study adopted a different combination of items.