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The marginal willingness-to-pay for attributes of a hypothetical HIV vaccine

Michael P. Cameron[a,*], Peter A. Newman[b], Surachet Roungprakhon[c], Riccardo Scarpa[a,d]

[a] Department of Economics, University of Waikato, Private Bag 3105, Hamilton 3240, New Zealand
[b] Factor-Inwentash Faculty of Social Work, University of Toronto, 246 Bloor St W, Toronto, Ontario, Canada M5S 1V4
[c] Faculty of Science and Technology, Rajamangala University of Technology Phra Nakhon, 138 Phibulsongkram, Bang Sue, Bangkok 10800, Thailand
[d] Centre for the Study of Choice, University of Technology Sydney, New South Wales, Australia

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ABSTRACT

This paper estimates the marginal willingness-to-pay for attributes of a hypothetical HIV vaccine using discrete choice modeling. We use primary data from 326 respondents from Bangkok and Chiang Mai, Thailand, in 2008–2009, selected using purposive, venue-based sampling across two strata. Participants completed a structured questionnaire and full rank discrete choice modeling task administered using computer-assisted personal interviewing. The choice experiment was used to rank eight hypothetical HIV vaccine scenarios, with each scenario comprising seven attributes (including cost) each of which had two levels. The data were analyzed in two alternative specifications: (1) best-worst; and (2) full-rank, using logit likelihood functions estimated with custom routines in Gauss matrix programming language. In the full-rank specification, all vaccine attributes are significant predictors of probability of vaccine choice. The biomedical attributes of the hypothetical HIV vaccine (efficacy, absence of VISP, absence of side effects, and duration of effect) are the most important attributes for HIV vaccine choice. On average respondents are more than twice as likely to accept a vaccine with 99% efficacy, than a vaccine with 50% efficacy. This translates to a willingness to pay US$383 more for a high efficacy vaccine compared with the low efficacy vaccine. Knowledge of the relative importance of determinants of HIV vaccine acceptability is important to ensure the success of future vaccination programs. Future acceptability studies of hypothetical HIV vaccines should use more finely grained biomedical attributes, and could also improve the external validity of results by including more levels of the cost attribute.

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1. Introduction

The search for a safe and efficacious prophylactic vaccine for HIV has accelerated in the past decade [1–3]. With over 2 million new HIV infections globally each year [4], a vaccine remains the most promising means of controlling the epidemic in the long term, possibly in combination with other preventive interventions including Pre-Exposure Prophylaxis (PrEP) [5], Treatment as Prevention [6] and condoms. In 2009, a large-scale clinical trial in Thailand (RV144), with over 16,000 volunteers, resulted in the first HIV vaccine to demonstrate partial efficacy against HIV infection, although insufficient to achieve licensure [7]. In the context of increasingly coordinated HIV vaccine development research [8], a growing emphasis on implementation science in health care indicates the importance of investigations that aim to avert expectable research-to-practice gaps between vaccine efficacy in clinical trials and effectiveness in the real world, where the epidemic ultimately must be controlled [9–11].

To date relatively few investigations have assessed the acceptability of future HIV vaccines, even less so in the developing world, which bears the greatest global burden of HIV [12]. An understanding of factors associated with vaccine acceptability, particularly among most-at-risk populations, is important to optimizing uptake of future HIV vaccines. Limited social-behavioral research on HIV vaccines, including investigations conducted in the ideal conditions of clinical trials – no cost, incentivized participation, ongoing education and counseling, community outreach – suggest challenges to uptake of future HIV vaccines approved for public licensure [12–14]. Data from RV144 further indicates that 25% of volunteers did not receive the full course of vaccination and had to be dropped from the analysis [7]. Even as a vaccine would obviate many of the challenges for HIV prevention products requiring daily or pericoital use (e.g., PrEP, condoms), vaccine efficacy in clinical trials does not ensure effectiveness [15].

Vaccine acceptability is a measure of potential users' judgment of the satisfactoriness of the vaccine and their willingness to be vaccinated [12]. In quantitative studies, vaccine acceptability is

* Corresponding author. Tel.: +64 7 858 5082; fax: +64 7 838 4331.
E-mail address: mcam@waikato.ac.nz (M.P. Cameron).

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typically measured as a dichotomous yes/no response to a willingness to be vaccinated question [16,17], on a numerical scale [18,19], or as a probability of accepting vaccination [20,21].

An alternative to investigating vaccine acceptability is to directly consider the willingness-to-pay (WTP) for it by potential recipients. Few studies have adopted a contingent valuation approach to estimate WTP for hypothetical HIV vaccines [22–24]. This approach involves presenting respondents with one or a small number of scenarios that include a price for a hypothetical vaccine of given attributes, then adjusting the price in several steps in order to determine the respondent's maximum WTP for each vaccine scenario [25]. An advantage of these studies is that they provide a more direct way to estimate potential demand for future HIV vaccines and evidence to inform public policy decisions [26].

In most studies of vaccine acceptability, each survey respondent is presented with a number of different vaccine alternatives, each with different attributes [27]; most studies have used conjoint value analysis [19,28,29]. In conjoint value analysis, respondents may be asked to disclose their preferences by ordering the alternative vaccines from best to worst and/or being asked to rate each alternative in terms of acceptability, using one of the measures noted above.

To investigate the determinants of vaccine acceptability, most studies then convert the vaccine acceptability variable into either a linear form for ordinary least squares regression analysis [30,31] or a dichotomous variable for logistic regression analysis [32]. In either case vaccine acceptability is the dependent variable and respondent characteristics and hypothetical vaccine attributes may be used as explanatory variables [28]. In a meta-analysis of HIV vaccine acceptability studies, the acceptability of a hypothetical vaccine varied between 37.2 and 94.0 on a 100-point linearized scale, with a weighted mean of 65.6; vaccine acceptability was substantially higher for higher efficacy vaccines [12]. Effect sizes were largest for efficacy, non 'risk group' membership, pragmatic obstacles (e.g. transportation, access to health facilities), and vaccine cost.

One problem with the linearized or dichotomised vaccine acceptability approach described above is that it does not necessarily correspond to how respondents interpret acceptability in their decision-making process. Furthermore, while the advantage of including cost in order to represent preference between attributes in monetary terms is recognized [33], in most studies vaccine cost, if included, is effects coded; thus the opportunity for a more detailed consideration of the marginal willingness-to-pay of different vaccine attributes is precluded.

An alternative method is to employ a random utility model approach [34], where the marginal effects of changes in attributes (e.g., efficacy) of hypothetical vaccines are estimated. This enables researchers to evaluate the acceptability of different vaccine profiles (or combinations of vaccine attributes). When one of the hypothetical vaccine attributes evaluated is cost, then the trade-off between other attributes and cost can be evaluated in terms of probability of acceptance [35]. Commonly accepted economic estimates of welfare change (consumer surplus and marginal WTP) for separate vaccine attributes can then be identified and estimated from the ranking data [36]. A full ranking of seven alternatives can, for example, be interpreted as a sequence of six discrete choices [37]. The first ranked alternative is chosen from seven, the second ranked from six, and so on until the alternative ranked second to the last is selected from two remaining alternatives. An extensive literature on choice modeling exists that analyzes ranking data of this sort [37–41]. Among the major advantages of applying the random utility approach to choice-based conjoint analysis is its efficiency and precision.

In this paper, we adopt the random utility approach to derive estimates of the marginal willingness-to-pay for different attributes of a hypothetical HIV vaccine among men who have sex with men (MSM), male and female sex workers, and transgender women in Thailand.

2. Methods

Based on preliminary qualitative research and previous studies of vaccine acceptability, eight hypothetical HIV vaccine scenarios were constructed. Qualitative data collection consisted of semi-structured face-to-face interviews with community participants ($n = 17$), frontline community-based service providers ($n = 18$) and healthcare professionals ($n = 4$) to explore HIV vaccine knowledge and awareness, concerns about possible future HIV vaccines, and vaccine preferences among most-at-risk populations in Thailand [42].

Each scenario featured a bundle of seven dichotomous vaccine attributes: (1) 99% versus 50% efficacy; (2) no versus minor side effects (specifically temporary body aches, skin rash and fevers); (3) 10-year versus one-year duration of protection; (4) vaccine-induced seropositivity (VISP) (wherein vaccinated individuals would subsequently test antibody positive for HIV) or not; (5) administered at private versus public hospital; (6) high versus low social saturation (the proportion of the population already vaccinated); and (7) vaccine cost of THB100 versus THB2500 (about US$3 versus US$75). Eight scenarios with seven attributes (including cost) were chosen in order to keep the number of vaccine scenarios to be rated manageable for respondents. A fractional factorial orthogonal design allowing only for main effects was used to develop the eight scenarios, based on a Plackett–Burman design [43]. Since out-of-pocket costs for medical procedures, including vaccines, are common in Thailand, the problem of respondents' misinterpretation of the cost variable [44,45] is less likely to arise.

Respondents (aged 18 years or over) were selected using purposive, venue-based sampling [46] across two strata in Bangkok and Chiang Mai cities. The first stratum included gay entertainment venues such as gay strip clubs, movie theaters, massage parlors, and sex motels. The second stratum included community-based organizations providing HIV prevention services to MSM, male and female sex workers, and transgender women, populations at disproportionately high risk based on HIV/AIDS and behavioral surveillance data in Thailand [47,48].

Data were collected from 326 respondents between March 2008 and February 2009 using Computer-Assisted Personal Interviewing (CAPI) [49]. The median age of respondents was 27 years; 67.2% were male, 20.2% female, and 12.6% transgender; 63.2% self-identified as gay, 4.3% bisexual, and 32.2% heterosexual. Over one-third (37.4%) of respondents had 9th grade or less education, 43.3% completed high school/some college and 19.3% completed college. Respondents' median monthly income was THB11,197 (US$345). Further details on data collection are available in Newman et al. [50]. The research received ethics approval from the institutional review boards of UCLA and the University of Toronto, and written informed consent was obtained from all respondents.

After initial socio-demographic questions were asked using CAPI, each respondent was presented with eight laminated cards, one with each vaccine scenario, and asked to rank the eight scenarios, from the 'best' vaccine to the 'worst' vaccine. Sample vaccine cards are presented in Fig. 1. The interviewer provided brief, scripted lay explanations of each vaccine attribute; for example, efficacy: "how well the vaccine works to protect against HIV"; and VISP: "a normal immune response to the vaccine that might show you as testing HIV positive although you are not really infected". The interviewer recorded respondent's rankings in the CAPI questionnaire. At the beginning of questionnaire administration, again immediately before presenting the vaccine scenarios and finally at

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