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Rethinking Cholera and Typhoid Vaccination Policies for the Poor: Private Demand in Kolkata, India

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Summary. — The "old" familiar diseases of cholera and typhoid remain a serious health threat in many developing countries. Health policy analysts often argue that vaccination against cholera and typhoid should be provided free because poor people cannot afford to pay for such vaccines and because vaccination confers positive economic externalities on unvaccinated individuals. In 2004, we conducted a contingent valuation (CV) survey of 835 randomly selected adults from two neighborhoods in Kolkata, India to provide information on private demand for cholera and typhoid vaccines for themselves and for household members to support more nuanced financial and economics analyses of such vaccination programs. The median private economic benefits of providing a typhoid vaccine to a household with five members is about US$23 in a middle-income neighborhood (US$27 for a cholera vaccine) and US$14 in a low-income slum (US$15 for a cholera vaccine). Our research raises an intriguing possibility. If user charges were set at a level to recover the costs of a vaccination program, there could be sufficient demand for the vaccine so that coverage of the vaccinated population might ensure that all the remaining unvaccinated individuals would be protected as well through indirect herd protection.
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Key words — typhoid, cholera, vaccine demand, willingness to pay, Kolkata, India

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1. INTRODUCTION

Cholera and typhoid fever impose both a private economic burden on patients and their families (treatment costs, lost productivity, pain and suffering, risk of death) and a financial burden on the public health systems in developing countries (Crump, Luby, & Mintz, 2004). Though both diseases can be controlled with improved housing, water supply, sanitation, and food handling in many typhoid- and cholera-endemic areas, these investments are expensive to implement and unlikely to occur in the near term. New-generation vaccines against cholera and typhoid are safe and effective (Acosta *et al*., 2004) and could be useful short-term public health tools in reducing incidence rates among endemic populations as well as in preventing large outbreaks. Vaccination programs against cholera and typhoid may protect not only vaccinated individuals, but in some cases unvaccinated individuals as well. By reducing the number of cases of these diseases, vaccination campaigns thus have the potential to deliver significant private and public economic benefits.

The International Vaccine Institute, with support from the Bill and Melinda Gates Foundation, launched the Diseases of the Most Impoverished Program (DOMI) in 2000 to accelerate the development and introduction of new-generation vaccines against cholera, typhoid fever, and shigellosis. The program involves a number of activities, including epidemiological studies, vaccine technology transfer, and sociobehavioral and economic studies. The DOMI research program provides much of the information needed to answer the question of how to deploy these new-generation vaccines against cholera and typhoid. However, the investment case for the use of cholera and typhoid vaccines remains controversial. There are now a large number of under-utilized vaccines that could be used against diseases common in developing countries. The effectiveness and duration of these vaccines differ, and periodic re-vaccination is typically necessary. Even when intellectual property rights issues are resolved, and the cost of the vaccine to the health sector in developing countries is reduced, the delivery costs of these vaccines are still significant. Because both governments' and international donors' financial resources for health care are limited, priorities must be established. Financial realities may dictate that households themselves pay for part of the costs of new vaccination programs, even when vaccination confers positive externalities on unvaccinated members of the population. Information on private demand of new-generation cholera and typhoid vaccines is an important piece of the puzzle in the determination of where and how these new-generation vaccines are most effectively utilized.

We report here on one in a series of DOMI-supported studies of private demand for cholera and typhoid vaccines in developing countries, including Vietnam (Canh *et al*., 2006; Cook, Whittington, Canh, Johnson, & Nyamete, 2007; Kim *et al*., 2008); Lingchuan county, China (Guh *et al*., 2008); Matlab, Bangladesh (Islam *et al*., 2008); and Beira, Mozambique (Lucas *et al*., 2007). These studies used stated preference methods (both contingent valuation and choice experiments) and similar (but not identical) survey instruments to measure private demand and WTP. This paper presents the first empirical estimates of private demand and willingness to pay (WTP) for cholera and typhoid vaccines in Kolkata (Calcutta), India. This Kolkata study is of special interest because of the high incidence of cholera and typhoid in the neighborhoods where the surveys were conducted, the long-standing interest of the global public health community in cholera in Kolkata, and the significance of Kolkata itself, one of the world's largest megacities.

In the summer of 2004, we interviewed 835 randomly selected individuals in two different neighborhoods in Kolkata, inquiring how many cholera or typhoid vaccines the respondent would purchase (for themselves and for their household members) if such vaccines were available for purchase at a specified price. This approach, called contingent valuation (CV), has been widely used in the environmental field for goods that are not sold in a marketplace (Carson, 2000; Hanemann, 1994). It has also been used in the health field for goods or services that are not widely available (Bayoumi, 2004; O'Brien & Gafni, 1996), including vaccines (Cropper, Haile, Lampietti, Poulos, & Whittington, 2004; Suraratdecha, Ainsworth, Tangcharoensathien, & Whittington, 2005; Whittington, Matsui, Freiberger, Van Houtven, & Pattanayak, 2002).

Our objective in the study reported here was to obtain the best estimates of private demand for cholera and typhoid vaccines in a low-income slum and a middle-class neighborhood in Kolkata. To ensure the reliability and validity of our results, we took the approach of many CV studies and followed a set of guidelines for what constitutes "best practice." Although these guidelines are constantly evolving, the interested reader should begin with those proposed by the NOAA panel (Arrow, Solow, Portney, Learner, & Radner, 1993; Carson, Flores, & Meade, 2001; Carson & Mitchell, 1993). For our Kolkata study, we took "best practice" to mean (1) carefully trained enumerators, who would conduct face-to-face interviews; (2) a survey instrument and scenario that was carefully worded and pretested to insure that the good or service in question (typhoid or cholera vaccine) was well understood by the respondent; (3) a reminder to the respondent that personal and family budget constraints and other types of competing expenditures should be considered; (4) a "cheap talk" passage (Cummings & Taylor, 1999); and (5) a dichotomous-choice (yes/no) valuation question for a specific price, rather than an open-ended elicitation method (for more recent work on elicitation formats and post-decision confidence measures see Bennett & Tranter, 1998; Vossler & McKee, 2006). In addition, to reduce the threat of hypothetical bias associated with some stated preference surveys (Carson, Flores, Martin, & Wright, 1996; Harrison, 2006; Hofler & List, 2004), we gave some respondents "time to think" (overnight) about the offered information before giving their reply.

The WTP estimates from this Kolkata study are important for several reasons. First, because such estimates promote a better understanding of households' perceptions of the economic benefits to be gained from vaccination programs, they can improve policymakers' economic assessments of vaccination programs. Second, assessments of private demand, such as the WTP estimates derived here, can help donors, governments, and policymakers design financially sustainable programs that maximize the number of people vaccinated for a given budget. Third, understanding the factors associated with households' WTP can enable public health professionals to design better information programs to promote vaccination campaigns.

2. BACKGROUND

Kolkata (formerly Calcutta, population 13 million) is the third largest city in India. Located in the Ganges–Brahmaputra river delta in the state of West Bengal, the city and the surrounding region (including Bangladesh) have long been a locus of endemic cholera. A passive surveillance survey con-

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ducted in 2004 found overall annual incidence of cholera in Narkeldanga, a low-income slum in Kolkata, to be 1.6 cases per 1,000 people, with incidence highest among young children (Deen *et al*., 2008). Though the overall incidence of typhoid fever is similar (2.0 cases per 1,000), it is more common in older children and teenagers (Ochiai *et al*., 2008).

A combined vaccine against typhoid, paratyphoid A&B, and cholera (TABC) was administered free of charge in Kolkata beginning in the 1950s. It was discontinued in the 1980s because of side effects (pain, swelling, redness, fever) and because recipients were often unable to work for some days after vaccination. Many of our respondents in 2004 recalled how painful the TABC shots had been. Currently no cholera vaccine is available for sale in Kolkata. The typhoid Vi polysaccharide vaccine is currently available for purchase in Kolkata at a few locations, but sales are low because many people do not know that it is available, and because of the time, expense, and inconvenience associated with obtaining the vaccine in private physicians' offices. The existing limited demand comes principally for young people in wealthier families who need the vaccine for travel abroad or for school.

Among our respondents, 8% of household members had received either the old cholera vaccine, the TABC vaccine, or a new typhoid vaccine. The majority of these (76%) were TABC vaccines. Only 1% of respondents reported paying anything for these vaccines. Our respondents were quite knowledgeable about vaccines in general: 97% had heard of vaccines, 88% remembered receiving some type of vaccine (not necessarily for cholera or typhoid), and approximately 85% understood the purpose of vaccination.

3. RESEARCH DESIGN AND FIELD WORK

(a) *Description of study sites*

To assess demand for cholera and typhoid vaccines among lower- and middle-income residents, we surveyed households in two neighborhoods in Kolkata. Tiljala is a densely crowded, mostly low-income, predominantly Muslim slum. Beliaghata is a predominantly Hindu area with more diverse living conditions and incomes. Though Beliaghata contains many middle-class families living in apartment buildings that are in relatively good condition, it also has several small slums where living conditions are similar to those in Tiljala. Most residents in our sample from both neighborhoods got their water from communal taps (around 70%), but more households in Beliaghata had private water connections in their homes (19%) than in Tiljala (11%). The vast majority of residents in both areas use shared flush toilets (over 90%), though again private flush toilets are more common in Beliaghata. In some parts of Tiljala, sewage from toilets flows into open drains outside the houses. Though rare, open pit latrines are still used in both areas.

(b) *Sampling*

Kolkata is a large and ethnically diverse city, with many Urdu-speaking Muslims and Hindi-speaking immigrants as well as native Bengalis. Because we did not have the time or resources to translate and implement our survey into more than one local language, we restricted our sample to Bengali speakers, though not necessarily to people who spoke Bengali as their mother tongue. Project staff who pre-interviewed households were carefully trained to evaluate how well a potential respondent could speak and understand Bengali before scheduling an interview. Interviewers were also instructed to stop any interview if a respondent appeared unable to understand what was being discussed because of language problems.

We used different sampling protocols to select survey participants in Beliaghata and in Tiljala. In Beliaghata we used a stratified two-stage simple random sampling procedure. As the sampling frame, we used the most recent voter list from the National Election Commission of India, which offers the most complete and accurate listing of households and individuals in Beliaghata. The area is divided into two administrative units (wards); we sampled each proportionately to its population.

Because the Beliaghata voter list contained no household information, we selected individuals as proxies for households in the first sampling stage. A few households were selected more than once (if, e.g., we drew both the father's name and the grandmother's name from the voter list). In those cases we interviewed the same household only once. In the second stage, a member of the project staff pre-interviewed each selected household to see if it fit three criteria. The first was that the household must include one or more children aged 17 years or less. If this criterion was met, project staff then asked to speak to either the mother or the father of those children. (The gender of the parent to be interviewed was randomly selected *before* the household visit, though we oversampled for males because their refusal rates tended to be higher.) The second criterion was that the selected parent understood the Bengali language well enough to be interviewed. Because of difficulties we experienced in interviewing older respondents during pretests, the third criterion was that the selected parent be aged 64 years or less.

In Tiljala, we made use of a complete household census compiled in 2003 by the National Institute of Cholera and Enteric Diseases (NICED). This allowed us to create a sample frame that included only households with children under the age of 18. Using this sample frame, we drew a two-stage simple random sample, first selecting households and then selecting the gender of the parent. As in Beliaghata, project staff pre-interviewed the selected households to confirm the presence of children and to insure that the selected parent could understand Bengali adequately and was younger than age 65.

Of the 1,471 households drawn from the voting list in Beliaghata, 666 were located and met our eligibility criteria. We interviewed 559 of these households (16% refusal rate). In Tiljala, we drew 506 households from the NICED census and ultimately interviewed 276. The refusal rate of eligible households in Tiljala was 6%.

(c) *Research design*

Each respondent was asked about willingness to purchase only one type of vaccine (cholera or typhoid) at a single, specific price. Both the type of vaccine offered and the price (one of four fixed amounts) were randomly preassigned. [1] We did not vary the immunological attributes of the vaccines offered; in all the cases we used the best available estimates of effectiveness and duration: oral cholera vaccine, 50% effective for 3 years; Vi polysaccharide typhoid vaccine, 70% effective for 3 years (Acosta *et al*., 2004).

Half of the respondents in Beliaghata were given overnight to think about their responses. Previous studies had found that giving respondents "time to think" (TTT) lowers average willingness to pay (WTP) measures in comparison to results from the standard practice of interviewing a respondent in a single sitting (Cook *et al*., 2007; Lauria, Whittington, Choe, Turingan, & Abiad, 1999; Whittington *et al*., 1992). Allowing time

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to think about their answers may give respondents a chance to consider household budget constraints more carefully, to discuss choices with family members and friends, and to answer questions more confidently. The remaining half of the Beliaghata respondents were not given the TTT protocol; their NTTT ("no time to think") interviews, completed in one session, provided comparison data for assessing the significance of the TTT results. For logistical reasons, we did not conduct TTT interviews in the Tiljala area.

(d) *Survey instrument*

The research team spent considerable time and effort developing and pretesting the interview questionnaire. The final version was divided into four main sections. The first section explored the respondents' perceptions and attitudes toward either cholera or typhoid fever (depending on which type of vaccine the individual had been preassigned), the respondent's knowledge of and experience with vaccines generally, and the household's history with the disease. The second section included information for the respondent on how cholera and typhoid fever are transmitted. It also explained the concept of vaccine effectiveness (following a protocol adapted from Suraratdecha *et al.*, 2005) and posed a series of short questions to test whether the respondent understood the concept. If the respondent did not understand, the enumerator repeated the explanation of the concept of vaccine effectiveness and repeated the test. Respondents who failed this effectiveness test twice still completed the rest of the questionnaire. [2]

The third section, a CV scenario, included three tasks designed to elicit information about willingness to pay (WTP). The first was a single-bounded, discrete-choice question: "Would you buy this (cholera or typhoid) vaccine for yourself if it costs x rupees?" The second was the question "How many such vaccines would you be interested in purchasing for members of your household (at this same price)?" Respondents who said that they would not buy the vaccine for themselves at the specified price were asked if they would take the vaccine if provided free; if so, we asked whether they would pay any positive price for the vaccine, and recorded their reply. Those who said they would not take a free vaccine or would not pay any positive price for it (we have termed these respondents "out of the market") did not proceed to the next task.

The third task was a "sliding scale" payment card exercise. In this procedure, the interviewer presented a price chart and began by indicating on that scale a very high price (Rs. 5,000, US$111) that we were confident all respondents would *not* be willing to pay. Using the analogy of a traffic signal, we called this price "red" ("stop"). The respondent's first task was to state, as the interviewer indicated lower and lower prices along the scale, the "yellow" ("caution") point, of being no longer *certain* that he (or she) would *not* pay that price for the vaccine for self-protection. The interviewer then indicated the bottom of the scale, zero (free), as "green" ("go"). The respondent's second task was to state, as the interviewer indicated higher and higher prices along the scale, the "yellow" ("caution") point, of being no longer *certain* that he (or she) would pay that price for the vaccine. These two specific amounts (lowest price the respondent certainly would not pay, and the highest price the respondent certainly would pay) were recorded as the upper and lower bounds of the respondent's WTP for the vaccine. In this way, we were able to map out an interval of WTP for each respondent.

The fourth and final section of the questionnaire collected socioeconomic information about the household.

4. RESULTS

(a) *Profile of sample respondents*

Table 1 presents summary statistics for the samples in Beliaghata and Tiljala. Respondents in Tiljala had lower incomes, owned fewer assets, and had less education than respondents in Beliaghata. Still, the mean monthly *per capita* self-reported income in Beliaghata was only US$28 (in 2004 US$), about US$1 per day. Although median household size was the same in both areas (five members), households in the Tiljala sample were slightly larger on average, with fewer adults and more older children and teens (5–15 years).

Only nine of the 835 total respondents from both areas did not believe the contingent valuation scenario: that is, they did not believe that the vaccine was safe or that it could prevent the disease. In our test to gauge whether the concept of vaccine effectiveness had been understood, 75% of Beliaghata respondents and 63% of Tiljala respondents correctly answered the questions for the first time; 10% of the Beliaghata respondents and 19% of Tiljala respondents answered these questions incorrectly even after the enumerator had reread the passage explaining effectiveness.

About 10% of all respondents stated that they would not be willing to take the vaccine even if it were provided to them free of charge. Refusal was slightly more common for a free cholera vaccine than for a free typhoid vaccine (10.4% *vs.* 9.0%), especially in Tiljala (12%), but this difference was not statistically significant. An additional 7% said that they would accept a free vaccination but would not pay any positive price for it. These "out of the market" respondents were older, had lower incomes, and more frequently reported never boiling their water (a common measure of health-related behavior). Overall, 19% of respondents who were offered a cholera vaccine were out of the market, as were 14% of respondents who were offered a typhoid vaccine.

We estimated a probit regression model to investigate which socioeconomic or behavioral factors could predict whether a respondent was out of the market. Four of the factors mentioned above (higher age, lower income, never boiling drinking water, and being offered a cholera vaccine) were statistically significant at the 5% level. Neither the respondent's education nor failure to pass the effectiveness test questions was a significant indicator of who was out of the market; nor were water and sanitation conditions, cholera or typhoid vaccination history, neighborhood (Tiljala *vs.* Beliaghata), the vaccine price offered, or whether the respondent was given time to think.

(b) *Respondent demand*

Table 2 presents the raw responses to our first WTP question: would the respondent purchase the vaccine for himself (or herself) if it cost the amount specified? The table includes the 138 respondents who were out of the market but excludes the nine respondents who had rejected the contingent valuation scenario altogether. Without relying on any statistical assumptions or using covariates, one can easily see that the percentage of respondents who said they would purchase the vaccine for themselves decreases as price increases. These data also suggest that demand for both cholera and typhoid vaccines is higher in Beliaghata than in Tiljala and is lower for respondents who were given time to think.

We calculated respondents' average WTP for the vaccines using the Turnbull lower-bound and Kristrom midpoint nonparametric estimators (Haab & McConnell, 2002; Kristrom, 1990). The Turnbull estimator does not rely on statistical

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Table 1. *Descriptive statistics of sample respondents*

Variable name	Description		Beliaghata ($n = 559$) Mean (SD)	Tiljala ($n = 276$) Mean (SD)
Respondent characteristics				
Male	Gender = 1 if male, =0 if female		52%	48%
Age	Age, years		36 years (8.0)	35 years (9.4)
Muslim	Religion = 1 if Muslim, =0 else		1%	76%***
Education low	=1 if respondent completed 1–9 years of school		44%	44%
Education mid	=1 if respondent completed 12 years of school or vocational school		30%	13%***
Education high	=1 if respondent completed university, postgraduate or prof. course		17%	3%***
Household characteristics				
Monthly *per capita* income	Total monthly household income divided by household size, 2004 US$		$28 ($42)	US$13 ($12)***
Num. young children	Number of young children (0–4.9 years)		0.3 (0.6)	0.5 (0.6)***
Num. school-aged children	Number of older children and teens (5–15 years)		1.0 (0.8)	1.5 (1.2)***
Num. of adults	Number of adults (15+ years),		4.0 (2.1)	3.6 (1.7)***
Health- and disease-related characteristics				
Knows person with disease	=1 if knows someone who has had disease (incl. respondent and household members)	Cholera	41%	47%
		Typhoid	46%	55%*
Disease is common	=1 if disease is "common" or "very common" in my neighborhood cholera	Cholera	24%	43%***
		Typhoid	22%	37%***
Likely to get disease – Resp.	=1 if "somewhat likely" or "very likely" that respondent will get disease in the next 5 years	Cholera	40%	42%
		Typhoid	38%	48%*
Likely to get disease – Child	=1 if "somewhat likely" or "very likely" that child in household will get disease in the next 5 years	Cholera	45%	52%
		Typhoid	48%	54%
Disease is serious for adults	=1 if disease is "serious" or "very serious" for adults	Cholera	65%	65%
		Typhoid	58%	65%
Disease is serious for children	=1 if disease is "serious" or "very serious" for children <18	Cholera	85%	78%
		Typhoid	86%	79%*
HH member had vaccine	=1 if someone in household had vaccine	Cholera or TABC	26%	17%**
		Typhoid or TABC	23%	15%**
Never boil drinking water	=1 if household never boils drinking water and does not have Aquaguard water filter		58%	65%**
Distance to health facility	Distance to nearest private health facility, minutes		8.9 (6.7)	12.5 (13.5)***

[a]37 Beliaghata respondents (6.6%) and nine Tiljala respondents (3.3%) could not (or would not) provide income information. These missing values were replaced with the neighborhood median income.
1 US$ = 45 Rs.
*Indicates the difference in means (two-tailed *t*-test) is significant at 10% level; ** at 5%; *** at 1%.

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Table 2. *Percent yes to respondent referendum question, by price*[a]

Price	Rs. 10 (US$0.22)	Rs. 25 (US$0.56)	Rs. 50 (US$1.11)	Rs. 500 (US$11.11)
Beliaghata cholera NTTT	89%	68%	63%	18%
Beliaghata cholera TTT	82%	60%	49%	18%
Beliaghata typhoid NTTT	91%	86%	63%	20%
Beliaghata typhoid TTT	83%	69%	52%	9%
Tiljala cholera NTTT	83%	53%	54%	9%
Tiljala typhoid NTTT	82%	66%	46%	9%

[a] Nine scenario-rejecting respondents were dropped. Exchange rate (US$1 = Rs. 45) at the time of survey.

assumptions about how WTP is distributed. The Kristrom midpoint estimator assumes that the distribution between design points (bids) is symmetrical (e.g., normal or uniform). This is weaker than a parametric assumption, but the estimator does make the fairly strong statistical assumption that the mean and median within each interval are the same. Both ignore potentially important covariates such as income but provide a useful point of comparison with the parametric WTP estimates. The conservative Turnbull lower-bound estimator yields a mean respondent WTP for a cholera vaccine of about US$2.5 in Beliaghata and US$1.3 in Tiljala (Table 3). Turnbull mean WTP values for a typhoid vaccine are similar: US$2.4 to $2.8 in Beliaghata and US$1.5 in Tiljala. These amounts represent the private economic benefits that would accrue to the average respondent if given a cholera or typhoid vaccine for free. The Kristrom midpoint estimator is less conservative than the Turnbull; Kristrom midpoint WTP estimates are generally about twice the Turnbull estimates for our data.

We estimated a multivariate probit model to investigate the determinants of respondent vaccine demand (Table 4). Because we believed private demand would be different in the two different neighborhoods, we ran probit models separately on the Beliaghata and Tiljala subsamples but pooled data for both the types of vaccines, controlling for this by adding a dummy variable for vaccine type in the analysis.

Eight main conclusions can be drawn from these models. First, as expected, respondents who were offered a higher vaccine price were less likely to agree to purchase either type of vaccine. Second, demand for cholera vaccines was somewhat lower than for typhoid vaccines in Beliaghata, but demand for the two vaccines is similar in Tiljala. Although significant only in Beliaghata, the interaction between price and whether the vaccine offered was cholera was positive, meaning respondents were somewhat *less* price sensitive for cholera vaccines. Third, having a higher income or having a primary-school education increased the likelihood that a respondent would purchase a cholera or typhoid vaccine. The effect of income was larger in magnitude in Tiljala. Having a secondary-school or university education increased the likelihood still further in Beliaghata. Fourth, results for the subsample of Beliaghata respondents given overnight to consider their answers were highly statistically significant: respondents given time to think (TTT) were less likely to purchase the vaccine.

Fifth, neither a respondent's assessment of the likelihood of personally contracting the disease in the next 5 years nor the perceived seriousness of the disease was a statistically significant determinant of demand, although respondents in Beliaghata who knew a person who had contracted cholera or typhoid were more likely to be willing to purchase a vaccine. Sixth, respondents in Beliaghata who never boiled their drinking water were less likely to purchase a vaccine. Seventh, respondents in households with more adults were more likely to purchase a vaccine. Eighth, older respondents in Tiljala were somewhat less likely to want to purchase a cholera or typhoid vaccine for themselves.

Table 3 reports mean WTP measures for respondents based on these probit model results (i.e., parametric WTP estimates). For cholera vaccines, the NTTT estimates are about US$5.2 in Beliaghata (US$3.0 with TTT) and US$2.6 in Tiljala (NTTT). The mean WTP for typhoid vaccines is similar in Beliaghata (US$5.2 NTTT, US$3.6 TTT) and US$3.3 in Tiljala (NTTT). These estimates generally fall within the range of estimates from the two nonparametric approaches reported in the same table.

Figure 1 shows the percentage of respondents who reported that a specified price was "green." Like the data in Table 2, this figure shows that the percentage of respondents who were sure that they would buy the vaccine clearly declines with price, is smaller in Tiljala than in Beliaghata at all prices, and is smaller for time to think (TTT) respondents than no time to think (NTTT) respondents.

Being given time to think may also increase the certainty that respondents feel about their answers. We asked respondents how certain they felt about their answer to the question of whether they would buy the vaccine for themselves. Among those who were offered a cholera vaccine, 86% of TTT respondents felt "very certain" about their response, compared to

Table 3. *Respondent and household willingness to pay (WTP), 2004US$*[a]

	Respondent WTP			Household WTP
	Turnbull lower-bound estimator (mean)	Kristrom midpoint estimator (mean)	Multivariate probit (median)	Negative binomial count model (median)
Beliaghata cholera NTTT	$2.5	$5.2	$5.1	$35
Beliaghata cholera TTT	$2.4	$4.5	$3.0	$27
Beliaghata typhoid NTTT	$2.8	$5.5	$5.2	$29
Beliaghata typhoid TTT	$1.6	$3.9	$3.6	$23
Tiljala cholera NTTT	$1.3	$3.9	$2.6	$19
Tiljala typhoid NTTT	$1.5	$3.6	$3.3	$17

[a] Exchange rate (1 US$ = Rs. 45) at the time of survey (2004).

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Table 4. *Multivariate models of respondent and household demand*[a]

Dependent variable	Respondent demand: multivariate probit		Household demand: negative binomial count model	
	Respondent yes/no to "would buy for yourself?"		Count of household members respondent would purchase for (including respondent)	
	Beliaghata	Tiljala	Beliaghata	Tiljala
Price (Rs.)	$-4.7e^{-3}(5.4e^{-4})^{***}$	$-5.2e^{-3}(8.6e^{-4})^{***}$	$-3.0e^{-3}(4.0e^{-4})^{***}$	$-4.4e^{-3}(8.8e^{-4})^{***}$
Price* Cholera	$1.2e^{-3}$ $(6.8e^{-4})^{*}$	$9.8e^{-4}(1.2e^{-3})$	$7.8e^{-4}(5.4e^{-4})$	$8.6e^{-4}(1.2e^{-3})$
Time to think	-0.35 $(0.13)^{***}$		-0.26 $(0.06)^{***}$	
Cholera	-0.29 $(0.15)^{*}$	-0.21 (0.21)	-0.12 $(0.07)^{*}$	-0.08 (0.12)
Monthly *per capita* income (000 Rs.)	0.17 $(0.09)^{*}$	0.77 $(0.26)^{***}$	0.038 $(0.01)^{***}$	0.41 $(0.13)^{***}$
Male	-0.02 (0.15)	0.05 (0.21)	0.04 (0.08)	0.12 (0.14)
Education low[b]	0.48 $(0.22)^{**}$	0.47 $(0.22)^{**}$	0.38 $(0.15)^{**}$	0.37 $(0.14)^{***}$
Education mid[b]	0.82 $(0.25)^{***}$	0.26 (0.32)	0.53 $(0.15)^{***}$	0.41 $(0.18)^{**}$
Education high[b]	0.54 $(0.28)^{*}$	0.55 (0.64)	0.39 $(0.16)^{**}$	0.07 (0.31)
Age	-0.01 (0.01)	-0.033 $(0.01)^{***}$	0.00 (0.01)	-0.01 (0.01)
Muslim	0.18 (0.76)	-0.18 (0.24)	-1.15 $(0.45)^{**}$	-0.06 (0.13)
No. of young children	-0.22 $(0.13)^{*}$	-0.04 (0.15)	0.04 (0.08)	0.12 (0.10)
No. of school-aged children	-0.15 $(0.08)^{*}$	0.03 (0.08)	-0.01 (0.05)	0.12 $(0.06)^{**}$
No. of adults	0.062 $(0.03)^{*}$	0.18 $(0.06)^{***}$	0.11 $(0.02)^{***}$	0.21 $(0.04)^{***}$
Distance to health facility	-0.019 $(0.01)^{**}$	-0.014 $(0.01)^{**}$	-0.01 (0.01)	-0.01 (0.00)
Likely to get disease – Resp.	-0.05 (0.13)	-0.10 (0.18)	0.02 (0.08)	-0.10 (0.15)
Likely to get disease – Child			-0.07 (0.08)	0.05 (0.14)
Disease is serious for adults	0.03 (0.13)	-0.10 (0.19)	0.01 (0.07)	0.11 (0.13)
Disease is serious for children			-0.12 (0.08)	-0.03 (0.15)
Knows person with disease	0.33 $(0.13)^{**}$	-0.02 (0.19)	0.11 $(0.06)^{*}$	-0.18 (0.13)
Never boil drinking water	-0.35 $(0.13)^{***}$	-0.23 (0.19)	-0.17 $(0.06)^{***}$	-0.26 $(0.12)^{**}$
HH member had vaccine	-0.14 (0.15)	0.37 (0.27)	-0.04 (0.08)	0.01 (0.15)
Constant	0.85 $(0.48)^{*}$	1.0 $(0.56)^{*}$	0.72 $(0.28)^{***}$	0.46 (0.33)
N	551	275	551	275
Pseudo-R^2	0.29	0.32	0.10	0.12
Wald Chi-sq ($p <$ Wald χ^2)	158	78	283	172
Alpha (standard error)[c]	n/a	n/a	0.16 $(0.05)^{***}$	0.46 $(0.13)^{***}$

[a] *Indicates significance at the 10% level, **at the 5% level, ***at the 1% level. Excluding nine scenario-rejecters. Robust standard errors in parentheses.
[b] Excluded category is no education.
[c] Alpha is the overdispersion parameter of the negative binomial model, and Stata 8.0 empirically tests whether alpha is significantly different from zero. When alpha = 0 there is no overdispersion in the data and the Poisson count model is sufficient. When alpha ≠ 0 then the negative binomial is the appropriate model.

68% of NTTT respondents. A simple *t*-test of sample means shows that the difference between these two percentages is statistically significant at the 1% level. The difference in certainty among respondents who were offered a typhoid vaccine was not significant.

(c) *Household demand*

Table 5 shows that the average number of vaccines that respondents wanted to purchase for household members decreased as vaccine price increased. About three-quarters of the households made an all-or-nothing decision: if the price was attractive, the respondent said they would buy vaccines for the entire household, but at higher prices said they would buy for no one. In fact, the percentage of respondents who said they would buy for no household members was strongly affected by price, increasing from 9% at the lowest price to 65% at the highest price. Thus, it does not appear that higher prices forced most respondents to think about *which* household members to vaccinate (e.g., whether to buy for a teenage daughter but not for a teenage son). Rather, it seems likely that respondents had a natural aversion to saying that they would buy for some household members and not others because this might suggest to the enumerator that they cared more about some members than others (a sensitive subject). There was, therefore, a tendency to buy for everyone in the household at low prices (and treat everyone equally), and to buy for no one at high prices (again treating everyone equally).

We estimated a negative binomial count model to explore the determinants of household demand. We used this model (rather than a simple Poisson count model) because the data showed signs of overdispersion (the standard deviation of the count variable was larger than its mean). We tested empirically for overdispersion, and in all the cases we rejected the null hypothesis of no overdispersion at the 1% significance level. The results, shown in the two rightmost columns of Table 4, are quite similar to the determinants of respondent demand. Results from age-specific count models (not reported here but available from the authors) indicate that, for both types of vaccines, respondents place a higher value on vaccinating children in the household than adults.

Average household WTP for cholera vaccines in Beliaghata was US$27 (TTT) and US$35 (NTTT). This amount repre-

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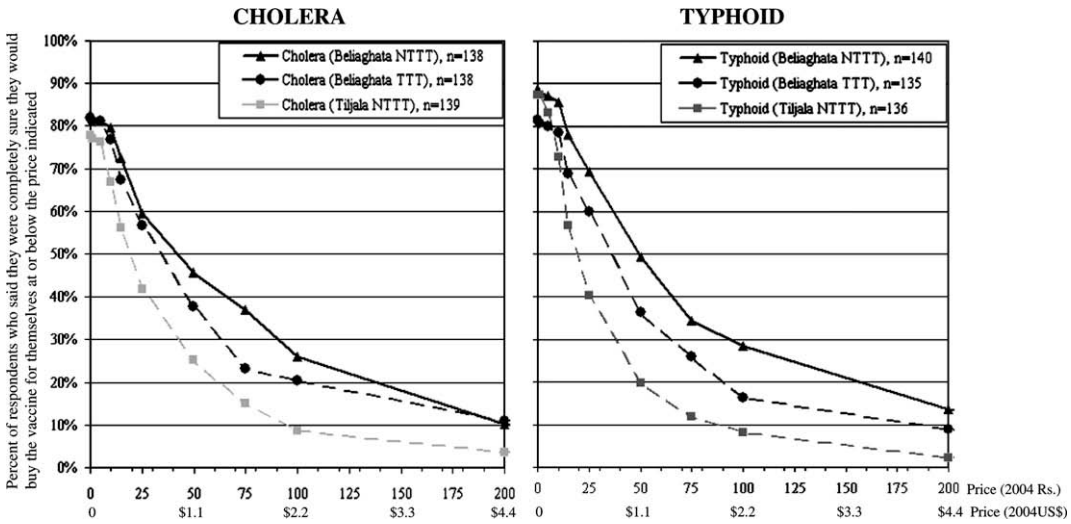

Figure 1. *Respondents who were certain that they would purchase a 50%-3 year cholera vaccine or 70%-3 year typhoid vaccine for themselves, by price, time to think (TTT), and neighborhood (based on raw data from sliding scale exercise).*

Table 5. *Average number of vaccines purchased for household members (not including the respondent), by price*

Price	Rs. 10 (US$0.22)	Rs. 25 (US$0.56)	Rs. 50 (US$1.11)	Rs. 500 (US$11.11)
Beliaghata cholera NTTT	3.3	2.7	2.2	1.3
Beliaghata cholera TTT	2.9	1.9	1.5	0.8
Beliaghata typhoid NTTT	3.6	3.5	2.7	1.4
Beliaghata typhoid TTT	2.9	2.3	1.7	0.5
Tiljala cholera (NTTT)	4.0	2.2	2.0	0.5
Tiljala typhoid (NTTT)	3.5	2.7	1.9	0.5

sents the perceived private economic benefits to a household of having everyone in the household receive free cholera vaccines. Average WTP for typhoid vaccines in Beliaghata was only slightly smaller: US$23 (TTT) and US$29 (NTTT). In Tiljala, WTP was about US$19 for cholera and US$17 for typhoid (both NTTT). Table 6 shows how household WTP varies with education and income.

5. CONCLUSIONS

On the basis of the information that respondents gave us in the first WTP question and the sliding scale "traffic light" exercise, we feel confident that the respondent WTP for either of the two vaccines is at least US$2. The perceived private *household* economic benefits of vaccination, however, are much larger because our results indicate that respondents valued vaccines for their children more highly than for adults. For Beliaghata, our best estimate of the median perceived household economic benefits of all household members (including the respondent) receiving a free typhoid vaccine is about US$23 (in 2004 $) for a household of five; the best estimate for cholera vaccination is US$27. For Tiljala, the median perceived household benefits (NTTT) are about US$17 for a typhoid vaccine and US$19 for a cholera vaccine for a household of the same size. Applying a 20% TTT reduction for median WTP observed in Beliaghata (comparing NTTT with TTT), the median perceived household benefit in Tiljala is about US$14 for a typhoid vaccine and US$15 for a cholera vaccine.

We now return to the three motivating policy questions discussed at the outset. First, health policymakers in India or donors could use our WTP estimates to determine whether the social benefits of providing free cholera or typhoid vaccines in Kolkata are likely to exceed total social costs. This question is explored in more detail in Cook, Jeuland, Whittington *et al.* (2008), but we provide a brief calculation here. The total social costs of providing the vaccine include the cost of acquiring the vaccine from the manufacturer, delivery costs, and the time costs households incur in traveling to clinics and waiting to be vaccinated. Although none of these are known with certainty, our best estimates are that acquisition costs for either vaccine are on the order of US$0.57 per dose, delivery costs are on the order of US$0.50 per dose, and time costs are likely to be small [3] (see Cook, Sur, Clemens, & Whittington, 2008 for more details on these cost parameters). We expect the total social costs to be US$1.1 (in 2007 US$) per person vaccinated for typhoid and US$2.2 per person vaccinated for cholera (because cholera requires two doses).

The cost of vaccinating a household with five members with the Vi vaccine would be about US$5.5, so the net private benefits of vaccinating the median household against typhoid would appear to be on the order of US$21 in Beliaghata and US$11 in Tiljala (after inflating our 2004 benefit estimates to 2007, using Indian consumer price inflation data). The cost of vaccinating a household with five members with the cholera vaccine would be about US$11. The net private benefits of vaccinating the median household against cholera would be about US$21 in Beliaghata and US$7 in Tiljala. In short, our WTP estimates indicate that providing free typhoid or cholera vaccines in Kolkata would most likely pass a social cost-benefit test.

According to the most recent health accounts data for India (Indian Ministry of Health, 2001), total public sector spending

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Table 6. *Effect of household characteristics on household WTP (2004 US$)*

	Median household WTP[a]	Median household WTP: no education, lowest 10% of income[b]	Median household WTP: 12 years of education, and highest 10% of income[c]
Cholera			
Beliaghata	$27	$18	$33
Tiljala[b]	$15	$10	$22
Typhoid			
Beliaghata	$23	$15	$28
Tiljala[b]	$13	$9	$19

[a] Median predicted household WTP based on the actual socioeconomic characteristics of each household. Tiljala household WTP adjusted for TTT by reducing 20%.
[b] Median predicted household WTP when all characteristics remain the same but monthly *per capita* income set at lowest 10% observed in neighborhood (US$7.4 in Beliaghata, US$4.4 in Tiljala) and education level set to "none."
[c] Median predicted household WTP when all characteristics remain the same but monthly *per capita* income set at highest 10% observed in neighborhood (US$74 in Beliaghata, US$25 in Tiljala) and education level set to "12 years or vocational school."

on health is US$6.6 per person (in US$2007). At 1.1% of GDP, this is among the lowest rates of public spending on health in Asia. In 2005, India launched an initiative (the National Rural Health Mission) to double or triple public spending on health (to 2–3% of GDP), but because the program's focus is mainly on rural, "disadvantaged" states, urban Kolkata may not see large increases in public spending. Without such increases, free vaccination against both cholera and typhoid would displace a large share of current spending on a *per capita* basis.

We speculate that Indian health policymakers may place a higher priority on existing or expanded funding for health interventions against other high-burden diseases. Although Cook *et al.* (2008) have found that typhoid vaccination programs in Kolkata slums would be considered "very cost effective" (cost per DALY avoided is less than *per capita* GDP), several other interventions compiled by the Disease Control Priorities Project (Jamison *et al.*, 2006) have even better cost-effectiveness ratios. Expanding the coverage rate for basic EPI vaccines like measles and DTP beyond the current 59% (WHO, 2006) or addressing drug-resistant tuberculosis, for example, has better cost-effectiveness ratios than for typhoid vaccination. The cost-effectiveness ratios for cholera vaccination are less favorable than for typhoid vaccination because of the higher cost associated with two doses (Jeuland *et al.*, 2008). Rather than continuing the present situation where cholera and typhoid vaccines are unavailable to those who are willing and able to purchase them, the government could make the vaccines available through public clinics but ask users to share some or all of the cost of providing them. [4]

Analysts often claim that vaccination against infectious diseases such as cholera and typhoid confers positive economic externalities on unvaccinated individuals, and then argue for universal provision of vaccines without user charges (without evidence of the magnitude or value of this indirect herd protection effect). WTP studies, such as reported here, provide part of the information needed for more nuanced economic and financial analyses. Our research on private vaccine demand raises an intriguing theoretical possibility. If user charges were set at a level to recover the costs of a vaccination program, there could be sufficient demand for the vaccine so that coverage of the vaccinated population (who are willing to pay the user charge) would ensure that all the remaining unvaccinated individuals would be protected as well through indirect herd protection. In such a situation, providing the vaccine for free would be suboptimal because it would result in more people being vaccinated than would be necessary to protect the entire population. In effect, providing free vaccines would result in too many vaccines being used; everyone would already be protected at a lower level of vaccination coverage Cook, Jeuland, Maskery *et al.* (in press).

Finally, understanding the factors associated with households' WTP can enable public health professionals to better design information programs to promote vaccination campaigns. We found that older respondents, those with lower incomes, and those who never boil their drinking water were most likely to be "out of the market" for vaccines, including not accepting a free vaccine. Respondents were also more likely to refuse a free cholera vaccine, indicating that a more extensive information effort might be needed for cholera vaccination programs.

NOTES

1. Vaccine prices were given to respondents in the local currency: 10, 25, 50, or 500 Indian rupees (Rs.), approximately US$0.22, $0.56. $1.11, and $11.11. The sample size at each price was approximately 35 respondents, or 835 in total. The exchange rate at the time of the survey was Rs. 45 = US$1. Unless otherwise noted, we present price information and results in 2004 US dollars using this exchange rate.

2. We controlled for this effect in the statistical analysis of both respondent and household demand, and the variable tracking whether the respondent failed the efficacy test twice was never significant; it is omitted in the results below.

3. See Cook *et al.* (2008) for more details on these cost parameters. One might estimate time costs as follows: if vaccine administration outposts in this densely crowded city are located within a 10-min walk of most residents, and if average wait times are 20 min, this implies (using one-half median hourly wages in Tiljala) an average time cost of ~$0.04 per dose.

4. We believe that using both the standard dichotomous-elicitation (yes/no) format and the sliding scale (traffic light) payment card exercise provides policy makers with more information about respondents' preferences than either procedure alone. Using both elicitation methods

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helps identify the range where actual WTP might fall if a vaccination program with user charges were implemented. This is important because the financial risk is asymmetric on the downside in the sense that not getting sufficient revenue to make the program workable is a much worse outcome than being pleasantly surprised at a high uptake of vaccines and larger revenue than forecast.

REFERENCES

Acosta, C., Galindo, C., Deen, J., Ochiai, R., Lee, H., von Seidlein, *et al.* (2004). Vaccines against cholera, typhoid fever, and shigellosis for developing countries. *Expert Opinion on Biological Therapy, 12*, 1939–1951.

Arrow, K., Solow, R., Portney, P. R., Learner, E. E., & Radner, R. (1993). Report of the NOAA panel on contingent valuation. *Federal Register, 58*(10), 4601–4614.

Bayoumi, A. (2004). The measurement of contingent valuation for health economics: Current opinion. *Pharmacoeconomics, 22*(11), 691–700.

Bennett, R., & Tranter, R. (1998). The dilemma concerning choice of contingent valuation willingness to pay elicitation format. *Journal of Environmental Planning and Management, 41*(2), 253–258.

Canh, D. G., Whittington, D., Thoa, L. T. K., Utomo, N., Hoa, N. T., Poulos, C., *et al.* (2006). Household demand for typhoid fever vaccines in Hue City, Vietnam: Implications for immunization programs. *Health Policy and Planning, 21*, 241–255.

Carson, R. (2000). Contingent valuation: A user's guide. *Environmental Science and Technology, 34*, 1413–1418.

Carson, R. T., Flores, N. E., Martin, K. M., & Wright, J. L. (1996). Contingent valuation and revealed preference methodologies: Comparing the estimates for quasi-public goods. *Land Economics, 72*(1), 80–99.

Carson, R. T., Flores, N., & Meade, N. F. (2001). Contingent valuation: Controversies and evidence. *Environmental and Resource Economics, 19*, 173–210.

Carson, R. T., & Mitchell, R. C. (1993). The issue of scope in contingent valuation studies. *American Journal of Agricultural Economics, 75*, 1263–1267.

Cook, J., Jeuland, M., Maskery, B., Lauria, D., Sur, D., Clemens, J., *et al.* (in press). Using private demand studies to calculate socially-optimal vaccine subsidies in developing countries. *Journal of Policy Analysis and Management*.

Cook, J., Jeuland, M., Whittington, D., Poulos, C., Clemens, J., Sur, D., *et al.* (2008). *The cost-effectiveness of typhoid Vi vaccination programs: Calculations for four urban sites in four Asian countries* (Evans School Working Paper). Seattle, Washington, USA.

Cook, J., Sur, D., Clemens, J., & Whittington, D. (2008). *Evaluating investments in typhoid vaccines in two Kolkata slums*. (Evans School Working Paper). Seattle, Washington, USA.

Cook, J., Whittington, D., Canh, D. G., Johnson, F. R., & Nyamete, A. (2007). Reliability of stated preferences for cholera and typhoid vaccines with time to think in Hue, Vietnam. *Economic Inquiry, 45*(1), 100–114.

Cropper, M. L., Haile, M., Lampietti, J., Poulos, C., & Whittington, D. (2004). The demand for a malaria vaccine: Evidence from Ethiopia. *Journal of Development Economics, 75*, 303–318.

Crump, J. A., Luby, S. P., & Mintz, E. D. (2004). The global burden of typhoid fever. *Bulletin of the World Health Organization, 82*(5), 346–353.

Cummings, R., & Taylor, L. (1999). Unbiased value estimates for environmental goods: A cheap talk design for the contingent valuation method. *American Economic Review, 89*(3), 649–665.

Deen, J. L., von Seidlein, L., Sur, D., Agtini, M., Lucas, M. E. S., Lopez, *et al.* (2008). The high burden of cholera in children: Comparison of incidence from endemic areas in Asia and Africa. *PLoS Neglected Tropical Diseases, 2*(2), e173.

Guh, S., Xingbao, C., Qu, Z., Jianwen, C., von Seidlein, L., Jichao, C., *et al.* (2008). Comparison of cost-of-illness with willingness-to-pay estimates to avoid shigellosis: Evidence from China. *Health Policy and Planning, 23*(2), 1–12.

Haab, T., & McConnell, K. (2002). *Valuing environmental and natural resources: The econometrics of non-market valuation*. Cheltenham (UK): Edward Elgar.

Hanemann, W. M. (1994). Valuing the environment through contingent valuation. *Journal of Economic Perspectives, 8*(4), 19–43.

Harrison, G. W. (2006). Experimental evidence on alternative environmental valuation methods. *Environmental and Resource Economics, 34*, 125–162.

Hofler, R. A., & List, J. A. (2004). Valuation on the frontier: Calibrating actual and hypothetical statements of value. *American Journal of Agricultural Economics, 86*(1), 213–221.

Indian Ministry of Health and Family Welfare. *National Health Accounts 2001–2002*. New Delhi. <http://mohfw.nic.in>.

Islam, Z., Maskery, B., Nyamete, A., Horowitz, M., Yunus, M., & Whittington, D. (2008). Private demand for cholera vaccines in rural Bangladesh. *Health Policy, 85*(2), 184–195.

Jamison, D. T., Breman, J. G., Measham, A. R., Alleyne, G., Claesen, R., & Evans, D. B. (Eds.) (2006). *Disease control priorities in developing countries*. Washington, DC: The World Bank and Oxford University Press.

Jeuland, M., Cook, J., Poulos, C., Lucas, M., Clemens, J., Whittington, D., *et al.* (2008). Cost effectiveness of new-generation oral cholera vaccines: A multi-country analysis. Unpublished manuscript.

Kim, D., Canh, D. G., Poulos, C., Thoa, L. T. K., Cook, J., Hoa, N. T., *et al.* (2008). Private household demand for cholera vaccines in Hue, Vietnam. *Value in Health, 11*(1), 119–128.

Kristrom, B. (1990). A nonparametric approach to the estimation of welfare measures in discrete response valuation studies. *Land Economics, 66*(2), 135–139.

Lauria, D. T., Whittington, D., Choe, K., Turingan, C., & Abiad, V. (1999). Household demand for improved sanitation services: A case study of Calamba, Philippines. In K. Willis, & I. Bateman (Eds.), *Valuing Environmental preferences: Theory and practice of the contingent valuation method* (pp. 540–584). Oxford: Oxford University Press.

Lucas, M., Jeuland, M., Deen, J., Lazaro, N., MacMahon, M., Nyamete, *et al.* (2007). Private demand for cholera vaccines in Beira, Mozambique. *Vaccine, 25*, 2599–2609.

O'Brien, B. O., & Gafni, A. (1996). When do the "dollars" make sense? Toward a conceptual framework for contingent valuation studies in health care. *Medical Decision Making, 16*(3), 288–299.

Ochiai, R. L., Acosta, C. J., Danovaro-Holliday, M. C., Dong, B., Bhattacharya, S. K., Agtini, *et al.* (2008). A study of typhoid fever in 5 Asian countries: Disease burden and implications for control. *Bulletin of the World Health Organization, 86*, 260–268.

Suraratdecha, C., Ainsworth, M., Tangcharoensathien, V., & Whittington, D. (2005). The private demand for an AIDS vaccine in Thailand. *Health Policy, 71*, 271–287.

Vossler, C., & McKee, M. (2006). Induced-value tests of contingent valuation elicitation mechanisms. *Environmental and Resource Economics, 35*, 137–168.

Whittington, D., Matsui, O., Freiberger, J., Van Houtven, J., & Pattanayak, S. (2002). Private demand for an HIV/AIDS vaccine: Evidence from Guadalajara, Mexico. *Vaccine, 20*, 2585–2591.

Whittington, D., Smith, V. K., Okorafor, A., Okore, A., Liu, J. L., & McPhail, A. (1992). Giving respondents time to think in contingent valuation studies: A developing country application. *Journal of Environmental Economics and Management, 22*, 205–225.

World Health Organization (2006). Cholera 2005. *Weekly Epidemiological Record 81*, 297–308.

APPENDIX A. CONTINGENT VALUATION (CV) SCENARIO

[*Interviewer, to all respondents:*]

Suppose that the government will not supply the new vaccine for free. Those who want a vaccine would have to pay a fixed price for it. Everyone would pay the same price.

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Now I would like to know whether you would buy the vaccine if it were available at a specified price. Some people say that they cannot afford the price of the vaccine or that they are actually not at risk of getting this disease. Other people say that they would buy the vaccine because the protection is really worth it to them. In other studies about vaccines, we have found that people sometimes say they want to buy the vaccine. They think: "I would really like as much protection from this disease as possible." However, they may forget about other things they need to spend their money on. Please try to think carefully about what you would actually do if you had to spend your own money. There are no right or wrong answers. We really want to know what you would do.

[*For respondents who were asked about a cholera vaccine:*]

When you give your answer about whether you would or would not buy the cholera vaccine, please consider the following: yours and your family's income and economic status compared with the price of the vaccine, and your risk of getting cholera. Apart from the vaccine, remember that we still have other ways to treat cholera, such as oral rehydration solution. Also, remember that the benefit of the vaccine in preventing cholera is 50% effective for 3 years. Again, the cholera vaccine cannot be used by children under 1 year old and by pregnant women.

[*For respondents who were asked about a typhoid vaccine:*]

When you give your answer about whether you would or would not buy the typhoid vaccine, please consider the following: your own income and your family's income and economic status compared with the price of the vaccine, and your risk of getting typhoid. Apart from the vaccine, remember that we can still treat typhoid with antibiotics. Also remember that the benefit of the vaccine in preventing typhoid is 70% effective for 3 years.

[*For all respondents:*]

First I am going to ask you about your willingness to purchase the vaccine for yourself. Then I am going to ask you about whether you would purchase the vaccine for other members of your household.

[*For cholera vaccine respondents:*]

Suppose that this cholera vaccine costs [one price, Rs. 10, Rs. 25, Rs. 50, or Rs. 500] for the two doses needed for one person. Would you buy this vaccine for yourself?

Suppose that this cholera vaccine costs [same price as above, Rs. 10, Rs. 25, Rs. 50, or Rs. 500] for the two doses needed for one person (same price for adults and children). How many people in your household (not including yourself) would you be willing to purchase vaccines for? (Remember, the cholera vaccine cannot be used by children under 1 year old or by pregnant women.)

[*For respondents who received the typhoid scenario, the questions were similar, except that only one dose of Vi polysaccharide typhoid was required to complete an immunization and that this vaccine did not require restrictions on infants and pregnant women.*]

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