# Willingness-to-pay for caregivers of children with asthma or wheezing conditions

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**Background:** Nearly 5 million children in the United States are affected by asthma, which is more than 5% of the population younger than 18 years. In children four years or younger, the prevalence increased 160% from 1980 to 1994. There are several effective drugs that relieve the symptoms of asthma and others are currently being developed, but even when these medications are prescribed, they may be underutilized because parents fear the possibility of adverse events. There is no knowledge whether caregivers would be willing to pay (WTP) for safe and effective medications in general.

**Material and methods:** In a conjoint analysis, the status quo and hypothetical treatment options are defined by four attributes: episode-free days, risk of exacerbation, information available on the long-term impact of the treatment, and out-of-pocket expenses. Based on random utility theory, a binary purchase decision equation is specified and estimated using probit. Several tests were performed with regards to the scaling of the attribute variables, the linearity of the utility function used, and the derivation of a final model.

**Results and conclusions:** Marginal willingness-to-pay per month for 20 additional episode-free days due to a new treatment turns out to be US$6.00. An interesting question from the (industry) policy point of view for possible new products is the amount of WTP for the product as a whole. Assuming that the final model is correctly specified, the (negative) constant may be interpreted as indicating that caregivers feel confident with the asthma treatment options already on the market and having hence not a positive relation to a new treatment.

**Keywords**: willingness-to-pay; conjoint analysis, preference study, health economics, discrete-choice analysis

## Introduction

Asthma is a chronic disease that effects between 9 and 12 million persons in the US (Weiss et al 1992) and is the most common chronic disease of childhood (CDCP 2000). Nearly 5 million children in the US are affected by asthma, which is more than 5% of the population younger than 18 years (Adams and Marano 1994). Asthma is the leading cause of lost school days in children (Taylor and Newacheck 1992; Graves 1993). In children four years or younger, its prevalence increased 160% from 1980 to 1994. There are several effective drugs that relieve the symptoms of asthma, and more are currently being developed. However, compliance is far from perfect because parents as caregivers fear the possibility of adverse drug reactions. The objective of this study is to measure the importance of these concerns in comparison with the benefits of treatment using willingness-to-pay (WTP) estimates derived from a discrete-choice experiment (DCE).

For an economic evaluation (such as a discrete-choice analysis) of treatments in diseases such as asthma, where a substantial impact is on quality of life rather than survival, it is crucial to be able to incorporate the effects of the new therapies on quality of life and include those effects in the economic evaluation. Since there are many health insurances in the US that have a co-payment rate for the insured in their contract, considerations of relative effectiveness could be complemented by WTP

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estimates. Within healthcare there is substantial evidence to suggest that, in addition to the treatment outcome (that is, the effectiveness), other aspects of the process of receiving treatment are also important for individuals (Ryan and Hughes 1997; Ratcliffe and Buxton 1999; Ryan 1999; Johansson et al 2004). The present study analyzes hypothetical products for the treatment of (preschool) asthma defined by four attributes. The target population is children with a maximum age of 4 years. Obviously the possibility to ask the children themselves was naturally limited and hence the caregivers answered for them.

The purpose of this study is to calculate, using discrete choice analysis, the WTP of caregivers with asthmatic children for different (hypothetical) treatments defined by four attributes. Additionally the marginal WTP for an improvement in efficacy (episode-free days) was analyzed. Furthermore the analyses were done for the whole study cohort as well as for various risk averse groups.

**Table 1** Characteristics of individuals from the pretest

| N=6 caregivers | Percent | Cumulative percent |
|---|---|---|
| **Gender** | | |
| Female | 83.3 | |
| **Age** | | |
| ≤35 years | 66.6 | |
| >35 years | 33.3 | 100 |
| **Number of children ≤4 years** | | |
| 1 child | 50 | |
| 2 children | 50 | 100 |
| **Most important attributes** | | |
| Efficacy (episode-free days) | 83.3 | |
| Ease of handling | 50 | |
| Side effects (exacerbation) | 100 | |
| Long-term information available | 83.3 | |
| Out-of-pocket expenses | 83.3 | |
| Number of administrations per day | 66.6 | |
| Time for administration | 66.6 | |

## Material and methods

The DCE (The study protocol was conducted in accordance with the Declaration of Helsinki and approved by local ethics committees, and all caregivers gave written informed consent) performed in this study rests on Lancaster's theory of demand (1971), which states consumers value not so much the quantities of consumer goods but their qualities and attributes. In the present context the consumer is a caregiver of at least one asthmatic child with the age of less than four years, and the commodities in question are treatment options defined by four attributes. Thus the preferences of caregivers substitute for those of their patients (which would have been far more difficult to investigate). Caregivers were asked to choose between pairs of asthma treatments for their child, viz. a fixed status quo and a new (hypothetical) alternative whose attribute levels changed in the course of the DCE. Attributes and their levels were pretested in face-to-face interviews with six caregivers in the autumn of 2005. Original attributes were ease of handling, efficacy (episode-free days), time for administration of treatment, number of administrations per day, side-effects (risk of asthmatic exacerbation), information on long-term effects in children between 4 and 14 years of age (provided by the Food and Drug Administration [FDA]) and out-of-pocket cost. The presence or absence of side effects (EXACERBATION) was deemed important without exception (see Table 1). The other retained attributes are episode-free days (FREEDAYS), available information provided by the FDA (INFORMATION), and the out-of-pocket cost of the treatment (EXPENSE).

The levels of attributes were defined as follows (see Table 2). FREEDAYS, symbolizing the change in the number of episode-free days from a baseline value of 180 days per year (Pauwels et al 1997). Increases are to 200 and 220 days, decreases are to 160 and 140 days, respectively. EXACERBATION varies between 6%, 10%, and 16%, indicating the share of patients who develop mild to severe exacerbation. A recent study with adults has shown that mild to moderate asthmatic exacerbation causes a marked decrease of well-being (Jongste et al 2002). This is assumed to hold true in preschool children. In INFORMATION on long-term effects specifically in children between 4 and 14 years of age, a study has found that caregivers are concerned if information is lacking about the long-term effects of asthma treatment in preschool children (Gibson et al 1995). Finally, EXPENSES ranges from $10, $30, to $50. Status quo treatment (see Table 3) was defined as having 180 episode-free days per year and a 10% risk developing mild to severe exacerbation of asthma with information provided by FDA and a monthly out-of-pocket cost of $20.

Since these attributes have 4, 3, 2, and 3 levels, respectively, the number of scenarios amounts to a total of 72 (= 4*3*2*3). This number would cause interviews of excessive length. Using the ORTHOPLAN procedure of SPSS (SPSS Inc., Chicago, Il, USA), the design was reduced to 16 scenarios while this still permits to infer utility values for all combinations of attribute levels (Louviere et al 2000). All study participants had to answer these 16 variants, whose

sequence was randomized to avoid possible ordering bias (Gibson et al 1995). Each time respondents had to indicate whether or not they preferred the treatment or the status quo (for a sample card presented to study participants, see Appendix A1).

Due to financial constraints, only 42 respondents were included in the study. However, to test the validity and significance of parameter estimates, a Monte-Carlo simulation yielding comparison estimates was also performed. The survey was conducted online in February 2006. The questionnaire also covered socioeconomic characteristics, subjective health status (chronic or other diseases) of the caregiver, specifics of the asthma treatment, and diagnosis of the physician.

Choices of caregivers are hypothesized to be governed by a common utility function

$$U_k = U(Z_k) \tag{1}$$

where $U_k$ denotes their utility in scenario $k$, which depends on $Z_k$, the vector of attribute values pertaining to $k$. Any alternative, which may affect choice, is included in the vector of measured attributes $z \varepsilon Z$ (McFadden 1983). For instance, the change in the number of episode-free days from the status quo constitutes an element of the attribute vector.

Since income $Y$ and out-of-pocket cost $p_k$ determine the number of units $x_k$ of the good that can be purchased, maximum attainable utility not only depends on permit attributes but income and prices. Thus the indirect utility function can be written

$$V_k = V(z_k, p_k, Y) = U[Z_k^*] \tag{2}$$

The marginal rate of substitution between two attributes $m$ and $n$ is given by the ratio of marginal utilities, which indicates the relative subjective importance of them

$$MRS = \frac{\partial V_k / \partial z_{km}}{\partial V_k / \partial z_{kn}} \tag{3}$$

If the variable $n$ in equation (3) is assumed to be price in the presented context, this can be interpreted as the marginal WTP for attribute $m$.

A vector of socioeconomic characteristics $h$ is introduced into the function to reflect the variability of tastes across the population to which the model of choice behavior applies (Ben-Akiva and Lerman 1985)

$$V_k = V(z_k, p_k, Y, h) \tag{4}$$

It is assumed that the chosen treatment maximizes the individual's utility, in keeping with the theory of homus economicus (McFadden 1983). However, the determinants of utility are never fully known to the observer, causing behavior to seemingly have a random component. Accordingly, the choice probability of alternative $k$ is equal to the probability that the (indirect) utility of alternative $k$, $V_k$, is greater than or equal to the utility of alternative $q$,

$$\Pr(k) = \Pr(V_k > V_q), \tag{5}$$

where $\Pr(k)$ is the probability of the caregiver choosing alternative $k$. In general, the random utility of an alternative

**Table 2** Product attributes and levels retained in the main survey

| Attributes | Label | Levels | Value labels |
|---|---|---|---|
| **Episode-free days** | FREEDAYS | Increase from 180 to 200 episode-free days per year | 200 |
| | | Increase from 180 to 220 episode-free days per year | 220 |
| | | Decrease from 180 to 160 episode-free days per year | 180 |
| | | Decrease from 180 to 140 episode-free days per year | 140 |
| **Exacerbation** | EXACERBATION | Risk of EXACERBATION: 6% of patients develop a mild to severe EXACERBATION | 6 |
| | | Risk of EXACERBATION: 10% of patients develop a mild to severe EXACERBATION | 10 |
| | | Risk of EXACERBATION: 16% of patients develop a mild to severe EXACERBATION | 16 |
| **Information about long-term effects by the FDA available** | INFORMATION | INFORMATION available on long-term effects in children between 4 years and 14 years of age | 1 |
| | | No INFORMATION available on long-term effects in children between 4 years and 14 years of age | 2 |
| **Out-of-pocket EXPENSES** | EXPENSES | $10 per month | 10 |
| | | $30 per month | 30 |
| | | $50 per month | 50 |

**Abbreviations:** FDA, Food and Drug Administration.

can be expressed as a sum of observable (or systematic) and unobservable components (Louviere et al 2000),

$$V_k = W(z_k, p_k, Y, S) + \varepsilon_k \equiv W_k + \varepsilon_k \quad (6)$$

With this result, equation (5) can now be rewritten as

$$\begin{aligned} \Pr(k) &= \Pr(W_k + \varepsilon_k > W_q + \varepsilon_q) \\ &= \Pr(\varepsilon_q > W_k - W_q + \varepsilon_k) \end{aligned} \quad (7)$$

Therefore the random element must be dominated by systematic differences in utility. For further analysis it is assumed that the error term ($\varepsilon_q - \varepsilon_k$) is standard normally distributed. With this assumption, the Probit model can be applied to estimate Pr($k$). Furthermore, assuming the indirect utility function to be additively separable, the determinants of $V$ that do not differ between scenarios $q$ and $k$ (in particular $Y$ and $S$) drop out of the equation.

# Results

## Descriptive statistics

In Table 4, descriptive statistics of the caregivers with regard to the dependent and explanatory variables are reported. Of all caregivers participating in this study, 19% came from the Eastern US, 33% from the Midwest, 35% from the South and 11.9% from the West. Nearly all caregivers who took part in the survey are female (92.9%), while 7% of caregivers are fathers or grandparents. The respondents on average have one child. Forty percent were working full-time and 45% were homemakers. Most of the study participants reported not to smoke (71.4%), whereas 16.7% reported to smoke about one pack of cigarettes per day. The reason for the high proportion of nonsmokers is to be found in the fact that the majority of caregivers have also diagnosed asthma (92.9%) or wheezing conditions (28.6%).

Caregivers were also asked how confident they are in knowing what they do when thinking about their overall ability to take care of their family's general health: eating right, getting check-ups, taking medicine, and deciding when to see the doctor. The median for this is 3.5 (standard deviation of 0.89), with 1 equivalent to "Not at all confident" and 5 "Extremely confident". Overall 42.9% of respondents agreed with the feeling "Very confident" (rating of 3), and another 26.7% agreed with feeling "Extremely confident" (rating of 4). There, 31% felt fairly or somewhat confident, while 69% felt very or extremely confident. These descriptive findings suggest that administration of drugs to the children should be relatively good.

**Table 3** Status quo treatment – definition by attribute levels

| Attributes | Levels |
|---|---|
| **FREEDAYS** | 180 episode-free days per year |
| **EXACERBATION** | Risk of EXACERBATION: 10% of patients develop a mild to severe EXACERBATION |
| **INFORMATION availability** | INFORMATION available on long-term effects in children between 4 years and 14 years of age |
| **Out-of-pocket EXPENSES** | $20 per month |

In 18% of cases, physicians never told the caregiver the diagnosed severity of their child with asthma. Thus, while 21.4% of caregivers rated the severity of their child as very mild, no physician gave the condition this low rating, likewise 4.8% of all cases, physicians diagnosed the children as having severe asthma, compared with 2.4% of caregivers.

Caregivers were also asked to estimate the frequency with which caregivers (in general) forget to administrate medication to their child during a week due to several reasons (job stress, care for other children, etc.). In various studies, this estimate is as high as 95% (with an average around 50%) (Peckelman and Sen 1979; Reinhardt 1999). Respondents estimated that 16.7% of caregivers never forget during a week. However, when asked about their own failure, 88.1% say they forget in 19% of all cases.

The characteristics of the children were as follows: the first born, 33% are male and have a mean age of four years. Anyway, the second born, 64.3% were male and had a mean age of 2.8 years (standard deviation 0.96). Notice also that children with diagnosed asthma have a higher probability of having allergies in comparison to the average of the same age (Peckelman and Sen 1979). In this sample, 88% of children have diagnosed asthma, 26% wheezing conditions, and 71% have allergies.

## Model specification

Since 16 different asthma treatment decisions had to be evaluated by each respondent, the data are of the panel type. For this reason, a random effects probit model is used, assuming responses of a given individual to purchase questions to be correlated, while answers provided by different individuals to be uncorrelated.

The first specification test was done on the scaling of the variables reflecting product attributes. The scaling issue concerns three product attributes, the episode-free days (FREEDAYS), the exacerbation probability (EXACERBATION), and the out-of-pocket expenses

**Table 4** Descriptive statistics of caregivers and their children between 0 and 4 years

| | Percent | Cumulative percent |
|---|---|---|
| **Gender** | | |
| Female | 92.9 | |
| **Age** | | |
| <30 years | 28.6 | |
| 30–39 years | 42.8 | 71.4 |
| 40–49 years | 19.1 | 90.5 |
| >50 years | 9.5 | 100 |
| **Number of children ≤4 years** | | |
| 1 child | 73.8 | |
| 2 children | 26.2 | 100 |
| **Rating of healthcare** | | |
| Fairly/somewhat confident | 31.0 | |
| Very/extremely confident | 69.0 | 100 |
| **Number of children with diagnosed asthma and/or wheezing conditions** | | |
| 1 child | 73.8 | |
| 2 children | 26.2 | 100 |
| **Regions** | | |
| East | 19.0 | 19.0 |
| Midwest | 33.3 | 52.4 |
| South | 35.7 | 88.1 |
| West | 11.9 | 100 |
| **Relationship to children** | | |
| Mother or female guardian | 85.7 | |
| Father or male guardian | 7.1 | 92.9 |
| Grandparent | 7.1 | 100 |
| **Level of education** | | |
| High school graduate (or lower) | 11.9 | |
| Some college | 31.0 | 42.9 |
| Associate/Bachelor's degree | 40.5 | 83.3 |
| Postgraduate school | 14.3 | 97.6* |
| **Current employment situation** | | |
| Working full-time | 40.5 | |
| Working part-time | 11.9 | 52.4 |
| Homemaker | 45.2 | 97.6** |
| **Annual household income in 2004** | | |
| <US$25 000 | 4.8 | |
| US$25 000–49 999 | 45.2 | 50.0 |
| US$50 000–74 999 | 19.0 | 69.0 |
| > US$75 000 | 23.8 | 92.9*** |
| **Nonsmoker** | 71.4 | |
| **Severity estimation by caregiver** | | |
| Very mild | 21.4 | |
| Mild | 35.7 | 57.1 |
| Moderate | 40.5 | 97.6 |
| Severe | 2.4 | 100 |
| **Severity diagnosis by physician** | | |
| Mild | 35.7 | |
| Moderate | 40.5 | 76.2 |
| Severe | 4.8 | 81.0 |
| Doctor never told me the severity | 19.9 | 100 |
| **Compliance estimation for other caregivers** | | |
| <20% | 54.8 | |
| 20%–39% | 23.8 | 78.6 |
| 40%–59% | 7.1 | 85.7 |
| >60% | 14.3 | 100 |

**Note:** *Other education: 2.4%; **Retired: 2.4%; ***Declined to answer: 7.1%.

*Continued over*

**Table 4** *Continued*

| | Percent | Cumulative percent |
|---|---|---|
| **Own compliance estimation** | | |
| <10% | 76.2 | |
| 10%–19% | 11.9 | 88.1 |
| 20%–29% | 4.8 | 92.9 |
| >30% | 7.1 | 100 |
| **Children characteristics** | **Percent** | **Cumulative percent** |
| **Age** | | |
| ≤2 years (child 1) | 33.3 | |
| ≤2 years (child 2) | 0 | |
| **Gender** | | |
| Female (child 1) | 35.7 | |
| Female (child 2) | 66.7 | |
| **Race** | | |
| White | 88.1 | |
| Black | 4.8 | 92.9 |
| Other | 7.1 | 100 |
| **Number of asthma attacks in the least 4 weeks** | | |
| Never | 85.7 | |
| A few days | 9.5 | 95.2 |
| Some/most days | 4.8 | 100 |
| **Prevalence of asthma** | 88.1 | |
| **Prevalence of wheezing conditions** | 26.2 | |
| **Prevalence of allergies** | 71.4 | — |

**Note:** *Other education: 2.4%; **Retired: 2.4%; ***Declined to answer: 7.1%.

(EXPENSES). The discussion will focus on FREEDAYS, dealing with EXACERBATION and EXPENSES more concisely. The efficacy in terms of episode-free days was scaled using two better outcomes than the status quo (180 days) and two worse outcomes: 200 and 220 days for the better outcomes and 160 and 140 days for the worse one. However, a linear representation of product attributes would simplify the calculation of the marginal WTP (MWTP) values considerably. The evidence suggests that a linear representation of FREEDAYS is compatible with the data, as the effect of a reduction in episode-free days from 180 to 160 days cannot be statistically distinguished from the increase in episode-free days from 180 to 200 days. Also, episode-free days reductions from 180 to 140 days and the improvement from 180 to 220 days have the same effect (close to 22%) according to the data. Therefore, the linear representation of FREEDAYS may be retained, permitting the construction of an average value of FREEDAYS and hence the calculation of MWTP at the sample means.

The same tests for linearity were used for the product attributes EXACERBATION and EXPENSES. Results clearly suggest that a linear representation of all parameters is compatible with the data. A popular alternative is the quadratic utility function (Gegax and Stanley 1997). The linearity of the coefficients was analyzed by the Wald test. In view of the orthogonal design imposed, the utility function to be tested contained no interaction terms (Johnson et al 1998). Results indicated that the quadratic terms were not significant at conventional levels, with the one exception of expenses. However, the estimated coefficient of $(EXPENSES)^2$ turned out so small as to make the linear alternative, evaluated at the mean cost, indistinguishable from the quadratic. A likelihood ratio test indicated that the exclusion of all quadratic terms does not entail a significant loss of explanatory power. Therefore, an indirect utility function linear in product attributes seems to serve as a sufficient local approximation to its true counterpart (which merely needs to be quasiconvex in price).

Up to this point, the specification tests involved only the product attributes because individual characteristics should be irrelevant in the choices analyzed if the utility function is assumed to be additively separable in product attributes and socioeconomic characteristics. To test this assumption a model was estimated including interaction terms between socioeconomic variables and EXPENSES. From an economic point of view this can be justified since these interaction terms reflect the marginal utility of money, which varies with personal characteristics (Vose 2001). However, all interaction terms lacked statistical significance. In addition a likelihood ratio test indicated clearly that

**Table 5** Random effects probit estimates for the final model

| Variable | Coefficient | Standard error | z | P>\|z\| |
|---|---|---|---|---|
| **FREEDAYS** | 0.0069* | 0.0024 | 2.85 | 0.004 |
| **EXACERBATION** | –0.0109 | 0.0117 | –0.93 | 0.351 |
| **INFORMATION** | –0.3447** | 0.1039 | –3.32 | 0.001 |
| **EXPENSES** | –0.0232*** | 0.0036 | –6.51 | 0.000 |
| **CONSTANT** | –0.7936 | 0.4990 | –1.59 | 0.112 |
| **Number of observations** | 756 | | | |
| **Chi² (4)** | 52.48 | | | |
| **Prob>chi²** | 0.0000 | | **Rightly predicted:** | 0.677 |

**Note:***, **, ***, Coefficient different from zero with an error probability of 5% (1%, 0.1%).

including interaction terms does not improve goodness of fit of the model. This finding is in agreement with the assumption of a utility function which is additively separable.

The estimates of the final random effect probit model (which contains only the four product attributes in linear form, including EXPENSES) are presented in Table 5 for the original data. All product attributes are highly significant except for EXACERBATION and the constant. This is of particular interest since the attribute EXACERBATION was one of the four most important attributes in the pretest interviews. One possible reason why this attribute is nonsignificant is the low number of respondents. Due to budget restrictions, only 42 respondents could be included in the survey. However, to improve the validity and significance of the study, the data have also been simulated by 100 Monte-Carlo iterations. For this the binomial distribution was assumed for the simulation of the outcome "Scenario". For the caregiver's socioeconomic characteristics, a beta-pert distribution was assumed to stay within the calculated ranges of the parameters given by the study participants (Zweifel et al 2004). It turned out that also the attribute EXACERBATION is highly significant when using 100 iterations (see Table 6), which was used as having 100 respondents.

## Willingness-to-pay

The calculation of MWTP for an improvement or reduction of episode-free days is based on equation (3). Since the indirect utility function is linear in its arguments, the marginal rate of substitution between the change in episode-free days and the out-of-pocket expenses for a treatment of caregiver's child amounts to a division of the regression coefficient pertaining to FREEDAYS by the coefficient pertaining to EXPENSES.

MWTP per month for 20 additional episode-free days due to a new treatment turns out to be US$6.00 (=–0.0069/–0.0231). A standard prediction in the theory of health economics is that individuals with a higher risk aversion should have a higher MWTP for a better outcome such as an improvement of episode-free days (Janse et al 2004). However as previously explained, risk aversion is one of the personal characteristics that should not influence the decision.

An interesting question from the (industry) policy point of view for possible new products is the amount of WTP for the product as a whole. Assuming that the final model is correctly specified, the (negative) constant may be interpreted as indicating that caregivers feel confident with the asthma treatment options already on the market and having hence not a positive assessment of a new treatment.

**Table 6** Random effects probit estimates for the simulated data (100 Monte-Carlo iterations)

| Variable | Coefficient | Standard error | z | P>\|z\| |
|---|---|---|---|---|
| **FREEDAYS** | 0.0078** | 0.0016 | 4.92 | 0.000 |
| **EXACERBATION** | –0.0283* | 0.0086 | –3.28 | 0.001 |
| **INFORMATION** | –0.5011** | 0.0702 | –7.14 | 0.000 |
| **EXPENSES** | –0.0216** | 0.0023 | –9.53 | 0.000 |
| **CONSTANT** | –0.5264 | 0.03134 | –1.68 | 0.093 |
| **Number of observations** | 1600 | | | |
| **Chi² (4)** | 142.48 | | | |
| **Prob>chi²** | 0.0000 | | **Rightly predicted:** | 0.689 |

**Note:** *, **, Coefficient different from zero with an error probability of 5% (1%, 0.1%).

From this benchmark, one may integrate the MWTP over the four attributes distinguished to obtain WTP for the product as a whole. As shown in Table 7, a treatment having average features with regard to each of the three attributes distinguished evokes a small but positive WTP (US$1.65). The attributes for this average product is defined as having no improvement in episode-free days, a probability of 6% to develop an exacerbation and information available by the FDA. The maximum WTP (US$13.54) for a new asthma treatment could be achieved with a maximum of improvement in episode-free days (220 days per year), 6% probability of exacerbation and information available by the FDA.

Out of the 16 variants described, one fourth of the treatment options have a positive average WTP. The negative WTP observed raises the issue of future product development and provision of information to potential users. As can be gleaned from Table 7, one increment on the scale of FREEDAYS (4 levels) is worth US$0.30 (=0.0069/0.0232). This means that a status quo of 180 episode-free days (Pauwels et al 1997) lead to WTP of US$53.53 with everything else held constant. In the case of EXACERBATION, this figure amounts to a negative amount of US$0.47 per percentage point of exacerbation probability. The available information from the FDA shows a worth of US$14.86. Therefore, assuming equal productivity of research and development efforts, these efforts should be directed at improved efficacy (episode-free days). Also, information about improvements and safety may prove of particular importance for encouraging the purchase and use of (new) asthma treatments for children.

**Table 7** Willingness-to-pay (WTP) for specified asthma treatments in US$

| | WTP for a specified asthma drug in US$ | Attributes (FREEDAYS, EXACERBATION, INFORMATION) |
|---|---|---|
| **Mean WTP** | 1.65 | 180/6/1 |
| **Maximum WTP** | 13.54 | 220/6/1 |
| **Minimum WTP** | –29.80 | 140/16/2 |

## Discussion and conclusion

To the best of our knowledge this study is the first one to analyze the impact of various treatment attributes on the WTP of caregivers for their preschool children. The sample size is relatively small due to budget restrictions. However, the results should be important in the rating of WTP and utility estimations in preschool children in chronic diseases such as asthma. Due to the fact that individuals have difficulties when dealing with probabilities (Tversky and Kahneman 1974), the measurement of the MWTP for an improvement in episode-free days (using probability) may lead to particular challenges. First, the individuals concerned probably are not only interested in the aspect of the change in efficacy (assumed to be episode-free days), but may consider other aspects of asthma treatment, such as the possibility to develop an asthmatic exacerbation or available information by the FDA (information on long-term effects in children between 4 and 14 years of age) as well as expenses. Secondly, the population of interest is of low age (between 0 and 4 years), which leads to the fact that these could not be included in the study due to natural limitations. Hence the caregivers of the target population were included in the survey as an approximation. This assumption could be verified due to the fact that the caregivers must decide which treatment (if any) should be offered to their child and to which price. Additionally it can be assumed that caregivers also want to maximize the utility (and quality of life) of their child.

Discrete-choice experiments required respondents to only indicate whether they prefer one scenario over another. Moreover, it was possible to use the status quo as the reference scenario. Based on random utility theory, a binary purchase decision equation was specified and estimated using probit. Several tests were performed with regards to the scaling of the attribute variables, the linearity of the utility function used, and the derivation of a final model.

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# Appendix

**Appendix 1** An example of a card presented to respondents is shown in Table A1.

**Appendix A1** Example of a card presented to respondents

| | AGENT A | AGENT B |
|---|---|---|
| **Episode free days** | 180 episode-free days per year | 220 episode-free days per year |
| **Exacerbation** | Risk of exacerbation: 10% of patients develop a mild to severe exacerbation | Risk of exacerbation: 16% of patients develop a mild to severe exacerbation |
| **Information availability** | Information available on long-term effects in children between 4 years and 14 years of age | Information available on long-term effects in children between 4 years and 14 years of age |
| **Out-of-pocket expenses** | $20 | $50 |
| | O | O |