Economic value to parents of reducing the pain and emotional distress of childhood vaccine injections

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Background. One reason that recommended childhood immunizations due at child health visits are deferred is to avoid the pain and emotional distress associated with the increasing number of injections required. This deferral leads to additional visits and costs and reduced immunoprotection against vaccine-preventable illnesses. To assess the economic value of combination vaccines that address this problem, we surveyed parents to determine the amount they would be willing to pay to avoid the pain and emotional distress experienced by their infants from injections.

Methods. A self-administered questionnaire was completed within 24 h of the vaccinations by 294 parents of children ages 11/2 to 7 months receiving vaccine injections at 26 outpatient child health centers. The willingness-to-pay (WTP) method was used to estimate the intangible cost of the pain and emotional distress of the 1 to 4 injections their child had received. Parents were asked how much of their own money they would have paid to avoid these injections, without any compromise in the safety and efficacy of the vaccinations.

Results. Wide variations in WTP amounts were observed, ranging from median values of $10 to $25 and average values of $57.06 to $79.28 to avoid the pain and emotional distress associated with eliminating all injections at visits in which one to four injections were administered. Parents placed greater value on reductions that avoided all injections than on reductions that avoided only some injections. Overall the median cost per injection avoided was $8.14, and the mean was $30.28

Conclusions. Parents have strong preferences for limiting vaccine injections. The economic cost of the pain and distress associated with such injections, reflected in the amounts they report they would be willing to pay to avoid them, represents a substantial component of the cost of disease control through immunization.

INTRODUCTION

Recommended childhood immunizations are sometimes not administered at routine health clinic visits, leading to lowered immunoprotection of children and reduced immunization rates. [1-4] These missed opportunities particularly affect socioeconomically disadvantaged children. [5-8] They frequently occur because vaccination is deferred in children with minor illness despite lack of accepted vaccine contraindication. [4, 9]

Deferrals also occur because clinicians and parents seek to limit the child's pain and emotional distress from multiple, sequential (often referred to as simultaneous) injections given at the same visit. [10-12] One study, conducted immediately after the addition of hepatitis B virus (HBV) vaccine to the recommended childhood immunization schedule, [13] found that 26% of physicians expected that more than one-half of parents would refuse three injections at a single visit, and 56% commonly schedule additional visits. [14] Another study reported more than one-half of pediatricians were concerned about giving three injections at a single visit, and 37% either routinely or occasionally scheduled additional visits. [15]

Properly administering all vaccines due at one clinic visit through multiple sequential injections is estimated to increase coverage rates from 9% to 30%. [3, 16-18] The importance of such simultaneous administration in maintaining and increasing immunization coverage will grow as additional injectable vaccines are included in the schedule. As of the end of 1999 a minimum of 11 injections were necessary (12 if an HBV birth dose was given) to satisfy the then current immunization schedule [19] for a child through age 23 months, assuming use of all available combination vaccines licensed in the United States. This minimum number increased to 12 (13 with perinatal HBV) to satisfy the schedule commencing in January, 2000, [20] which recommended that only (injectable) inactivated poliovirus vaccine be used, a change from the prior year's recommendation of 2 initial inactivated poliovirus vaccine doses followed by 2 oral poliovirus vaccine doses. The minimum number of injections has further increased with the recommended addition of 4 injectable doses of pneumococcal conjugate vaccine. [21]

Several polyvalent vaccines now in development [22, 23] offer the potential of decreasing the number of injections required to accomplish the presently recommended vaccine schedule and, in some cases, even protecting against diseases that are not yet vaccine-preventable in infants, such as *Neisseria meningitidis* infection. [22] The new combination vaccines may reduce vaccination deferral and thus improve immunization rates and reduce the cost burden of preventable disease. Their impact on minimizing multiple injections may help not only children who are up to date for their vaccinations but also children who are behind schedule and who need catch-up vaccination. [3, 24, 25] Two-thirds of children who start immunization late (at >3 months of age) remain behind schedule at age 2 years. [2, 26]

Polyvalent vaccines may also lower healthcare costs by reducing total vaccine administration charges and, perhaps, the number of clinic visits. An economic algorithm has been proposed to help clinicians and other vaccine purchasers determine the most efficient use of polyvalent vaccines. [22, 27] This study provides data for the model to weigh the cost effects of pain and emotional distress from vaccine injections.

To provide such economic data, we sought to answer the following questions. What dollar value do parents place on reducing their child's pain and emotional distress from childhood vaccination? How does this amount vary with the number of injections administered?

METHODS

The willingness-to-pay (WTP) method [28, 29] was used to estimate the intangible costs of pain and emotional distress. It entails asking respondents how much they would be willing to pay, of their own money, to obtain a specific health outcome. The WTP approach has been increasingly applied to measure the economic value of health states and interventions, including those that are transitory. [30-37]

A random sample from national lists of pediatric and general practice physicians was used to obtain participation of 26 geographically dispersed outpatient centers. During September to December, 1999, centers were asked to invite participation of 14 to 20 parents (or whomever accompanied the patient) of children ages 11/2 to 7 months consecutively presenting to receive 1 or more scheduled vaccine injections. This age range was selected because it coincides with the most frequent visits in the immunization schedule, when multiple injections are most common. Parents were asked to self-administer the questionnaire and return it by mail in an accompanying postage-paid envelope within 24 h of the vaccine injection(s). The number of parents invited to participate but refusing was not monitored.

Separate questionnaires were used according to the number of injections (from one to four) administered to the parent's child. For example, the three injection questionnaire posed the following hypothetical situation: a) the nurse or physician could have done something (i.e. taken an action), which would have the effect of eliminating all the shot-related emotional distress and pain your child may have experienced; b) the action could have this effect on one, two, or all three of the shots your child received; c) this action would have no other effect; and d) insurance plans do not cover the cost of the action. The questionnaire then asked for their willingness to pay specified dollar amounts to obtain the same number of vaccines with various reduction scenarios: one fewer injection, two fewer injections, etc. The specified amounts were limited to \$2, \$5, \$10, \$25, \$50, \$75, \$100, \$250 and \$500, and each answer was limited to the following likelihoods: Yes, definitely, Yes, probably, No, probably not, No, definitely not, and Don't know.

The data presented here reflect only Yes, definitely responses. The WTP value used for each reduction scenario was the highest dollar amount receiving a Yes, definitely response; Yes, probably responses were ignored. A WTP of \$0 was assigned for a reduction scenario when there was no Yes, definitely responses and at least one No, probably not or No, definitely not response at any value. Don't know and blank responses were not analyzed.

Summary statistics were calculated as follows. The response in dollars of each parent to each reduction scenario posed in his or her questionnaire was converted to a per-injection valuation. For example the actual amount stated for 1-shot reductions (4-to-3, 3-to-2, 2-to-1 and 1-to-0 scenarios) was used. For 2-shot reduction scenarios (4-to-2, 3-to-1, 2-to-0), the response amount was divided by 2. For 3-shot reductions (4-to-1, 3-to-0) and 4-shot reductions (4-to-0), the amount reported was divided by 3 or 4, respectively. The summary mean and median were determined from among all these per-injection values.

RESULTS

Survey responses were obtained from 294 (99%) of 296 parents accepting questionnaires, with a range of 3 to 28 respondents in each of the 26 centers. Although refusers were not formally quantified, investigators at the centers estimated that fewer than 10% of solicited respondents declined participation, with the most common reason cited being to avoid delay in leaving the clinic. About 95% of surveys were completed at home, with the balance completed before leaving the clinic.

Nearly all respondents were parents, and most were mothers, with an average age of 29 years (Table 1). The mean age of the index child undergoing vaccination was 4.3 months (sd 1.7 months), with a range of 11/2 to 7 months. Three-fourths were either first or second born, and two-thirds were insured through a managed care plan. A total of 799 injections were received by the index children of parents completing questionnaires. There were 31 children who received 4 injections, 180 who received 3 injections, 52 who received 2 injections and 31 who received 1 injection, for an average of 2.7 injections per child on the index visit.

TABLE 1. Characteristics of 294 willingness-to-pay survey respondents and children

Characteristics	% or Mean	SD
Respondents		
Gender		
Female	89.1%	
Male	10.1%	
Age	29 yr	6
Relationship to child		
Parent	99.0%	
Other	1.0%	
Annual household income ($)		
<10 000	5.4%	
10 000–14 999	6.5%	
15 000–24 999	10.2%	
25 000–34 999	13.9%	
35 000–49 999	19.0%	
50 000–74 999	22.1%	
>75 000	22.8%	
Children		
Gender		
Female	51.4%	
Male	48.6%	
Age	4.3 mo	1.7
Birth order		
First	38.4%	
Second	37.8%	
Third	19.0%	
Fourth/higher	4.8%	
Health insurance status		
Private, fee-for-service	13.3%	
Managed care	66.3%	
Government	19.0%	
Uninsured	1.4%	

Parents were willing to pay median amounts of $10 to $25 to avoid the pain and emotional distress of one or more injections (Table 2). Mean WTP values were consistently higher than the medians. The average value of avoiding all injections ranged from $57.06 for a two injection visit to nearly $80 for three and four injection visits. Considering all injection reduction scenarios, the mean cost per injection avoided was $30.28, and the median was $8.14.

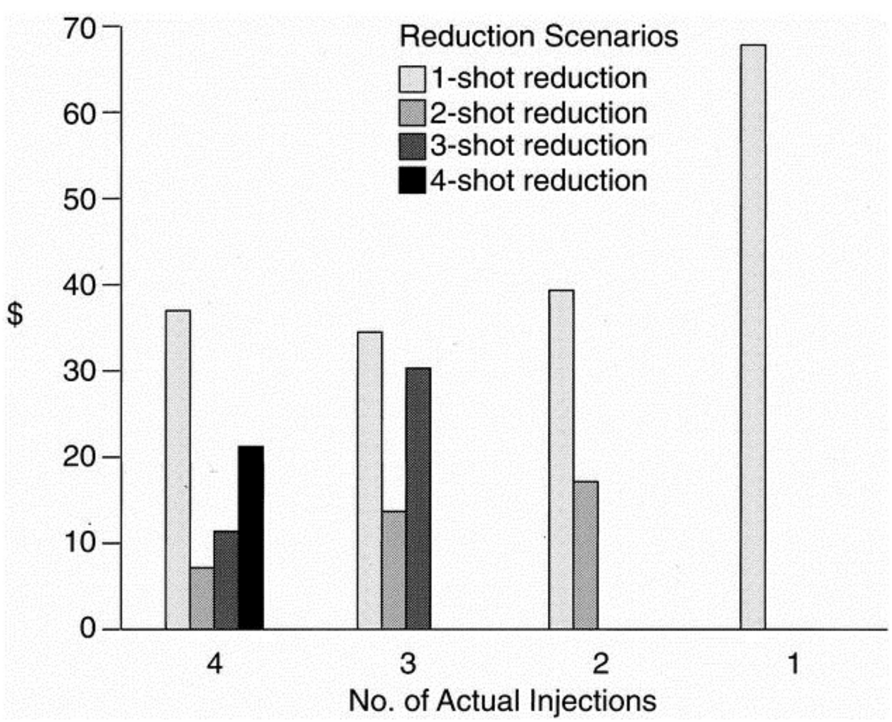
TABLE 2. Willingness-to-pay estimates

Reduction Scenario					Willingness-to-Pay Amounts ($) at Following Distribution Percentile		
No. of actual injections	No. of hypothetical injections	*n*	Mean	SD	25%	50%	75%
4	3	30	37.47	91.56	5	10	25
4	2	29	44.86	92.25	5	25	50
4	1	29	56.52	93.10	10	25	75
4	0	27	77.96	127.69	10	25	100
3	2	165	34.84	93.80	0	10	25
3	1	167	48.70	103.39	2	10	50
3	0	168	79.28	129.23	5	25	100
2	1	49	39.55	119.17	5	10	10
2	0	49	57.06	135.19	5	10	25
1	0	31	67.77	146.74	5	10	50
Overall, per injection:*			30.28			Median: 8.14	

* See Methods for how overall (summary) mean and median statistics were calculated.

Parents differentially valued the stepwise reductions of injections. The largest WTP values were observed for avoidance of one injection, particularly if that reduction resulted in avoidance of all injections (Fig. 1). We observed substantial variation in what parents indicated they would be willing to pay. For example 26% of parents of children receiving three injections were not willing to pay more than $5 to avoid all three injections, whereas another 26% were willing to pay at least $100 for the same outcome. Furthermore 11% were unwilling to pay anything ($0 WTP), whereas 7% reported the maximum allowed response of $500. Most WTP standard deviations were greater than twice the WTP mean.

Fig. 1



Child age was predictive of WTP amounts, with parents of younger children willing to pay more than parents of older children (Table 3). Younger parents and lower income parents were willing to pay more than other strata, but these trends were not statistically significant.

TABLE 3. WTP responses by respondent and child characteristics (data for three actual and zero hypothetical injections)

Characteristics	*n*	WTP Values			*P**
		Mean ± SE	Median	IQR*	
Respondents					
Gender					
Female	149	\$74 ± \$10	\$50	\$5–\$100	NS
Male	19	\$120 ± \$47	\$10	\$5–\$100	
Age					
<30 yr	90	\$86 ± \$14	\$50	\$10–\$100	NS
≥30 yr	78	\$72 ± \$15	\$25	\$5–\$75	
Annual household income					
<\$50 000	83	\$84 ± \$14	\$50	\$10–\$100	NS
≥\$50 000	85	\$74 ± \$14	\$25	\$5–\$75	
Children					
Gender					
Female	85	\$81 ± \$13	\$25	\$10–\$100	NS
Male	83	\$77 ± \$15	\$25	\$5–\$75	
Age					
<4 mo	65	\$92 ± \$16	\$50	\$10–\$100	<0.05
≥4 mo	103	\$71 ± \$13	\$25	\$5–\$75	
Birth order					
First	57	\$80 ± \$17	\$25	\$5–\$100	NS
Second or higher	111	\$79 ± \$12	\$25	\$5–\$100	
Health insurance status					
Managed care	118	\$75 ± \$11	\$25	\$5–\$75	NS
Other	50	\$89 ± \$20	\$50	\$10–\$100	

* Wilcoxon signed rank test.
IQR, interquartile range.

DISCUSSION

Parents are willing to pay considerable amounts of money to reduce or avoid the pain and emotional distress associated with childhood vaccine injections. Assuming a median cost per injection of \$8.14 and a minimum of 10 injections at clinic visits during ages 11/2 to 7 months, we estimate the annual economic value of pain and emotional distress for infant injections at these ages to be ~\$317 million for a US birth cohort of 3.9 million children. The comparable estimate using mean WTP values is \$1.18 billion. Considering all injections due up to age 23 months (20 total) and assuming that the WTP amounts we observed are representative of older ages up to 2 years, these estimates are \$725 million using median WTP values and \$2.70 billion using means.

Our study involved various limitations, the largest of which is probably the WTP methodology itself. The contingent valuation approach and WTP method are regarded as the preferred technique [38, 39] to measure an intangible cost such as injection pain and emotional distress. The approach is consistent with the consumer demand theory, which states that the value of a commodity is equivalent to the maximum amount people are willing to pay for it. It also permits comparisons of preferences across populations, interventions and health states. Its cardinal limitation is that it measures what people say *vs.* what they actually do. Thus these results must be interpreted with that weakness in mind.

Another limitation of the WTP method is the constraint on monetary values permitted by response options, known as response scale anchoring.[40-42] We limited the maximum WTP response to $500. Yet in the 3-injection questionnaires, 12 respondents answered the maximum $500 value, suggesting that at least some may have been willing to pay more. Hanemann [43] has argued that the upper response bound should be unlimited. Another weakness of this study is that neither nonresponse rates nor bias were specifically assessed, although we observed no reason to suspect such bias.

Our study may also be limited by the order in which we asked reduction scenario items in the questionnaire. We observed greater per-injection values for avoiding 1 injection (even at 2-, 3- and 4-injection visits when not all shots are avoided) than per-injection values for avoiding a second or subsequent shot (Fig. 1). For example the value of a 1-shot reduction at a 2-injection visit is $39.55, yet the incremental value of avoiding the second shot at such a visit is only $17.51 (Fig. 1). This could suggest that avoiding the initial shot at a multiple injection visit is more valuable than avoiding any subsequent shot, including avoidance of a shot that would reduce the number of injections to zero. This inferential ability is quite limited, however, because the questionnaire made no distinction among the ordering of injections avoided. Rather it only sought preferences regarding the total number of actual *vs.* hypothetical injections. Indeed we may have observed a different stepwise pattern had the ordering of the questions been changed. For example the 3-injection questionnaire sequentially sought WTP amounts for 3-to-2, 3-to-1 and then 3-to-0 reduction scenarios. The stepwise pattern we observed may have been different had the item order been 3-to-0, 3-to-1 and then 3-to-2.

The wide variation observed in WTP amounts could have resulted from limited reliability of the survey instrument. Parents completed the instrument only once, however, and thus test-retest reliability could not be examined. Much of the variation may be within the WTP approach, because sizable variations have been reported in other WTP studies of different health states than those examined here. [34-38] Alternatively the variation may be specific to the health state we examined, because 2 other recent surveys also observed substantial variation in WTP values. [44, 45] Those studies report somewhat larger WTP values, which may be explained by asking WTP questionnaire items in an open-ended manner, rather than the forced choice method we used.

The costs we measured for the pain and emotional distress of childhood injections are borne entirely by patients and parents. Such costs are incurred outside the health care system and may therefore be ignored by the physicians, managed care organizations and government agencies that purchase vaccines and pay for other components of the immunization system. However, failure to administer multiple vaccine doses when due has cost consequences to the health care system, including increased disease burden and additional clinic visits.

The substantial dollar amounts reported here, relative to the purchase price of vaccines, quantify the strong preference of parents to avoid the pain and emotional distress of childhood vaccine injections. They reveal one of the real and measurable benefits of new combination vaccines and other innovations such as oral, mucosal and transcutaneous immunization that protect against multiple diseases with more convenient dosing.

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