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Conjoint Analysis of French and German Parents' Willingness to Pay for Meningococcal Vaccine

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Abstract

Objective: To estimate the willingness of parents in France and Germany to pay for meningococcal conjugate vaccines for their teenage children.

Methods: A conjoint analysis survey was administered to parents who had received counselling on the nature and risks of meningococcal disease in young people. In each country, half were randomly assigned to view a video with graphical depictions of the effects of meningococcaemia. Subjects were then shown a series of 18 sets of three vaccine descriptions. Each description listed the price of a hypothetical vaccine (range €15–304; 2001 values), the duration of protection, and the number of serogroups of the bacteria covered. The survey asked which vaccine they preferred and whether they would buy it. Conditional logit and generalised linear-random effects logit models assessed the effect of product attributes, personal background and video viewership on the probability of indicating a purchase.

Results: 92.6% of subjects would purchase at least one of the vaccines they encountered. Price elasticity ranged from −1.20 (France) to −2.48 (Germany). Exposure to graphical depictions of disease consequences negligibly increased the overall willingness to purchase vaccine in French participants, but lowered the overall willingness in German participants.

Conclusion: In Germany and France, where there is still limited out-of-pocket health spending, the majority of sampled respondents stated that they would purchase meningococcal vaccines with their own money.

The bacterium *Neisseria meningitidis* (meningococcus) causes two serious and often fatal diseases: meningococcal meningitis and meningococcaemia. Even with appropriate treatment, meningococcal disease is fatal in 9–12% of cases and leaves 11–19% of survivors with serious sequelae such as neurological impairment or limb amputation.[1] Different subgroups of meningococci are distinguished by 13 different capsular polysaccharides; however, only five subgroups (A, B, C, Y and W-135) cause almost all clinical disease. Serogroup A is the most prevalent serogroup in Africa, while serogroups B and C are most common in Europe and North America.[1] Between 1995 and 1998 in the US and

Canada, serogroup Y represented 34% of clinical infections and 11% of cases in the late 1990s.[2] Serogroup W-135 was responsible for outbreaks associated with the Hajj pilgrimage in Saudi Arabia and more recently an epidemic in Burkina Faso.

A licensed meningococcal polysaccharide-based vaccine provides coverage against serogroups A, C, Y and W-135. The polysaccharide vaccine induces serum bactericidal antibody responses to all four vaccine serogroups, which persist for 3–5 years. In contrast to polysaccharide vaccines, conjugated vaccines consist of polysaccharide antigen covalent linked to a carrier protein. Conjugate vaccines induce T cell-dependent immune responses, which are expected to confer longer lasting protection.[3] A recent epidemiological model used a 10-year duration of vaccine protection as a baseline assumption for vaccination of children older than 1 year.[3] Conjugate vaccines also reduce bacterial carriage and therefore improve herd immunity.[4] A meningococcal conjugate serogroup C vaccine is routinely used in the UK,[3] Spain, The Netherlands and in most Canadian provinces. A quadrivalent (A, C, Y, W-135) conjugate vaccine was launched in the US in 2005.

The economic evaluation of meningococcal vaccination strategies has heretofore relied entirely on models of the value of the vaccine in terms of the medical costs of prevented disease supplemented by simplistic models of the value of lost life.[5] In 1995 an influential paper by investigators at the US Centers for Disease Control and Prevention (CDC) concluded that a policy to vaccinate all US college students with meningococcal polysaccharide vaccine would cost $US56.2 million (in 1995 values), prevent $US500 000 of treatment costs and, assuming a $US1 million value for a statistical life, would prevent $US9 million worth of premature death costs.[6] The authors' conclusion that vaccination was not cost beneficial relied heavily on the assumption of a willingness-to-pay threshold of $US1 million for a statistical life. The range of estimates for the value of a statistical life includes several estimates in excess of the threshold value of $US6.1 million required to conclude that vaccination was cost beneficial.[7] A more recent cost-effectiveness analysis of a strategy to deploy the conjugate quadrivalent vaccine (MCV-4) among US 11-year-olds used the productivity lost over life expectancy (human capital approach) to value the economic value of life, in addition to the burden of disease in terms of direct medical costs.[8] The adolescent vaccination strategy was estimated to cost $US138 000 per QALY saved in the reference case.[8] Depending on society's acceptability threshold and the presence of indirect vaccine benefits (i.e. herd immunity) not captured by the model, MCV-4 may or may not be judged a cost-effective strategy. That the Advisory Committee on Immunisation Practices (ACIP) of the CDC has recommended routine vaccination with MCV-4 of all adolescents beginning at age 11 years offers an indication that at least one important policy-making body has judged the benefits to society worth the costs.[9]

Several European countries have developed cost-effectiveness models to evaluate group C meningococcal vaccine.[3,5] The adherence of existing meningococcal vaccine models to modelling guidelines is celebrated for permitting comparability.[5] But adherence entrenches shortcomings of these guidelines, notably their difficulty in incorporating external benefits of health technology, which are key issues for vaccines.[10] One important vaccine externality is the prevention of secondary cases of disease – shown to be very important in the case of meningococcal vaccine.[11] Another externality is the potential value that parents may place on the health of their child over and above a human capital model of the value of a child's life.[12,13]

The need to place a dollar value on human life is an inescapable feature of both cost-benefit and cost-effectiveness methods.[14] One advantage of using a survey approach such as the one described here is that the valuation process can be left to patients and their families instead of being overtaken by policy makers. Rather than making assumptions about the value of human life, this study will apply the methods of choice-based conjoint analysis to inform parents about the effect of meningococcal vaccine on their child's risk of death and disability, and then assess parents' willingness to pay out of pocket for this product. In order to ascribe authority to consumers in making these important value judgments, it is critical that the informants in these studies have a firm understanding of the health consequences that would ensue from their choices. The cost-benefit paradigm thus shifts from policy makers deciding whether private health benefits are worth public funds to a paradigm where families decide whether private health benefits are worth private funds.[15-17] By using stated preferences we can capture the private perspective on the value of new products.[10]

Respecting consumer sovereignty is not new to economics; however, very few economic evaluations have directly measured consumer valuation. In this vein are prior studies showing that US parents were willing to pay a premium for a safer influenza vaccine for their child[12] and willing to pay $US500 (2001 value) for a pneumococcal conjugate vaccine that lowered meningitis risk from 21 to 6 per 100 000.[13] In terms of the value of a statistical life, this parental willingness to pay roughly $US3.3 million per life might be interpreted as a value in addition to, not as a proxy for, whatever the child would pay on their own behalf to save their own life.

When a parent is answering their willingness to pay to increase the odds of child survival, they may simply be expressing their willingness to avoid being a bereaved parent. The child's interest in preserving their own life is not identical with the interest to avoid bereavement, and we simply do not know the extent to which the parental responses confuse the two. Existing cost-effectiveness analysis guidelines offer little guidance on matters such as these, and a common default is to apply human capital valuations of the child's lifetime earnings, which assume that potentially large parental externalities from losing a child are zero.

With stated preference methods, it is possible to distinguish how effects of information about the pharmaceutical might differ from fear and dread of the disease. Models of rational choice emphasise a dispassionate weighing of costs and benefits based on factual information. In contrast, the field of health communication includes a role for affect and emotion in decision making. If fear distorts rational decision making by increasing or decreasing the subjective perception of a danger, then there may be grounds to distrust consumers' expression of the value of a health intervention. Prior studies indicate that presentations heightening the fear surrounding health consequences can magnify the demand for protective measures, especially when subjects are informed of the protective measures in advance.[18] Fear can also backfire, causing avoidance behaviour in a phenomenon known as fear reversal.[19] Thus, in evaluating consumers' preferences for a new health technology it is important to evaluate not just how much they 'know' about the condition and the technology, but also the potential role of their emotional state in determining the valuation.

The objective of this study was to establish the effects of price, vaccine characteristics and the parents' informational state on whether parents would purchase meningococcal vaccines out of pocket for their teenage children. The study also addresses whether fear-based efforts to 'inform' consumers about the dreaded nature of disease consequences might have paradoxical or distorting effects on the value they place on meningococcal vaccination.

Methods

Data

A sample of 229 parents of adolescents aged 11–21 years were recruited, with 114 in Germany and 115 in France (figure 1). Advertisements were placed in GPs' offices informing potential subjects that their assistance was needed in a research study. The topic of meningococcal vaccines was not mentioned in recruitment. All subjects received a standardised short introduction in lay terms about the nature of meningococcal disease and the properties of vaccines that protect against the disease. The presentation included information about the epidemiology of meningococcal disease, distribution of serogroups throughout the world, as well as descriptions of the frequency and severity of complications including amputation, brain damage and death. At the end of the survey they were quizzed to assess

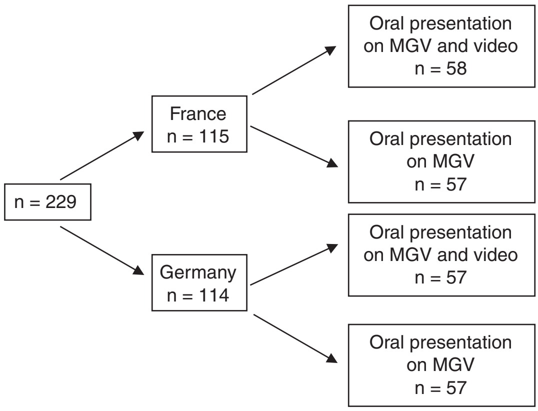

Fig. 1. Study design. A total of 229 subjects were recruited, 114 in Germany and 115 in France. All received an oral presentation on meningococcal vaccine (MGV). Half of all subjects watched a video presentation about a woman who developed meningococcaemia.

their retention of the information about the disease. Using a multiple choice format, the survey asked them to describe a serogroup and to estimate how many students on a campus of 50 000 would get meningococcal meningitis in 5 years.

Within each country, half of the subjects were assigned by alternating sequence in enrolment to view a 5-minute video presentation featuring photographs of a young college student before and after having multiple amputations due to a case of meningococcal disease.[20] Each subject gave informed consent, but since identifying data for subjects were not recorded in the database, the research reported here was classified as exempt research by the Committee on Human Research of Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA.

The scenario presented to each parent was that their doctor had recommended in favour of their child receiving a meningococcal vaccine, if the parent was willing to pay for it. All subjects were told to accept that: (i) they would not be reimbursed for the vaccine cost; (ii) all the vaccines were efficacious; (iii) all had equal very low probability of local adverse effects; and (iv) that only one injection would be required.

Two versions of the survey instrument presented a set of 18 opportunities to choose among three competing vaccine scenarios. The competing vaccine scenarios varied across three attributes: the price, duration of effect and number of serogroups covered. Possible attribute levels for price were (€15, €76, €122, €183 and €304) expressed in the local currency of each country in 2001. Attribute levels for duration of vaccine efficacy tested were 4 and 10 years. The serogroup options tested were C, AC and ACYW-135. After viewing the three options, subjects were asked, “From these 3 cards, which vaccine would you prefer?”. The subsequent question was, “Would you actually buy this vaccine?” – which could be coded ‘yes’ or ‘no’. Although subjects were forced to indicate a preference among each card set, they could answer ‘yes’ or ‘no’ about whether they would buy their preferred vaccine. Since all subjects were parents of an 11- to 21-year-old child, the purchase would be on behalf of this child.

Sawtooth software (Version 3, Sequim, WA, USA) choice-based conjoint (CBC) design module was used to ensure that the set of 18 choices in each version maximised the orthogonality of the design, while keeping respondent burden reasonable.[21,22] Orthogonality, level balance and minimal overlap are all desirable attributes in a conjoint instrument, which the Sawtooth CBC algorithms seek to achieve.[23,24] Each version intentionally included one choice set in which one vaccine clearly dominated the other two – a choice having a longer duration, more serogroups, and lowest price. Subjects who preferred dominated vaccines were flagged and subsequent analyses were done that could include or exclude these subjects. Prior research suggests that such individuals may have reformulated the experiment in some way.[25]

Statistical Analysis

The evaluation of each of these 54 vaccines (18 sets × 3 vaccines per set) always occurred in the context of exactly two competitor vaccines in that no vaccine ever appeared in isolation, but rather each was always considered relative to two alternatives. The respondents indicated which vaccine they preferred and, in a separate question, whether or not they would buy the preferred one. This analysis studies the response to the second question. A general model would be as shown in equation 1:

$$\Pr(\text{Buy } Y_j) = C + \beta_p P_{own} + \beta_{p1}P_1 + \beta_{p2}P_2 + \beta_D Dur_{own} + \beta_{D1}Dur_1 + \beta_{D2}Dur_2 + \beta_S S_{own} + \beta_{S1}S_1 + \beta_{S2}S_2 + \beta'_A X_i \quad \text{(Eq. 1)}$$

where Y_j is a dichotomous choice to buy one of the 54 vaccines encountered by each subject. Subscript 'j' denotes which of the 54 vaccines is being considered, and subscript 'own' denotes that vaccine's own price (P), own duration (Dur) and own serocoverage (S), and subscripts '1' and '2' denote the respective attributes of alternatives one and two, which appeared on the same card as j. The β coefficients apply to the respective prices and attributes with subscripts P, D and S for price, duration and serocoverage, respectively. C is a regression constant. Coefficient vector β′ applies to the individual's background features such as age, gender and income that might affect choice.

Besides intra-choice set correlation there could also be intra-subject correlation. To correct for correlated error terms we used robust standard errors,[26] which cluster on each constellation of vaccine set and subject. There are potentially 18 vaccine sets × 228 subjects = 4104 of these clusters. Another way to correct for intra-cluster correlation, which we used here, is to apply a generalised linear model with two separate random effects: a question-specific random effect and a subject-specific random effect.

The generalised linear model takes the form of equation 2:

$$E(Y) = g^{-1}[\beta_p P_{own} + \beta_{p1}P_1 + \beta_{p2}P_2 + \beta_D Dur_{own} + \beta_{D1}Dur_1 + \beta_{D2}Dur_2 + \beta_S S_{own} + \beta_{S1}S_1 + \beta_{S2}S_2 + \beta'_A X_i) + (\mu_{Question} + \mu_{Subject} + \varepsilon)] \quad \text{(Eq. 2)}$$

where $g^{-1}[\ldots]$ is an inverse link function and ($\mu_{Question} + \mu_{Subject}$) are separate random effects associated with each of the 18 questions and each of the 228 subjects, respectively. The ε component of the error term is assumed to be independent of questions and subjects. In order to estimate this model using maximum likelihood methods the link function is assumed to be the logistic function and the family of distributions is assumed to be binomial. The 'gllam6' program in Stata™ (Version 8, StataCorp, College Station, TX, USA) estimates generalised linear models with random effects using adaptive quadrature.[27] *A priori* it is expected that a failure to account for random effects associated with each question and subject will lead to biased parameter estimates; however, the extent of the bias can be assessed using a Hausman test.[28]

In order to interpret the coefficients, post-test transformations were used. The delta method was used to calculate own price and cross-price elastici-

Table I. Descriptive data on the sample

Demographic	France [n (%)]		Germany [n (%)]	
	video	no video	video	no video
Number of respondents	58	57	57	57
Female	52 (89.7)	47 (82.5)	53 (93)	49 (86)
Understood meaning of 'serogroup'	40 (68.9)	42 (73.7)	21 (36.8)	37 (64.9)[a]
Respondent is employed	42 (72.4)	38 (66.7)	45 (78.9)	47 (82.4)
Preferred a dominated choice	8 (13.7)	18 (31.5)[b]	13 (22.8)	15 (26.3)
Unwilling to purchase vaccine at any price between €15 and €304	4 (6.9)	3 (5.3)	8 (14.0)	2 (3.5)[b]
Number of children per respondent (mean [SD])	2.45 [0.939]	2.33 [1.005]	1.75 [0.695]	1.75 [0.662]
Perceived risk of meningitis in university students [cases per 100 000 person-years][c] (mean [SD])	3.52 [2.33]	2.93 [2.00]	2.87 [1.94]	3.05 [1.94]
Log income [in logged €] (mean [SD])	10.19 [0.85]	10.27 [0.79]	11.18 [0.23]	11.26 [0.21]

a Within-country difference statistically significant at $p < 0.01$.

b Within-country difference statistically significant at $p < 0.05$.

c Subjects were asked to estimate the number of cases that would occur on a campus of 50 000 in 5 years. They were given several choices between 1 and 15 cases. True incidence is estimated at two cases per 100 000 person-years.

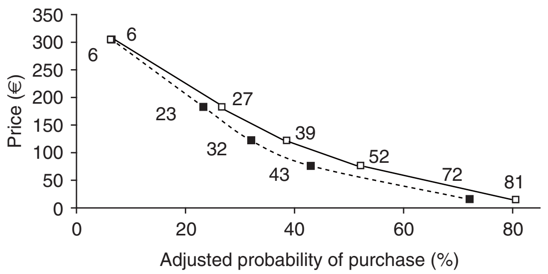

Fig. 2. French sample demand curves. A plot of vaccine prices vs median of adjusted probability of purchase in the French sample as per model in table II. Dotted line indicates responses of subjects who were only given a verbal presentation of standardised facts about meningococcal disease. Solid line indicates responses of subjects who viewed the video depicting the story of a woman who acquired meningococcaemia as well as the standardised facts about the disease.

ties. These arc elasticities have the conventional interpretation: the percentage increase in quantity demanded from a percentage decrease in price. The elasticity will only be valid around the means of all of the covariates in the sample. It will reflect the response to one vaccine in an environment where there are two alternatives, each with the mean price, duration and serogroup coverage of the products on the 18 sets of vaccines. It will also reflect the mean income and perceived risk characteristics of the sample.

Results

Table I lists the descriptive data of the sample. Fifty-four subjects preferred dominated vaccines and were dropped from the analyses presented here. Separate analyses (not shown) retained these subjects and the findings were not dramatically different whether or not these subjects were retained. The majority of subjects (92.6%) indicated that they would buy the vaccine for at least one of the prices (range €15–304 in 2001) that they encountered in the vaccine descriptions. Grouping together video viewers and non-viewers, the price at which the estimated probability of purchase equalled 50% was €50 in German subjects and €80 in French subjects for a vaccine of 10 years duration protecting against serogroups A, C, Y and W-135 (figures 2 and 3).

The different samples of parents were comparable within each country, with the exception that for unclear reasons the German video viewers were less likely to comprehend the meaning of the term 'serogroup' and the French video viewers were less likely to prefer dominated offerings. The German sample had a statistically significantly higher income than the French sample. Multivariate methods controlled for all of these potential confounders.

Following the preliminary introductory presentation, the respondents had attained a surprisingly high comprehension of the technical issues surrounding meningococcal vaccines: 61% could state what a serogroup was. The subjectively perceived risk of meningitis without vaccination was quite accurate: the median and modal response that 5 university students out of 50 000 would succumb to the disease in a 5-year period was exactly correct. The mean response that 7.7 students would succumb without vaccination was also quite accurate and translated to a perceived rate of 3.08 cases per 100 000 person-years. Figures 2 and 3 show predicted probabilities of purchase based on the parameters displayed in table II. The predicted responses model the relationship between price and the probability that the average respondent would buy. In this simulation the product under consideration is a meningococcal vaccine with 10-year duration, covering four serogroups, being considered in the context of two competing vaccines with an average 7 years' duration, and average coverage of two serogroups. The simulations show probabilities of purchase of

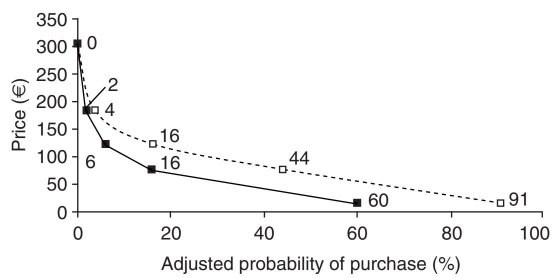

Fig. 3. German sample demand curves. A plot of vaccine prices vs median of adjusted probability of purchase in the German sample as per model in table II. Dotted line indicates responses of subjects who were only given a verbal presentation of standardised facts about meningococcal disease. Solid line indicates responses of subjects who viewed the video depicting the story of a woman who acquired meningococcaemia as well as the standardised facts about the disease.

Table II. Logit coefficients (SE) with random effects accounting for complex error distribution

Generalised linear random effects	Logit probability of purchase	
	France	Germany
Price of vaccine being considered	−0.013 (0.001)***	−0.032 (0.002)***
Increased price of alternative 1	0.002 (0.001)***	0.003 (0.001)**
Increased price of alternative 2	0.132 (0.026)***	0.005 (0.001)***
Duration of effect of vaccine being considered	0.132 (0.026)***	0.161 (0.043)
Increased duration of effect of alternative 1	−0.096 (0.025)***	−0.070 (0.039)*
Increased duration of effect of alternative 2	−0.284 (0.029)***	−0.268 (0.042)***
Number of antigens covered by vaccine being considered	0.681 (0.075)***	0.893 (0.130)***
Increased number of antigens of alternative 1	−0.788 (0.085)***	−0.782 (0.138)***
Increased number of antigens of alternative 2	−0.963 (0.082)***	−0.801 (0.127)***
Increased log income	0.022 (0.156)	−1.397 (0.868)
Increased perceived risk	−0.152 (0.120)	0.059 (0.868)
Knows what a serogroup is	−0.484 (0.261)*	−0.828 (0.375)**
Video × own price	−0.002 (0.001)	0.007 (0.002)***
Video	0.500 (0.284)*	−1.968 (0.434)***
Constant	3.058 (1.850)***	18.161 (9.780)*

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ for test of null hypothesis that coefficient = 0.

60–91% for a vaccine priced at €15 for the German sample (figure 3, two points in bottom right) with a narrower range for the French sample.

Tables III and IV display the results of a stratified analysis using four separate samples: French subjects with video (table III), French subjects without video (table III), German subjects with video (table IV) and German subjects without video (table IV). In each table the first regression model used is the robust logit model[1] with product attributes only. The second column displays the coefficients of a logit model augmented with data about each subject (income, perceived risk of meningitis without vaccine and knowledge of what a serogroup is) and the third column shows the elasticities emerging from column two. These elasticities can be interpreted as the percentage change in the probability of purchase from a 1% change in the attribute. The personal information about the parent's age and education had a negligible interactive effect on the responses to the product attributes. For convenience, the general pattern in price elasticity is summarised in table V and indicates a greater sensitivity to price in the German sample, with video viewership diminishing this price sensitivity. For example, a 10% price increase would make non-video viewers 24.8% less likely to buy the vaccine, but video viewers would be only 18.7% less likely to buy after the same price increase.

As expected, the probability of purchase was higher for products with longer duration and greater antigenic protection. It was also greater when the competing vaccines appearing on the same card had high prices, short duration and less antigenic protection. Income and perceived risk of meningitis had inconsistent effects on the probability of purchase across the four samples. Knowing what a serogroup is consistently lowered the probability of purchase, perhaps because this degree of knowledge lowered consumer interest in being protected against strains such as W-135, which were not locally prevalent.

The key findings were that the German and French samples have markedly different price elasticities, with the German subjects being more price sensitive than the French. Furthermore, viewing the video appears to have a stronger effect among German participants where it makes demand less sensitive to price changes. In the German participants, the video appeared to shift the demand curve downward while tilting the slope towards less elasticity (figure 3). Among the French participants, the video appears to shift the demand curve slightly upward, but had little effect on elasticity (figure 2). Table II displays the results of the generalised linear

Table III. Logit coefficients for probability of purchase of a chosen hypothetical meningococcal vaccine vs two alternatives; data from French participants exposed or not exposed to video

Attributes of product and respondent	Logit[a] (SE)	Logit[b] (SE)	Elasticity[c] (SE)
French participants exposed to video			
Price of vaccine being considered	−0.011 (0.001)***	−0.011 (0.001)***	−1.204 (0.132)***
Increased price of alternative 1	0.001 (0.001)	0.001 (0.001)	0.126 (0.095)
Increased price of alternative 2	0.004 (0.001)***	0.004 (0.001)***	0.424 (0.091)***
Duration of effect of vaccine being considered	0.059 (0.026)**	0.059 (0.026)**	0.342 (0.152)**
Increased duration of effect of alternative 1	−0.072 (0.028)***	−0.072 (0.029)***	−0.386 (0.153)***
Increased duration of effect of alternative 2	−0.199 (0.031)***	−0.200 (0.031)***	−1.136 (0.184)***
Number of antigens covered by vaccine being considered	0.556 (0.104)***	0.562 (0.084)***	0.989 (0.150)***
Increased number of antigens of alternative 1	−0.645 (0.104)***	−0.650 (0.104)***	−0.987 (0.163)***
Increased number of antigens of alternative 2	−0.671 (0.091)***	−0.678 (0.091)***	−1.387 (0.194)***
Increased log income		−0.055 (0.075)	−0.448 (0.616)
Increased perceived risk		−0.150 (0.058)***	−0.216 (0.084)***
Knows what a serogroup is		−0.390 (0.131)***	−0.213 (0.072)***
Constant	2.565 (0.753)***	3.668 (1.090)***	
French participants not exposed to video			
Price of vaccine being considered	−0.010 (0.001)***	−0.010 (0.001) ***	−1.172 (0.160)***
Increased price of alternative 1	0.001(0.001)	0.001 (0.001)	0.102 (0.130)
Increased price of alternative 2	0.004 (0.001)***	0.005 (0.001)***	0.538 (0.111)***
Duration of effect of vaccine being considered	0.117 (0.033)***	0.123 (0.034)***	0.725 (0.202)***
Increased duration of effect of alternative 1	−0.066 (0.035)**	−0.067 (0.035)**	−0.368 (0.195)**
Increased duration of effect of alternative 2	−0.192 (0.035)***	−0.205 (0.036)***	−1.226 (0.224)***
Number of antigens covered by vaccine being considered	0.442 (0.112)***	0.455 (0.089)***	0.828 (0.164)***
Increased number of antigens of alternative 1	−0.494 (0.112)***	−0.522 (0.116)***	−0.826 (0.188)***
Increased number of antigens of alternative 2	−0.702 (0.104)***	−0.744 (0.108)***	−1.569 (0.240)***
Increased log income		0.193 (0.113)*	1.642 (0.964)*
Increased perceived risk		−0.042 (0.081)	−0.053 (0.102)
Knows what a serogroup is		−0.258 (0.180)*	−0.164 (0.114)*
Constant	1.833 (0.923)**	0.243 (1.544)**	

a Robust logit model with product attributes only.

b Robust logit model augmented with data about each respondent.

c Elasticities emerging from the logit model in column two.

SE = robust standard errors; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ for test of null hypothesis that coefficient = 0.

model,[2] and uses an interaction term between video exposure and own price. This table confirms and clarifies the above findings: the interaction effect of video exposure and price shows that video exposure made demand less price sensitive among German participants, but not among the French participants. Video exposure independently reduced the overall likelihood of purchase in German subjects and increased the overall likelihood of purchase in French subjects.

Discussion

The unadjusted results of this survey revealed that 93% of parents said they would purchase at least one meningococcal vaccine product at a price that was in the range proposed (€15–304).

The survey-based responses of parents are at odds with a prior cost-benefit analysis of polysaccharide meningococcal vaccine, which concluded that vaccinating teenagers was not cost beneficial based on modelled assumptions about what the life of a child was worth.[6] How can this be reconciled?

The meningitis knowledge quiz at the end of the survey showed that parents did not greatly overestimate the probability of meningitis. Furthermore, higher subjective estimates of the risk of meningitis did not consistently predict an increased willingness to purchase the vaccine. Nor is it likely that the parents imagined the pain and suffering of meningococcal disease was worse than it actually was. Viewing graphical depictions of disease consequences had an inconsistent effect (and in German participants a negative effect) on the probability of purchase. Putting aside misinformation, there are better explanations for the high willingness of European parents to purchase a product deemed 'not cost beneficial' by a team of economists.[6]

It is possible that the scope of options considered by the parents (do nothing vs buy a vaccine) led to a greater willingness to purchase than if the parents were confronted with do nothing versus a long list of investments they could make to improve their child's health and safety. But was the contingent situation so unreal as to make the parents' responses invalid? The contingent purchase decision faced by the European parents in the survey bears a strong

Table IV. Logit coefficients for probability of purchase of a chosen hypothetical meningococcal vaccine vs two alternatives; data from German participants exposed or not exposed to video

Attributes of product and respondent	Logit[a] (SE)	Logit[b] (SE)	Elasticity[c] (SE)
German participants exposed to video			
Price of vaccine being considered	–0.014 (0.002)***	–0.014 (0.002)***	–1.847 (0.219)***
Increased price of alternative 1	0.000 (0.001)	0.000 (0.001)	–0.009 (0.159)
Increased price of alternative 2	0.002 (0.001)***	0.003 (0.001)***	0.325 (0.129)***
Duration of effect of vaccine being considered	0.014 (0.035)***	0.017 (0.035)***	0.111 (0.234)***
Increased duration of effect of alternative 1	–0.074 (0.038)	–0.073 (0.038)	–0.451 (0.237)
Increased duration of effect of alternative 2	–0.127 (0.037)***	–0.129 (0.037)***	–0.859 (0.248)***
Number of antigens covered by vaccine being considered	0.318 (0.141)***	0.324 (0.103)***	0.659 (0.210)***
Increased number of antigens of alternative 1	–0.741 (0.141)***	–0.741 (0.141)***	–1.305 (0.254)***
Increased number of antigens of alternative 2	–0.596 (0.114)***	–0.599 (0.116)***	–1.410 (0.276)***
Increased log income		–0.102 (0.385)	–1.057 (4.000)
Increased perceived risk		0.251 (0.091)***	0.332 (0.122)***
Knows what a serogroup is		–0.301 (0.184)*	–0.102 (0.062)*
Constant	2.599 (1.007)**	3.452 (4.443)**	
German participants not exposed to video			
Price of vaccine being considered	–0.019 (0.002)***	–0.020 (0.002)***	–2.481 (0.235)***
Increased price of alternative 1	0.001 (0.001)	0.001 (0.001)	0.139 (0.145)
Increased price of alternative 2	0.003 (0.001)***	0.003 (0.001)***	0.326 (0.128)***
Duration of effect of vaccine being considered	0.063 (0.035)***	0.060 (0.035)*	0.386 (0.224)***
Increased duration of effect of alternative 1	–0.062 (0.037)	–0.065 (0.037)	–0.395 (0.226)
Increased duration of effect of alternative 2	–0.180 (0.036)***	–0.183 (0.036)***	–1.210 (0.243)***
Number of antigens covered by vaccine being considered	0.632 (0.107)***	0.634 (0.109)***	1.265 (0.221)***
Increased number of antigens of alternative 1	–0.263 (0.113)***	–0.279 (0.124)***	–0.487 (0.217)***
Increased number of antigens of alternative 2	–0.392 (0.113)***	–0.404 (0.115)***	–0.938 (0.270)***
Increased log income		–0.516 (0.424)	–5.323 (4.371)
Increased perceived risk		–0.038 (0.096)	–0.050 (0.126)
Knows what a serogroup is		–0.571 (0.205)***	–0.050 (0.126)***
Constant	1.177 (0.977)	7.606 (4.835)	

a Robust logit model with product attributes only.

b Robust logit model augmented with data about each respondent.

c Elasticities emerging from the logit model in column two.

SE = robust standard errors; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ for test of null hypothesis that coefficient = 0.

Table V. The general pattern in price elasticity

Group	Own price elasticity
France group 1 (video)	−1.242
France group 2	−1.204
Germany group 1 (video)	−1.872
Germany group 2	−2.478

resemblance to the actual decisions faced by US parents between 2000 and 2004, where 18 states passed laws requiring physicians to discuss the facts about meningococcal disease with parents of college students.[29] None of these parents were required to vaccinate their children, yet all of them had to decide whether to do nothing or buy a vaccine, which was only occasionally reimbursed by insurance. The polysaccharide, tetravalent vaccine available during this period was priced around $US65 in the US, and protection would last about 3 years. Sales of the polysaccharide vaccine grew substantially as state laws mandating college students simply be informed about vaccination swept through the US.

The real-world choice of many informed US parents to voluntarily purchase a vaccine for meningococcal disease suggests that parental interest in meningococcal vaccination uncovered in our respondents is not just a phenomenon attributable to survey design. The positive responses of the survey respondents and US parents are entirely rational if households value the life of a child at rates greater than $US1 million. Given a meningococcal disease attack rate of 2 per 100 000 person-years and a case fatality rate of 10%, parents were purchasing a reduced death risk of 2 per million per year that would last 10 years in the case of MCV-4. Stating that a statistical life is worth $US1 million is equivalent to saying that a 2 per million chance of death is worth $US2.00. Without discounting, 10 years of protection from a 2 per million death risk would thus be worth $US20 if a statistical life is only worth $US1 million. Discounting at 5%, an annuity of $US2 per year over 10 years is worth $US15.44. In other words, a decision to purchase a $US65 vaccine that had a present value of $US15.44 is not consistent with the sales increase observed in the market. This suggests that the value of life is substantially more than $US1 million. This calculation also neglects all of the pain and suffering and medical care costs of the disease.

One can use the results in figures 2 and 3 to estimate the distribution of the value of statistical life in the subjects from the two countries. The point at which the probability of purchase was 50% in French subjects was €80, which would be consistent with valuing a statistical life at €5.2 million. The corresponding value for German parents was €3.3 million. Few, if any, estimates of the value of statistical life are based on parents acting on behalf of their children. The estimates here may not be comparable with other estimates, because it is possible that, when parents make choices involving payments in exchange for risk reduction, they confound the value of the child's life to the child, with their own selfish interests in enjoying the child's continued survival.

Paradoxically, the data show that greater knowledge about the technical properties of the vaccine – e.g. the nature of serogroup coverage – and exposure to a dramatic display of the effects of the disease could lower the probability of purchase. German subjects who were exposed to a video depicting the shocking story of a woman who develops meningococcaemia and has amputations were less likely to indicate that they would purchase meningococcal vaccine for their children. It is possible that these results were an example of a 'fear reversal' – a phenomenon well known to marketing experts. Fear reversals were first noted in field studies when high school freshmen who were given more extensive information on the awful outcomes of poor dental hygiene were *less* likely to change their dental care practices.[19] Since then, paradoxical effects of fear appeals have been a commonplace observation in the communications literature, and are thought by some to be mediated by a parallel affective response to the emotional content of communication.[30]

It is unlikely that these effects are being driven by inclusion or exclusion of parents who either irrationally prefer dominated vaccines or who do not understand what a serogroup is. Separate analyses (not shown here) confirmed that the effects of the video exposure on demand remained robust whether these groups of parents were included or excluded.

The majority of parents sampled in France and Germany would purchase a meningococcal vaccine if the price were as low as €50. This expression of interest is consistent with the experience in the US where polysaccharide meningococcal vaccine has been a successfully marketed product generating out-of-pocket purchases. The results are parallel to findings from a survey of willingness to pay for pneumococcal conjugate vaccine among parents of small children, which demonstrated that informed parents perceive substantial additional benefits to vaccinating their children that may not be fully captured by human capital models of the burden of disease.[13] Furthermore, heterogeneity among parents in our study and in prior studies[13] suggests that the rigid adoption of any single uniform cost-effectiveness acceptability threshold could deny health technology to many individuals for whom the benefits exceed costs. Heterogeneity offers a cautionary lesson in the use of model-based evaluations of pharmaceuticals. The parents in our survey varied greatly in their willingness to pay for the vaccine. Policy makers who assume that all parents place a uniform value on risk reduction (e.g. acceptability threshold less than $US100 000 per QALY gained) could potentially deny a beneficial product to many people whose valuation exceeds the one assumed by the policy maker.

The limitations of our study are the small sample size of parents, which cannot be representative of the general population of either country from which they were sampled. By including demographic covariates as controls in our regression analysis, we attempted to control for observable aspects of the population that may be associated with preferences. However, the effects of product attributes on purchase probability were robust to inclusion or exclusion of variables for respondent income, age, gender, etc. Furthermore, our exclusion of individuals who preferred dominated choices had very little effect on the estimates of response to product attributes.

Conclusion

In Germany and France, where there is still limited out-of-pocket health spending, the majority of sampled respondents stated that they would purchase meningococcal vaccines with their own money.

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References

1. Rosenstein NE, Perkins BA, Stephens DS, et al. Meningococcal disease. N Engl J Med 2001 May 3; 344 (18): 1378-88
2. Pollard AJ. Global epidemiology of meningococcal disease and vaccine efficacy. Pediatr Infect Dis J 2004 Dec; 23 (12 Suppl.): S274-9
3. Trotter CL, Edmunds WJ. Modelling cost effectiveness of meningococcal serogroup C conjugate vaccination campaign in England and Wales. BMJ 2002 Apr 6; 324 (7341): 809
4. Fergus S, Zimmerman MA. Adolescent resilience: a framework for understanding healthy development in the face of risk. Annu Rev Public Health 2004 Oct 26; 26: 399-419
5. Welte R, Trotter CL, Edmunds WJ, et al. The role of economic evaluation in vaccine decision making: focus on meningococcal group C conjugate vaccine. Pharmacoeconomics 2005; 23 (9): 855-74
6. Jackson LA, Schuchat A, Gorsky RD, et al. Should college students be vaccinated against meningococcal disease? A cost-benefit analysis. Am J Public Health 1995 Jun; 85 (6): 843-5
7. Viscusi WK. The value of risks to life and health. J Econ Lit 1993; 31: 1912-46
8. Shepard CW, Ortega-Sanchez IR, Scott RD, et al. Cost-effectiveness of conjugate meningococcal vaccination strategies in the United States. Pediatrics 2005 May; 115 (5): 1220-32
9. Bilukha OO, Rosenstein N. Prevention and control of meningococcal disease. Recommendations of the advisory committee

on immunization practices (ACIP). MMWR Recomm Rep 2005 May 27; 54 (RR-7): 1-21

10. Bridges JF. Future challenges for the economic evaluation of healthcare: patient preferences, risk attitudes and beyond. Pharmacoeconomics 2005; 23 (4): 317-21
11. Trotter CL, Edmunds WJ. Reassessing the cost-effectiveness of meningococcal serogroup C conjugate (MCC) vaccines using a transmission dynamic model. Med Decis Making 2006 Jan-Feb; 26 (1): 38-47
12. Prosser LA, Bridges CB, Uyeki TM, et al. Values for preventing influenza-related morbidity and vaccine adverse events in children. Health Qual Life Outcomes 2005; 3 (1): 18
13. Prosser LA, Ray GT, O'Brien M, et al. Preferences and willingness to pay for health states prevented by pneumococcal conjugate vaccine. Pediatrics 2004 Feb; 113 (2): 283-90
14. Pauly MV. Valuing health care benefits in money terms. In: Sloan F, editor. Valuing health care. Cambridge: Cambridge University Press, 1996
15. Vogt F, Schwappach DL, Bridges JF. Accounting for tastes: a German perspective on the inclusion of patient preferences in healthcare. Pharmacoeconomics 2006; 24 (5): 419-23
16. Ryan M, Gerard K. Using discrete choice experiments to value health care programmes: current practice and future research reflections. Appl Health Econ Health Policy 2003; 2 (1): 55-64
17. Ryan M, Bate A, Eastmond CJ, et al. Use of discrete choice experiments to elicit preferences. Qual Health Care 2001 Sep; 10 Suppl. 1: i55-60
18. Eppright DR, Hunt JB, Tanner JF, et al. Fear, coping, and information: a pilot study on motivating a healthy response. Health Mark Q 2002; 20 (1): 51-73
19. Janis I, Feshbach S. Effects of fear-arousing communications. J Abnorm Soc Psychol 1953; 48 (1): 78-92
20. ABC News. Campus killer. 20/20 [aired 1999 Sep 17]. New York: ABC, 1999
21. Louviere JJ. Analyzing decision-making: metric conjoint analysis. London: Sage Publications, 1988
22. Sawtooth Software Inc. The CBC system user's manual. Evanston (IL): Sawtooth Technologies, 1999
23. Huber J, Zwerina K. The importance of utility balance in efficient choice designs. J Mark Res 1996; 33: 307-17
24. Chrzan K. An overview and comparison of design strategies for choice-based conjoint analysis. Sequim (WA): Sawtooth Software Inc., 2000
25. Miguel FS, Ryan M, Amaya-Amaya M. 'Irrational' stated preferences: a quantitative and qualitative investigation. Health Econ 2005 Mar; 14 (3): 307-22
26. White H. A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. Econometrica 1980; 48 (4): 817-38
27. Rabe-Hesketh S, Skrondal A. Reliable estimation of generalized linear mixed models using adaptive quadrature. Stata J 2002; 2 (1): 1-21
28. Hausman JA. Specification tests in econometrics. Econometrica 1978; 46 (6): 1251-71
29. National Conference of State Legislatures. Meningitis laws by state [online]. Available from URL: http://www.ncsl.org/programs/health/meningitisleg.htm [Accessed 2006 Dec 4]
30. Rajecki DW. Persuasive communication and attitudes: attitudes. Sunderland (MA): Sinauer Associates, 1990

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