HSR Health Services Research

DOI: 10.1111/j.1475-6773.2009.01039.x
RESEARCH BRIEF

Research Briefs

Preventive HIV Vaccine Acceptability and Behavioral Risk Compensation among a Random Sample of High-Risk Adults in Los Angeles (LA VOICES)

Peter A. Newman, Sung-Jae Lee, Naihua Duan, Ellen Rudy, Terry K. Nakazono, John Boscardin, Lisa Kakinami, Steven Shoptaw, Allison Diamant, and William E. Cunningham

Objective. To assess HIV vaccine acceptability among high-risk adults in Los Angeles.
Study Setting. Sexually transmitted disease clinics, needle/syringe exchange programs, Latino community health/HIV prevention programs.
Study Design. Cross-sectional survey using conjoint analysis. Participants were randomly selected using three-stage probability sampling.
Data Collection. Sixty-minute structured interviews. Participants rated acceptability of eight hypothetical vaccines, each with seven dichotomous attributes, and reported post-vaccination risk behavior intentions.
Principal Findings. Participants ($n = 1164$; 55.7 percent male, 82.4 percent ethnic minority, mean age = 37.4 years) rated HIV vaccine acceptability from 28.4 to 88.6; mean = 54.5 (SD = 18.8; 100-point scale). Efficacy had the greatest impact on acceptability, followed by side effects and out-of-pocket cost. Ten percent would decrease condom use after vaccination.
Conclusions. Findings support development of social marketing interventions to increase acceptability of "partial efficacy" vaccines, behavioral interventions to mitigate risk compensation, and targeted cost subsidies.

Key Words. HIV, AIDS, HIV vaccine, conjoint analysis, risk compensation, venue-based probability sampling

HIV vaccines are the holy grail of AIDS research. Stable annual HIV incidence in the United States estimated at 56,500 per annum (Hall et al. 2008) and 2.5 million new HIV infections worldwide in 2007 (UNAIDS 2006) strongly suggest that behavioral prevention alone is insufficient to control the epidemic.

To date, over 100 HIV vaccine (including three phase III) trials have been conducted (IAVI 2009), though no candidate vaccine has yet proven

efficacious. Increasing resources for HIV vaccine research (Cohen 2006) and a doubling of candidate vaccines in clinical trials in the past decade (IAVI 2009) demonstrate a commitment to HIV vaccine development as a crucial component of combination prevention (Padian et al. 2008), the best long-term strategy for addressing the most urgent global health challenge of our time.

Dozens of studies have focused on critical social and behavioral dimensions of HIV vaccine trials—willingness to participate (Mills et al. 2004), social consequences of participation (Allen and Lau 2008; Newman et al. 2008), and behavioral risk compensation (Colfax et al. 2005). Relatively fewer investigations have addressed the very different and much broader challenges for dissemination of an approved HIV vaccine to millions of people (Newman et al. 2004a). UNAIDS has estimated global HIV vaccine uptake at only 19 percent among the 8 percent of 15–49-year-olds at high risk for HIV infection—due to challenges around availability, access, and acceptability (Esparza et al. 2003). Bridging the gap between global need and future uptake is fundamental to the success of HIV vaccines in controlling the epidemic.

In addition to challenges for uptake, risk compensation—the possibility that individuals might respond to HIV vaccination with increased high-risk behaviors—may offset the benefits of "partial efficacy" vaccines (Blower, Schwartz, and Mills 2003; Newman et al. 2004b). Furthermore, widespread expectations of an HIV vaccine as the long awaited "magic bullet" coupled with breakthrough HIV infections among those newly vaccinated may produce an "early idealization, sudden condemnation" phenomenon—for example, evidenced with Rotavax (Danovaro-Holliday, Wood, and LeBaron 2002)—that threatens the success of the entire HIV vaccine enterprise.

Address correspondence to Peter A. Newman, Ph.D., Centre for Applied Social Research, Factor-Inwentash Faculty of Social Work, University of Toronto, 246 Bloor Street West, Toronto, ON, Canada M5S 1A1; e-mail: p.newman@utoronto.ca. Sung-Jae Lee, Ph.D., is with the Center for Community Health, University of California, Los Angeles, CA. Naihua Duan, Ph.D., is with the Departments of Psychiatry and Biostatistics, Columbia University, and the Division of Biostatistics, NYS Psychiatric Institute. Ellen Rudy, Ph.D., is with the Los Angeles County Department of Health Services, Sexually Transmitted Disease Program, Los Angeles, CA. Terry K. Nakazono, M.A., is with the Department of Health Services, UCLA School of Medicine, Los Angeles, CA. John Boscardin, Ph.D., is with the Department of Biostatistics & Center for AIDS Research, UCLA, Los Angeles, CA. Lisa Kakinami, Ph.D. (cand.), is with the School of Public Health, University of Rochester, Rochester, NY. Steven Shoptaw, Ph.D., is with the UCLA Department of Family Medicine, Los Angeles, CA. Allison Diamant, M.D., and William E. Cunningham, M.D., M.P.H., are with the Department of Health Services, UCLA School of Medicine, Los Angeles, CA.

To address these issues, we designed the LA VOICES study. The purpose of this investigation was to assess the acceptability of future FDA-approved HIV vaccines among individuals from vulnerable communities at risk for HIV infection and to quantify the relative impact of several potential vaccine attributes on HIV vaccine acceptability. We also estimated behavioral risk compensation in response to HIV vaccine uptake.

METHODS

Participants

We recruited participants at risk for HIV infection in Los Angeles (LA) County using three-stage probability sampling. Stage I: we randomly selected sites from three venue-based strata: (1) LA County sexually transmitted disease (STD) clinics ($n = 12$); (2) Latino community-based organizations (CBOs) offering HIV testing and health-related services ($n = 8$); and (3) needle/syringe exchange programs (NEP; $n = 8$). Probability-proportional-to-estimated size (PPES) sampling assigned sampling probability for each site proportional to estimated client load. Stage II: we randomly selected 4-hour sessions (morning, afternoon, or evening) within each site; 75 sessions from each stratum were sampled. Stage III: we randomly selected participants within each session at selected sites.

Eligibility criteria included the following: at least 18 years old, not employed by recruitment site, and not known to be HIV positive. Trained interviewers administered one-time, 60-minute structured questionnaires using laptop computers programmed with *Questionnaire Development System* (*QDS*) software (NOVA Research Company 2003). Participants were reimbursed U.S. $20. The study protocol was reviewed and approved by UCLA, LA County Department of Public Health, and University of Toronto IRBs. All participants provided informed consent.

Measures

We used conjoint analysis to assess the acceptability of hypothetical FDA-approved HIV vaccines and the impact of various vaccine attributes on acceptability. In contrast to a compositional approach—presenting a series of vaccine attributes one by one for evaluation—we used a decompositional approach (Green and Srinivasan 1978; Hay 2002) by presenting participants with composite HIV vaccine scenarios.

We constructed eight hypothetical HIV vaccines that varied across seven dichotomous attributes. We used a 2^{7-4} fractional factorial experimental

design (Plackett and Burman 1946) to reduce the number of scenarios required from 128 ($2^7 = 128$) to 8. We based attributes and values on our formative research (Newman et al. 2004b, 2006, 2009), consultation with HIV vaccine scientists, and the need to present meaningful alternatives from a consumer perspective (Green and Srinivasan 1978; Ryan and Farrar 2000). We constructed a ninth, optimized HIV vaccine to check the validity of conjoint analysis ratings, by setting each attribute to our hypothesized preferred value: 99 percent (versus 50 percent) efficacy, no (versus minor) side effects, U.S. $10 (versus U.S. $250) cost, 10-year (versus 1-year) duration of protection, 1 (versus 4) dose(s), administered orally (versus by injection), and cross-clade (versus single-clade) protection.

Trained research staff administered HIV vaccine conjoint scenarios during face-to-face interviews. The nine scenarios were presented simultaneously in a set of laminated cards. Participants rated their acceptance of each vaccine on a five-point Likert-type scale, from "definitely not" to "definitely." Ratings were transformed linearly into a 0–100 scale: "definitely not" = 0 to "definitely" = 100.

Data Analysis. We derived the acceptability score of each hypothetical HIV vaccine by computing the mean of the individual vaccine acceptability ratings across respondents. Next, we applied a one-way analysis of variance (ANOVA) model to fit each respondent's acceptability ratings across eight vaccine scenarios, with the seven vaccine attributes as independent variables. The effect for each vaccine attribute (e.g., efficacy) from the ANOVA model is the impact score of the attribute on vaccine acceptability for the individual respondent (Newman et al. 2006). We averaged individual impact scores across respondents for each attribute (e.g., efficacy) to compute its impact on overall HIV vaccine acceptability, with a one-sample *t*-test to determine statistical significance. We conducted a Wald's *F*-test to compare mean acceptability of the eight vaccines in the factorial design to the acceptability rating of the ninth, optimized vaccine.

We assessed postvaccination risk behavior intentions in regard to condom use for vaginal sex and anal sex, number of sexual partners, and needle sharing. Participants rated each item on a five-point Likert-type scale from "definitely increase" to "definitely decrease" the behavior. We assessed risk behavior intentions in response to one of eight HIV vaccine scenarios randomly selected for each participant, in order to mitigate respondent burden.

For each respondent, we constructed an analytic weight, which permits us to adjust the sample to represent the reference population of persons

attending each site. Each weight is the product of the session sampling weight (adjusts for differential sampling probabilities across sessions and participants within sessions) and a nonresponse weight (adjusts for differential cooperation with the survey) (Duan et al. 1999). To adjust standard errors and statistical tests for the complex sample design and differential weighting, we used linearization methods in *STATA* v10 (Kish and Frankel 1974).

RESULTS

Between August 2006 and May 2007, we recruited 1,164 participants in LA County across three strata: STD clinics ($n = 408$), NEPs ($n = 355$), and Latino CBOs ($n = 401$). Over half (55.7 percent) of participants were male; mean age = 37.4 years. The majority were ethnic minorities (20.5 percent African American, 50.0 percent Latino, 11.9 percent Asian Pacific Islander/American Indian/Other). Most (57.1 percent) had high school–degree education or less, with median annual income of U.S. $14,280. Half (50.4 percent) had no medical insurance and 46.7 percent were unemployed. Table 1 reports sociodemographic characteristics of the sample.

HIV vaccine acceptability ranged from 28.4 to 88.6 on a 100-point scale, from "definitely not" = 0 to "definitely" = 100, with mean acceptability of 54.5 (SD = 18.8). Table 2 shows the acceptability of the eight HIV vaccines and their attribute profiles. The acceptability rating of the ninth, optimized vaccine was 93.1 (SD = 19.2), significantly higher than mean acceptability (54.5; SD = 18.8) of the eight vaccines in conjoint analysis ($F(1, 448) = 1{,}945.49$, $p < .001$).

Efficacy had the greatest impact on acceptability, controlling for other vaccine attributes. Participants were significantly less likely to indicate acceptance of immunization with a 50 percent efficacy than a 99 percent efficacy vaccine (39.6 versus 69.5 on the 100-point scale; $p < .001$). Side effects (temporary body aches and fevers) had the second greatest impact on HIV vaccine acceptability, followed by out-of-pocket cost (U.S. $250 versus U.S. $10). Table 3 shows the impact of the seven vaccine attributes on HIV vaccine acceptability.

Overall, 9.7 percent (95 percent CI = 7.4, 11.9 percent) indicated they would use condoms less for vaginal sex if they received an HIV vaccine; 10.4 percent (95 percent CI = 7.2, 13.5 percent) would use condoms less for anal sex; and 10.4 percent (95 percent CI = 7.4, 13.3 percent) would increase their number of sexual partners. Very few (2.2 percent; 95 percent CI = 0.1, 4.4 percent) participants reporting injection drug use indicated intentions to increase needle/syringe sharing after HIV vaccination.

Table 1: Sociodemographic Characteristics of the Study Sample (N= 1,164)*

Characteristics	*n (%)*
Age (years)	37.4 (12.2, 17–86)†
Ethnicity	
African American	238 (20.5%)
Caucasian	205 (17.7%)
Hispanic (English is primary langauge)	148 (12.7%)
Hispanic (Spanish is primary language)	434 (37.3%)
Asian Pacific Islander, American Indian, multiple race, Other	138 (11.9%)
Born in the United States	769 (66.0%)
Gender	
Male	649 (55.7%)
Female	494 (42.4%)
Transgender	21 (1.8%)
Sexual orientation	
Heterosexual	921 (79.2%)
Gay	141 (12.1%)
Lesbian	26 (2.3%)
Bisexual	76 (6.5%)
Injection drug user	301 (25.9%)
Highest education completed	
No formal education or incomplete primary	344 (29.6%)
Completed high school or GED	320 (27.5%)
Some college or associate's degree	356 (30.6%)
Bachelor's degree or higher (graduate/professional school)	143 (12.3%)
Relationship status	
Single (never married)	737 (63.4%)
Married/common law	234 (20.1%)
Separated/divorced/widowed	192 (16.5%)
Ongoing relationship with a spouse or partner	
No	493 (42.4%)
Yes	670 (57.6%)
Monthly income from all sources combined (U.S.$)	$1,190 ($0–$25,000)‡
Insurance	
Public	322 (27.7%)
Private	255 (21.9%)
None	586 (50.4%)
Current employment status	
Working	621 (53.4%)
On disability or retired	85 (7.3%)
Not working	458 (39.4%)

*All numbers are weighted and adjusted for sampling design effect.

†Mean, standard deviation, and range are reported.

‡Median and range are reported.

Table 2: Acceptability (Mean) of Hypothetical HIV Vaccines with Different Attribute Profiles (in Order of Decreasing Acceptability; $N = 1{,}164$)*

HIV Vaccine Acceptability—Mean (SD)†	*Vaccine Attributes*						
	Efficacy (%)	*Side Effects*	*Cost*	*Duration of Protection (Years)*	*Doses*	*Route*	*Protection (Cross-Clade)*
88.6 (21.4)	99	None	10	10	1	Injection	One type
68.6 (29.9)	99	None	250	1	1	Mouth	Multiple
60.8 (32.9)	99	Minor‡	250	10	4	Injection	Multiple
60.0 (32.3)	99	Minor	10	1	4	Mouth	One type
47.3 (32.3)	50	None	10	1	4	Injection	Multiple
41.5 (32.7)	50	None	250	10	4	Mouth	One type
41.1 (31.8)	50	Minor	10	10	1	Mouth	Multiple
28.4 (30.9)	50	Minor	250	1	1	Injection	One type

*All numbers are weighted and adjusted for sampling design effect.

†Overall vaccine acceptability: 54.5 (SD: 18.8).

‡Temporary body aches and fevers.

Table 3: Impact of HIV Vaccine Attributes on Hypothetical HIV Vaccine Acceptability ($N = 1{,}164$)*

HIV Vaccine Attributes	*Attribute Values*	*Acceptability of Vaccine with Preferred Attribute—Mean (Lower 95% CI, Upper 95% CI)*	*Acceptability of Vaccine with Nonpreferred Attribute—Mean (Lower 95% CI, Upper 95% CI)*	*Impact on Vaccine Acceptability—Mean (Lower 95% CI, Upper 95% CI)*	*p-Value*†
Efficacy	99% versus 50%	69.5 (68.0, 71.0)	39.6 (37.9, 41.2)	29.9 (28.1, 31.7)	<.001
Side effects‡	None versus minor	61.5 (60.1, 62.8)	47.6 (45.9, 49.2)	13.9 (12.3, 15.5)	<.001
Cost	$10 versus $250	59.3 (58.0, 60.6)	49.8 (48.3, 51.3)	9.5 (8.3, 10.6)	<.001
Duration of protection	10 years versus 1 year	58.0 (56.6, 59.4)	51.1 (49.6, 52.5)	6.9 (5.7, 8.1)	<.001
Doses	1 versus 4	56.7 (55.4, 58.0)	52.4 (50.9, 53.9)	4.3 (3.3, 5.3)	<.001
Route	Oral versus injection	52.8 (51.3, 54.3)	56.3 (55.0, 57.6)	−3.5 (−4.7, −2.3)	<.001
Protection (cross-clade)	Multiple versus one type	54.4 (53.1, 55.8)	54.6 (53.2, 56.1)	−0.2 (−1.4, 1.0)	0.72

*All numbers are weighted and adjusted for sampling design effect.

†Derived from Wald's test.

‡Temporary body aches and fevers.

Intentions to increase sexual risk behaviors were significantly greater in the case of a 99 percent versus a 50 percent efficacy HIV vaccine. Among those reporting vaginal sex ($n = 938$), 14.0 percent (95 percent CI = 10.3, 17.8 percent) indicated they would decrease condom use after receiving a 99 percent efficacy HIV vaccine versus 6.0 percent (95 percent CI = 3.5, 8.6 percent, $p < .001$) if they received a 50 percent efficacy vaccine. For anal sex ($n = 687$), 13.2 percent (95 percent CI = 8.4, 17.9 percent) reported intentions to decrease condom use after receiving a 99 percent efficacy HIV vaccine versus 7.0 percent (95 percent CI = 3.6, 10.5 percent; $p = .025$) after receiving a 50 percent efficacy vaccine. Among the 987 participants who responded to the item about sexual partners, 13.0 percent (95 percent CI = 9.5, 16.6 percent) would increase their number of partners if they received a 99 percent efficacy vaccine versus 7.7 percent (95 percent CI = 3.8, 11.5 percent, $p = .038$) with a 50 percent efficacy vaccine.

DISCUSSION

This probability sample survey of ethnically and racially diverse adults recruited from venues that serve populations at elevated risk for HIV infection indicates that future HIV vaccine acceptance is far from guaranteed among those likely to be targeted for initial dissemination. HIV vaccine acceptability varied widely depending on the characteristics of the vaccine. Overall, the moderate level of vaccine acceptability suggests hope; however, initial HIV vaccines (Stover et al. 2007) are more likely to parallel the least acceptable of the vaccine scenarios presented.

Vaccine efficacy had the greatest impact on acceptability. Participants indicated high levels of acceptability for a vaccine that delivers sterilizing immunity. However, initial HIV vaccines will likely be of low to moderate efficacy (Stover et al. 2007). Low levels of acceptability of partially efficacious HIV vaccines portend significant challenges for the effectiveness of vaccines in controlling HIV on a population level.

Concerns about temporary minor side effects had the second greatest impact on HIV vaccine acceptability. A public perception of vaccines as delivering sterilizing immunity using a "small dose" of virus to generate an immune response (Newman et al. 2009) may pose particular challenges in the case of HIV (versus influenza, for example) due to fear of iatrogenic infection. Social marketing interventions to promote acceptability of partially efficacious HIV vaccines (Newman et al. 2004a), and public education about recombi-

nant genetic vaccines (i.e., that they cannot cause HIV infection) and possible vaccine side effects, may be key components of programs to facilitate uptake of initial HIV vaccines among vulnerable adults.

The impact of out-of-pocket cost on HIV vaccine acceptability is notable among this sample of low-socioeconomic status adults, half of whom lacked health insurance coverage. The intersection of poverty and HIV prevalence (Simon et al. 1995; Cunningham et al. 2005) suggests the importance of proactive government policies to subsidize HIV vaccine costs for low-income adults. Given the relative lack of control that vaccine scientists may have over initial vaccine efficacy and minor side effects, price subsidies are a readily available and likely a cost-effective mechanism (Hecht and Suraratdecha 2006) to facilitate broad vaccine uptake among vulnerable adults.

Among other HIV vaccine characteristics, likely vaccine consumers exhibited flexibility regarding the number of doses required and the vaccine's duration of protection. Overall, it may be advisable for vaccine promotion efforts to target efficacy, side effects, and cost in order to have the greatest impact on uptake among adults from vulnerable communities.

Beyond challenges for HIV vaccine acceptability, we found evidence suggesting modest risk compensation—a 10 percent increase in sexual risk behaviors in response to HIV vaccine uptake. Mathematical modeling of the epidemic suggests that even slight increases in sexual risk behaviors may compromise the effectiveness of a partially efficacious HIV vaccine, particularly with less than optimal uptake (Blower, Schwartz, and Mills 2003). The significantly lower estimate of risk compensation in response to a moderately versus a highly efficacious vaccine, however, suggests that diverse, low-socioeconomic-status adults understood the implications of partial efficacy.

Educational and social marketing interventions delivered at the advent of public HIV vaccine availability may need to carefully balance vaccine promotion—particularly in the case of a partially efficacious vaccine—with clear messages about the imperative for integrated behavioral and biomedical prevention in order to mitigate behavioral risk compensation. However, such caveats that communicate the realities of partial efficacy may render social marketing of a vaccine more challenging. To this end, formative research is needed to support balanced, evidence-informed dissemination strategies.

Limitations to this study include reliance on stated intentions, which are imperfect proxies of behavior. However, we used conjoint analysis to more closely simulate real-world decision making (Green and Srinivasan 1978; Ryan and Farrar 2000). The wide range of acceptability, in expected directions, based on HIV vaccines with different attribute profiles increases the

validity of the findings, as does the significantly greater acceptability of the vaccine scenario with all attributes optimized. Nevertheless, subjective and objective factors not included in this analysis may also have an impact on HIV vaccine uptake. Additionally, stated risk behavior intentions in response to future vaccine uptake may be an underestimate; risk compensation, fueled in part by nonrational cognitive processes (Stacy, Newcomb, and Ames 2000), may be greater in response to an actual vaccine. In particular, IDUs sampled at needle exchange programs may be more concerned about the risks of HIV infection and needle/syringe sharing than IDUs who do not access prevention services; HIV vaccine acceptability might be lower and risk behavior intentions higher among the latter. Finally, the present sample, while representative of adults attending venues in Los Angeles that provide services to a range of persons at elevated risk for HIV infection, is not meant to represent persons at risk for HIV infection in the United States and may not generalize to other locales or populations. Further research on HIV vaccine acceptability among adults and adolescents in other HIV epicenters is warranted, particularly in low- and middle-income country settings.

HIV vaccines are an important component of evolving combination prevention that integrates an array of biomedical and behavioral approaches in preventing new HIV infections. With over 50,000 annual HIV incident infections in the United States (Hall et al. 2008) and 2.5 million globally (UNAIDS 2006), each year of delay in dissemination of initial HIV vaccines will result in millions of new infections that might otherwise have been averted. Supporting formative research to build evidence-informed interventions for roll-out of initial, even imperfect HIV vaccines—and other innovations in biomedical prevention—is likely to be a cost-effective strategy in contrast to the price of lifetime antiretroviral treatment. In addition to providing a foundation for social marketing and behavioral interventions, formative sociobehavioral research conducted among vulnerable adults can contribute to a long-term process of community engagement in HIV vaccine development (Newman 2006) that may foster communication, trust, and the acceptability of future HIV vaccines.

ACKNOWLEDGMENTS

Joint Acknowledgments/Disclosure Statement: This study was supported by grant number R01MH69087 from NIMH to Dr. Cunningham (PI) and Dr. Newman (Co-PI). Its contents are solely the responsibility of the authors and do not

necessarily represent the official views of the NIMH. Dr. Newman also received partial support from the Canada Research Chairs Program and the Social Sciences and Humanities Research Council of Canada. Dr. Cunningham also received partial support from the UCLA/DREW Project EXPORT (NCMHD grants P20MD000148/P20MD000182), and the UCLA Center for Health Improvement of Minority Elderly/Resource Centers for Minority Aging Research (NIA grant P30AG021684). We thank Tonya Hays and Eve Fielder, DrPH, at the UCLA Survey Research Center for implementation of data collection.

Disclosures: Preliminary data from this study were presented at the International AIDS Conference (2008), Mexico City, Mexico; AIDS Vaccine 2008 Conference, Cape Town, South Africa; and the Society for Social Work and Research 12th Annual Conference (2008), Washington, D.C.

Disclaimers: None.

Conflicts of Interest: The authors declare no conflicts of interest.

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