Factors affecting direction and strength of patient preferences for treatment of molar teeth with nonvital pulps

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Abstract

Aim

To elicit the factors affecting Willingness to Pay values for the preferred options of participants for dealing with a molar tooth with a non-vital pulp, a common but difficult problem.

Methodology

A total of 503 patients were recruited from dental practices in the North East of England and interviewed. Their preferred treatment option for a molar tooth with a non-vital pulp (endodontics, extraction and various prosthetic restorative options) and WTP for this preferred option were elicited. Factors affecting preferred option and WTP were analysed using econometric modelling.

Results

Overall, 53% of the sample wished to save the tooth with a mean WTP of £373. The variance in WTP was high. Of those opting for extraction the majority chose to leave a gap or have an implant. The preferred option was influenced by previous treatment experience. WTP was only influenced by having a low income.

Conclusions

The high level of variance in WTP and its relatively unpredictable nature pose difficult questions for policy makers trying to ensure the delivery of an equitable service. For dentists, it is important not to make assumptions about patient preference and strength of preference when making decisions. Ideally, WTP values should be considered alongside effectiveness data, and those on costs, in policy making.

Introduction

The decisions of whether to save or extract a molar tooth with a non-vital pulp and then, if extracted, whether and how to prosthetically restore the space, are commonly encountered in dental practice. Arguments have been advanced both for the retention of teeth using endodontic treatment and for extraction and prosthetic replacement based on effectiveness (Zitzmann et al. 2009) although there are often problems in comparing effectiveness due to different measures being used. Some of these arguments have centred around the balance of long term costs against different levels of effectiveness, with some for example arguing that implant replacement is more effective and that the initial higher costs are offset by savings in the future (Felton 2005).

To evaluate fully the long term costs together with the success rates in a holistic manner, economic evaluation techniques can be employed. Although such evaluations can inform clinical questions, they are of most use to policy makers when taking decisions concerning the most efficient allocation of resources. To date, published economic evaluations comparing endodontics and implants have only addressed technical efficiency questions, in other words, how to achieve the best outcome for a given level of resource (Pennington et al. 2009, Kim & Solomon 2011).

Given the complex and multi-dimensional nature of resource allocation decisions (allocative efficiency questions), it is necessary but potentially complex to elicit patient preferences or values to inform decisions. Health economics gives a framework for eliciting such preferences in a systematic and well defined single measure across a population or sample. When elicited in this way, the information about direction and strength of preferences can be used directly by policy makers in combination with cost and other attributes to inform decisions about which treatments to fund in budget-constrained systems such as the National Health Service (NHS) in the UK or weighed directly against costs in a cost-benefit analysis in privately funded (or non-budget constrained systems (Shackley & Donaldson 2000). The values may also be of use in informing decisions at an individual level as an important element of shared decision making (Charles et al. 1999). However, the area of

patient preferences has not been extensively explored in dentistry (Vernazza et al. 2012). Previous research of relevance to the specific context of this study has investigated patient preference for implants (Esfandiari et al. 2009, Leung & McGrath 2010, Augusti et al. 2013) but investigation and valuation of preferences for all options for a molar tooth with a non-vital pulp (an extremely common clinical scenario) has not been undertaken.

The field of health economics has a specific way of defining and studying patient preference, in terms of utility. Utility can be measured in specific health state utility measures often presented as quality adjusted life years (QALYs), but there are theoretical and practical problems with using such measures in oral health (Birch & Ismail 2002). An alternative method of eliciting utility is to determine a monetary valuation most commonly using the technique of willingness to pay (WTP) (Donaldson et al. 2006). With WTP, the respondent is presented with a hypothetical scenario, for example receiving a particular health care intervention, and asked the maximum they would be willing to pay to receive the intervention. It is important to note that this is not asking what price they think the intervention should be but how much, based on their own income constraints, they personally value the intervention.

Willingness to pay is not without its own criticisms, most notably its link with ability to pay and the hypothetical nature of the valuation but these criticisms have been discussed in detail and mostly addressed (Donaldson 1999, Kennedy 2002, Murphy et al. 2005, Bryan & Jowett 2010). It is worth bearing in mind that QALYs also suffer from similar problems. Bearing in mind the advantages and disadvantages of WTP and health state utility measures, WTP has been suggested as the most suitable method for dental interventions (Matthews et al. 1999).

The aim of this study was to devise an approach to eliciting WTP values in the complex situation of deciding over multiple options for treating an asymptomatic molar tooth with a non-vital pulpand to use this approach to explore the factors influencing the direction and strength of preference (in terms of WTP) of dental patients for the different treatment options.

Methods

The study was approved by the NHS County Durham and Tees Valley 2 Research Ethics Committee.

The sampling frame was routine dental attenders from 8 dental practices in the North East of England which were also the setting for recruitment and interviews. The practices were purposively sampled by size, location and patient payment type (National Health Service (NHS), private and mixed) to ensure a range of participants. In this context, the NHS is a taxation funded system which provides some subsidisation of dental treatments for all UK citizens as well as free dental treatment for certain groups (such as children and low income groups). Some patients choose to seek dental care privately either paying on a fee per item or insurance basis. Of the treatment options studied all are available through the NHS with the exception of implants which are usually only available privately. In order to allow multi-variate modelling a broad range of demographic and dental characteristics were necessary in the sample and this was reviewed constantly throughout recruitment. The possibility of stratified sampling was considered, but found not to be necessary as the study progressed.

Over a period of 51 days, sequential patients aged 18 and over and having at least one natural tooth (i.e. dentate) were asked by the dentist at the end of any type of appointment if they wished to be involved in the research. Exclusion criteria were only that the participant could not complete or understand the interview. The sample size calculation was based on the primary aim of investigation (factors affecting WTP and choice) and so a logistic research events per variable (EPV) approach (Peduzzi et al. 1996) was employed showing a necessary sample size of at least 500. Sampling was ceased when the target number was reached.

Structured interviews were conducted by one researcher (CV). Demographic, socio-economic and dental history questions were included based on best practice guidelines (Office for National Statistics 2009, The NHS Information Centre 2010). Participants were presented with the scenario of an asymptomatic mandibular first permanent molar with a non-vital pulp with extensive caries. They were then given the options of saving (with a root canal treatment and crown) or extracting the tooth and then the 4 prosthetic options of leaving a gap, a removable partial denture, a fixed bridge or a single implant restoration. All of these items were described in lay terms and supplemented with photographs and illustrations.

The WTP exercise was prefaced with an explanation of this method along with a script to ensure that patients understood that the exercise was hypothetical but to encourage realistic and budget constrained responses. The participant was asked to state which would be their preferred treatment option and WTP was elicited for this choice using a shuffled payment card method (Smith 2006). The approach of eliciting WTP for the preferred option (rather than a marginal or "WTP for each" approach) was taken based on the likely use of such data by policy makers. Zero values were classified as true or protest by asking the participant to select the reason for this value from a standard list (Ryan et al. 2004).

Data were inputted by one researcher (CV) into Stata 11 (Statacorp LP. College Station, Texas, USA). Validation consisted of performing rationality and consistency tests on the whole sample. Descriptive statistics were used for the basic analysis followed by a series of econometric models to look at factors influencing the choices and WTP values. Treatment option choices were analysed using logistic and multinomial logistic regressions. . When analysing WTP, even when "protest" zeros are excluded, the data are censored at zero as it is not possible to be willing to pay a negative amount. This usually leads to a right skewing of the data. Various techniques have been used to account for both the censoring and skew but the use of tobit models is one widely accepted solution in econometrics (Halstead et al. 1991). Measuring predictive ability of such models in an absolute sense is difficult, but the McFadden's pseudo R2 gives some indication (Veall & Zimmermann 1996) with values of 0.2-0.4 indicating excellent fit. Finally, as WTP would not be independent of treatment choice, a Heckman, or sample selection model (Heckman 1979) was used to explore WTP whilst controlling for treatment choice.

As well as full models with all variables, more limited models were constructed based on backwards stepwise elimination, with essential variables retained in all models (experience of RCT, extraction and crowns in choice models and income variables in WTP models). The selection of most appropriate model was based mainly on the Bayesian information criterion (BIC) (Gujarati 2003).

Results

Nature of the sample

In total, 504 potential participants were referred by the dentists to the researcher, of which 503 agreed to participate and were interviewed. Data regarding those approached by the dentist and refusing to see the researcher were not collected. The basic demographics and

dental history of the sample are given in Tables 1 and 2 and compared to appropriate population data.

Strength and direction of preference (descriptive analysis)

The proportion of the sample preferring different options and the respective WTP values of each sub-sample for their preferred option are shown in Table 3. The overall mean WTP for the whole sample for their preferred option (the WTP for dealing with the problem, irrespective of treatment choice) was £327.66 but with a very large standard deviation (SD) (£774.58). In the whole sample and each individual sub-sample, the WTP distribution was not normal but right skewed and left censored, as expected (see Figure 1). There were only 6 zero responses in the whole data set (4 in the RCT sub-group, 2 in the extraction only sub-group) and these were all "true" zeros, rather than protest responses and so contribute to the mean values.

Factors affecting direction of preference

A series of economic models were developed to explain the factors influencing the direction and strength of preference. The first model explains the choice between extracting (with all subgroups of prosthetic choice combined into this one larger group) the tooth and saving it (RCT + crown) with odds ratios referring to the likelihood of choosing extraction. The model is given in Table 4, with significant factors of low socio-economic status (SES) and experience of extraction making choosing extraction doubly and almost triply more likely respectively and experience of RCT or crowns making choosing extraction around half as likely. The likelihood ratio of Chi^2 indicated that the model was significant, but the pseudo R^2 of 0.098 indicated a relatively poor fit. All other demographic and dental factors that are reported in Tables 2 and 3 including income were not statistically significant but large effect sizes were seen for some aspects of dental experience (experience of fillings and scale and polish both reducing the risk of choosing extraction). A more limited model, based on stepwise elimination, did not show significant improvements in model parameters but low socio-economic status did become a significant predictor of choosing extraction.

Additionally, a multinomial logistic regression model was developed to explain factors influencing choices of all five potential options (RCT, extraction and gap and the three other extraction and prosthetic replacement choices). In this model (not shown here for simplification), no experience of extractions and experience of crowns and RCT made choosing RCT over extraction and leaving a gap more likely. Having no experience of

extractions increased the likelihood of choosing implant over leaving a gap. Otherwise there were no significant predictors of different choices.

Factors affecting strength of preference (WTP)

The next set of models explains variation in WTP. When analysing WTP across the whole sample, the choice of treatment modality will have an influence on the WTP value and so in order to account for this a 2 part model in necessary with the first part developing a correction factor to take account of the treatment choice which is fed into the second part of the model to correct for treatment choice. A Heckman selection model is therefore used here. The model is given in Table 5, with the first step of the model, shown in the lower half of the table, giving the correction factor which is incorporated into the top half which is the actual model of WTP. This shows high income as the only significant factor increasing WTP with the coefficient indicating that high income increases WTP by over £200, holding all other variables constant.

Tobit models were also constructed for each sub-sample by initial choice, where the size of the sub-sample was sufficient. Again, the likelihood ratio of Chi^2 indicated that models were significant, but the pseudo R^2 indicated a poor fit. Bearing this poor fit in mind, the model of WTP for RCT (n=259) shows significant factors of being female and high income increasing WTP and previous experience of extraction decreasing WTP. The model of WTP for extract and leave a gap (n=88) showed no significant variables and WTP was therefore assumed to be entirely unpredictable based on the variables measured. The model of WTP for extract and implant (n=85) shows that only high income increased WTP.

Discussion

The aim of this study was to explore the factors influencing the direction and strength of preference (in terms of WTP) of dental patients in the treatment decisions for an asymptomatic molar tooth with a non-vital pulp. In total, 503 patients were interviewed and asked for their preferred treatment option in the scenario outlined and then asked their maximum WTP to secure this treatment option.

The study is one of the most comprehensive elicitations of WTP for dental interventions in the literature to date and adds to the literature by exploring an extensive range of demographic and dental influences on WTP. In general, both preference and WTP for the different treatment options were highly variable and unpredictable.

The aim of the study was not to elicit absolute WTP values for a representative sample but to investigate factors affecting WTP and so the sample needed to be sufficiently diverse to allow multivariate analysis. This was achieved but in addition, the sample was fairly representative of the local population, although the absolute values should still be interpreted with caution. The sampling frame, being dental attenders only, and the non-responders may have biased the response even when looking at the multi-variate analysis but given the high variance and unpredictable nature of the WTP values, this is unlikely to have had any major effect on the results. Additionally, given the significant personal financial contributions of patients in NHS dentistry, from a policy maker's viewpoint there is a greater justification for eliciting views from those that actually access dental services.

It would have also been possible to weight the data to correct for the representativeness and should the values be used in policy making, this would be a valuable step. In particular, given the potential link with ability to pay (or income) and WTP, it has been suggested that weighting should be undertaken to positively discriminate towards the values of those with lower income (Donaldson 1999). As expected, income was positively correlated with WTP but the relationship was not strong and so did not merit additional weighting.

Where multiple options are being considered, it has been proposed that "WTP for each" or marginal approaches would yield more useful and robust information (Donaldson 2001). However, in the context of this study, the most likely use of such values is by policy makers faced with a choice of what to fund or specifically in the NHS in the UK, which treatments to offer on a subsidised basis. In this case, a cost-benefit analysis of the treatment options could be undertaken in which it would be necessary to know what value is attached by the gainers (i.e. those who prefer the chosen option) to their gains and by the losers (i.e. those who prefer an excluded option) to their losses. In the context of this study then, there was a need to elicit who prefers what, and what their WTP was for this preferred option.

Results relating to direction of preference show that around half of the participants would have chosen to save the tooth, and that when people selected to have the tooth extracted the most preferred options were to leave a gap or have an implant. The factors influencing these choices were mostly related to previous experience implying that people's preferences remain relatively constant over time. It is likely that they would use past decisions as their frame of reference in this hypothetical scenario, although it should be borne in mind that previous supply factors may have limited that previous experience. Interestingly,

preferences appeared to be highly personal and demographic factors did not appear to influence direction of preference to any great degree.

In terms of strength of preference, it is interesting to note that the mean values for RCT, fixed partial denture and implant were broadly similar with leaving a gap and a removable denture much lower. In terms of the final outcome, the latter three options are all similar resulting in a fixed tooth (natural or prosthetic) and this suggests that the resultant health state rather than the health care (or process) itself is being valued. The mean values were of the same order of magnitude as the NHS prices at the time of the study. The exception was for implants, which are not generally available on the NHS and where the value was at variance to the market (local private) price for a single implant of approximately £1500 (at the time of the study). Although private price data was not sought at the time of the study for the other options, it is likely that these would be significantly higher than the NHS prices and so WTP values would also be at variance with these.

The presence of "anchors" has been found to be important in influencing WTP values (Kahneman et al. 1999) and the NHS values may be acting as anchors here. However, the large variance exhibited casts some doubt over the importance of these anchors. The scenario presented to the patient did not specify how the patient was paying (i.e. NHS or privately) but did encourage participants to think in terms of value rather than price. It is likely that patients considered the value in terms of their usual system, and, although the majority of the participants were NHS payers, there is no evidence that usual system systematically influenced WTP. One question of interest for potential further research is whether there is a difference between what participants are willing to pay for NHS and private treatments. In theory, participants should be giving the total value of any treatments. However, there is a possibility that they are giving the value at the "subsidised" NHS rate. This has important implications for the users of such data as resource allocation decisions may differ if a "subsidised" value is given but used as a complete value.

Despite all of this, the most notable feature of the strength of preference data is the substantial variance in the valuations. The factors affecting the valuations showed few predictors that were significant, again reflecting the highly individual nature of the valuations. The factors that are not significant or excluded from the model are again interesting as many would be expected to influence the valuation, in particular low income (which was not significant in any model in contrast to high income). This may suggest that it is the amount of disposable income that is important in determining choice as has been found elsewhere (Bhatti et al. 2007). These findings contrast with those of others who found demand for

dental services was influenced by both changes in dental attendance (Nguyen et al. 2005) and number of teeth (Grytten 1990) and that WTP for implants was influenced by education (not found to be a factor in this study) as well as gender and income (which had limited influence in this study) (Leung & McGrath 2010).

The overall results illustrate a fundamental concept; that the sample, as a whole, expressed preference for all of the treatment options, but in ways which are extremely difficult to predict. In terms of policy, this leaves difficult questions. Normally, the costs of the options would be weighed against the valuations (including the loss for those who value an alternative) in order to decide which treatment(s) to fund. However, given the varied and unpredictable of direction and strength of preference, what resource allocation decisions should be taken based on the valuations elicited? If valuations had a small confidence interval around the mean, the mean or median value could be used confidently to make allocative decisions. However, here, the variance is very large. In a taxation based system, all participants are paying into the system and so someone with a low valuation may regard it as unfair if individuals with a high valuation are catered for. Similarly, if a system is designed to cater for those with a low valuation (by providing low levels of treatment), the individual with a high valuation may see this as unfair, as their legitimate demands are not being catered for. However, the decisions still need to be made and it may be that using a median value is the only way of reaching a societal decision. Insurance based systems may be able to address this to some degree by utilising different premiums, but the complexity of the decision making process still makes this problematic and potentially unfair. The equity issues of any decision taken would have to be considered carefully (Donaldson & Gerard 2005). Even if the values were deemed impractical to use in an absolute sense, they may be useful in a more qualitiative way in informing decisions.

The unpredictable variation is also important for individual dentist, reinforcing the need to avoid making any assumptions about patient preferences and values when making decisions.

The potential to elicit WTP values for dental interventions has been demonstrated and the use of these valuations has been outlined. Future research could, then, elicit WTP for a representative population and investigate how these could be used with policy makers. There is also a need to investigate the influence of potential anchors and how usual payment vehicle affects valuation in systems with a patient co-payment.

Conclusions

Willingness to Pay can be used for valuing treatment options for a molar tooth with a non-vital pulp, and the data can be potentially useful for both policy makers and dentists working with their patients. For policy makers, there is a potential conflict to address between demand (in terms of the valuations elicited) and equity as well as between demand and affordability. The variation in valuations makes addressing such problems even more difficult. Ideally, such values should be used alongside other economic tools to inform these difficult decisions.

For dentists, it is important to remember that patients' choices and valuations are unpredictable. Therefore to engage in fully shared decision making dentists need to try to avoid pre-judging patients and enter into dialogue concerning these aspects of treatment planning.

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References

Augusti D, Augusti G, Re D (2013) Prosthetic restoration in the single-tooth gap: patient preferences and analysis of the WTP index. *Clinical Oral Implants Research* **0,** 1-8.

Bhatti T, Rana Z, Grootendorst P (2007) Dental insurance, income and the use of dental care in Canada. *Journal of the Canadian Dental Association* **73,** 57.

Birch S, Ismail AI (2002) Patient preferences and the measurement of utilities in the evaluation of dental technologies. *Journal of Dental Research* **81,** 446-50.

Bryan S, Jowett S (2010) Hypothetical versus real preferences: results from an opportunistic field experiment. *Health Economics* **19,** 1502-9.

Charles C, Gafni A, Whelan T (1999) Decision-making in the physician-patient encounter: revisiting the shared treatment decision-making model. *Social Science & Medicine* **49,** 651-61.

Department for Work and Pensions (2008) Family Resources Survey. Colchester, Essex: National Centre for Social Research and Office for National Statistics. .

Donaldson C (1999) Valuing the benefits of publicly-provided health care: does 'ability to pay' preclude the use of 'willingness to pay'? *Social Science and Medicine* **49,** 551-63.

Donaldson C (2001) Eliciting patients' values by use of 'willingness to pay': letting the theory drive the method. *Health Expectations* **4,** 180-8.

Donaldson C, Gerard K (2005) *Economics of health care financing : the visible hand*, 2nd edn; New York: Palgrave Macmillan.

Donaldson C, Mason H, Shackley P (2006) Contingent valuation in health care. In: Jones A, ed. *The Elgar companion to Health Economics*. Cheltenham: Elgar.

Esfandiari S, Lund JP, Penrod JR, Savard A, Mark Thomason J, Feine JS (2009) Implant overdentures for edentulous elders: study of patient preference. *Gerodontology* **26,** 3-10.

Felton DA (2005) Implant or root canal therapy: a prosthodontist's view. *Journal of Esthetic and Restorative Dentistry* **17,** 197-9.

Grytten J (1990) How age influences expenditure for dental services in Norway. *Community Dentistry and Oral Epidemiology* **18,** 225-9.

Gujarati D (2003) *Basic econometrics*, 4th ed., International ed. edn; Boston: McGraw-Hill.

Halstead JM, Lindsay BE, Brown CM (1991) Use of the Tobit-Model in Contingent Valuation - Experimental-Evidence from the Pemigewasset Wilderness Area. *Journal of Environmental Management* **33,** 79-89.

Heckman JJ (1979) Sample Selection Bias as a Specification Error. *Econometrica* **47,** 153-61.

Kahneman D, Ritov I, Schkade D (1999) Economic preferences or attitude expressions? An analysis of dollar responses to public issues. *Journal of Risk and Uncertainty* **19,** 203-35.

Kelly M, Steele J, Nuttall N *et al.* (2000) Adult Dental Health Survey: Oral Health in the United Kingdom 1998. London: The Stationery Office.

Kennedy CA (2002) Revealed preference valuation compared to contingent valuation: radon-induced lung cancer prevention. *Health Economics* **11,** 585-98.

Kim SG, Solomon C (2011) Cost-effectiveness of Endodontic Molar Retreatment Compared with Fixed Partial Dentures and Single-tooth Implant Alternatives. *Journal of Endodontics* **37,** 321-5.

Leung KCM, McGrath CPJ (2010) Willingness to pay for implant therapy: a study of patient preference. *Clinical Oral Implants Research* **21,** 789-93.

Matthews DC, Gafni A, Birch S (1999) Preference based measurements in dentistry: a review of the literature and recommendations for research. *Community Dental Health* **16,** 5-11.

Murphy JJ, Allen PG, Stevens TH, Weatherhead D (2005) A meta-analysis of hypothetical bias in stated preference valuation. *Environmental & Resource Economics* **30,** 313-25.

Nguyen L, Hakkinen U, Rosenqvist G (2005) Determinants of dental service utilization among adults--the case of Finland. *Health Care Management Science* **8,** 335-45.

Office for National Statistics (2001) 2001 Census: Standard Area Statistics (England and Wales). Manchester: ESRC/JISC Census Programme, Census Dissemination Unit, Mimas (University of Manchester).

Office for National Statistics (2009) Harmonisation [WWW document]. URL http://www.ons.gov.uk/about-statistics/harmonisation/index.html [accessed on 10th December 2009].

Peduzzi P, Concato J, Kemper E, Holford TR, Feinstein AR (1996) A simulation study of the number of events per variable in logistic regression analysis. *Journal of Clinical Epidemiology* **49,** 1373-9.

Pennington M, Vernazza CR, Shackley P, Armstrong NT, Whitworth JM, Steele JG (2009) Evaluation of the cost-effectiveness of root canal treatment using conventional approaches versus replacement with an implant. *International Endodontic Journal* **42** 874-83.

Ryan M, Scott DA, Donaldson C (2004) Valuing health care using willingness to pay: a comparison of the payment card and dichotomous choice methods. *Journal of Health Economics* **23,** 237-58.

Shackley P, Donaldson C (2000) Willingness to pay for publicly-financed health care: how should we use the numbers? *Applied Economics* **32,** 2015-21.

Smith RD (2006) It's not just what you do, it's the way that you do it: the effect of different payment card formats and survey administration on willingness to pay for health gain. *Health Economics* **15,** 281-93.

The NHS Information Centre (2010) Adult Dental Health Survey 2009 – First Release. 1 edn. London: The NHS Information Centre.

Vernazza C, Heasman P, Gaunt F, Pennington M (2012) How to measure the cost-effectiveness of periodontal treatments. *Periodontology 2000* **60,** 138-46.

Zitzmann NU, Krastl G, Hecker H, Walter C, Weiger R (2009) Endodontics or implants? A review of decisive criteria and guidelines for single tooth restorations and full arch reconstructions. *International Endodontic Journal* **42,** 757-74.

		Number in sample	Percent of whole sample (n=503)	Percent of NE population
Gender	Male	227	45	48
	Female	276	55	52
Age (years)	16-24	45	9	16
	25-34	73	15	31
	35-44	84	17	
	45-54	115	23	33
	55-64	97	19	
	65-74	61	12	15†
	75+	28	6	6†
Weekly gross household income	£0-£99	36	7	2
	£100-£199	88	18	15
	£200-£299	92	19	18
	£300-£399	47	10	14
	£400-£499	47	10	11
	£500-£599	39	8	7
	£600-£699	41	8	8
	£700-£999	43	9	13
	£1000+	52	11	12
	No response	18	4	0
Highest qualification gained (equivalent)	None/Unsure	156	31	42
	GCSE (D-G)	32	6	17
	GCSE (A-C)	125	25	19
	A level	69	14	7

	1st Degree	76	15	15
	Higher Degree	43	9	
	No response	2	<1	0
Socio-	1 (highest)	177	35	21
economic	2	58	12	9
grouping	3	34	7	5
(NS-SEC*)	4	82	16	8
	5	139	28	24
	Not classified	13	3	31

Table 1 Demographic details of sample and comparison to North East England (NE) population levels (Office for National Statistics 2001, Department for Work and Pensions 2008) *NS-SEC = National Statistics Socio-economic Classification (Office for National Statistics 2009) † age band boundary in population data is 79 giving bands of 66-79 and 80+

			Number in sample	Percent of sample	Percent of NE England population
Frequency of visits to dentist		Regular	377	75	61
		Occasional	48	10	10
		Only when having trouble	78	16	27
Usual method of paying for dentistry		NHS payer	318	63	N/A
		Private fee per item	13	3	
		NHS exempt	166	33	
		Private insurance	6	1	
Most recent dental pain experience		Never experienced	144	29	N/A
		Longer than 2 years ago	185	37	
		6 months to 2 years ago	60	12	
		In last 6 months	64	13	
		Currently in pain	50	10	
Teeth remaining		Fewer than 10	30	6	14
		10-19	110	20	
		20 or more	372	74	86
Last experience of:	Crowns	In last 2 years	61	12	25
		2 or more years ago	163	32	
		Never	279	55	75
	Bridges	In last 2 years	18	4	5
		2 or more years ago	33	7	

	Never	452	90	95
Root canal treatment	In last 2 years	34	7	N/A
	2 or more years ago	115	23	
	Never	354	70	
Extractions	In last 2 years	149	30	87
	2 or more years ago	269	53	
	Never	85	17	13
Dentures	In last 2 years	59	12	N/A
	2 or more years ago	54	11	
	Never	390	78	

Table 2 Dental characteristics of sample compared to NE England population (Kelly et al. 2000, The NHS Information Centre 2010) N/A = Not available

Initial choice	**Prosthetic replacement**	**Proportion (%)**	**Mean (SD) WTP (£)**
Save tooth (RCT + crown)	N/A	53	372.79 (991.46)
Extract tooth	None (leave gap)	19	97.86 (108.61)
	Removable denture	3	252.50 (415.13)
	Fixed partial denture	8	405.63 (633.03)
	Implant	17	422.85 (428.75)

Table 3 Mean WTP values with standard deviation (SD) by initial preference

Predictor	Odds Ratio	p	Confidence Interval
Experience of fillings (Ref no experience)	0.48	0.200	0.16 – 1.47
Experience of scale and polish (Ref no experience)	0.64	0.247	0.31 – 1.36
Experience of root canal treatment (Ref no experience)	0.59	0.025	0.37 – 0.94
Experience of extractions (Ref no experience)	3.22	0.000	1.78 – 5.86
Experience of crowns (Ref no experience)	0.49	0.001	0.32 – 0.75
Experience of dentures (Ref no experience)	1.38	0.252	0.80 – 2.39
Female (Ref male)	0.91	0.662	0.61 – 1.37
Low income (Ref medium/high income)	1.09	0.748	0.63 – 1.89
High income (Ref low/medium income)	0.68	0.195	0.38 – 1.22
Low educational qualification (Ref medium/high)	1.25	0.370	0.77 – 2.01
Low socio-economic status (Ref medium/high)	1.54	0.055	0.99 – 2.40
Regular dental attender (Ref irregular or only in pain)	0.98	0.940	0.59 – 1.63
Exempt from NHS charges Ref pays NHS charges/private fees/insurance)	0.68	0.162	0.40 – 1.17
20 or more teeth (Ref less than 20)	1.38	0.259	0.79 – 2.41
In dental pain (Ref never or previously experienced)	1.36	0.371	0.69 – 2.68
Younger than 35 years (Ref 35 and older)	1.16	0.601	0.66 – 2.06
Older than 64 years (Ref 64 and younger)	0.83	0.528	0.46 – 1.49
Lowest 2 deprivation quintiles (i.e. least deprived) (Ref highest 3)	0.68	0.173	0.40 – 1.18
Highest 2 deprivation quintiles (i.e. most deprived) (Ref lowest 3)	0.86	0.586	0.50 – 1.48

Constant	1.23	0.803	0.24 – 6.29

Table 4 Logistic regression model of initial choice for extraction (versus saving tooth) (Ref = reference level) (n = 483, LR chi^2 = 65.60 (p<0.0000), McFadden's pseudo R^2 = 0.098)

Predictor	Coef.	p	95% confidence interval
Regression model for WTP including selection correction			
Low income (Ref middle and high income)	-37.56	0.539	-157.33 – 82.22
High income (Ref low and middle income)	213.56	0.007	59.33 – 367.80
Experience of extraction (Ref no experience)	75.27	0.406	-102.31 – 252.84
Constant	76.63	0.609	-217.30– 370.57
Probit selection model for extraction versus saving tooth			
Low Socio Economic Status (Ref mid & high Socio-economic status)	0.39	0.001	0.15 – 0.62
Experience of crown (Ref no experience)	-0.45	0.000	-0.70 – -0.20
Experience of RCT (Ref no experience)	-0.37	0.008	-0.64 – -0.096
Experience of extraction (Ref no experience)	0.65	0.000	0.33 – 0.97
Constant	-0.52	0.002	-0.84 – -0.20
Mills Lambda	148.10	0.224	-90.36 – 386.55
Rho	0.357		
Sigma	415.25		

Table 5 Heckman selection model of WTP to deal with problem (whole sample) (Ref = reference level) (n=491, Wald chi^2=10.04 ($p<0.05$))

Figure Legends

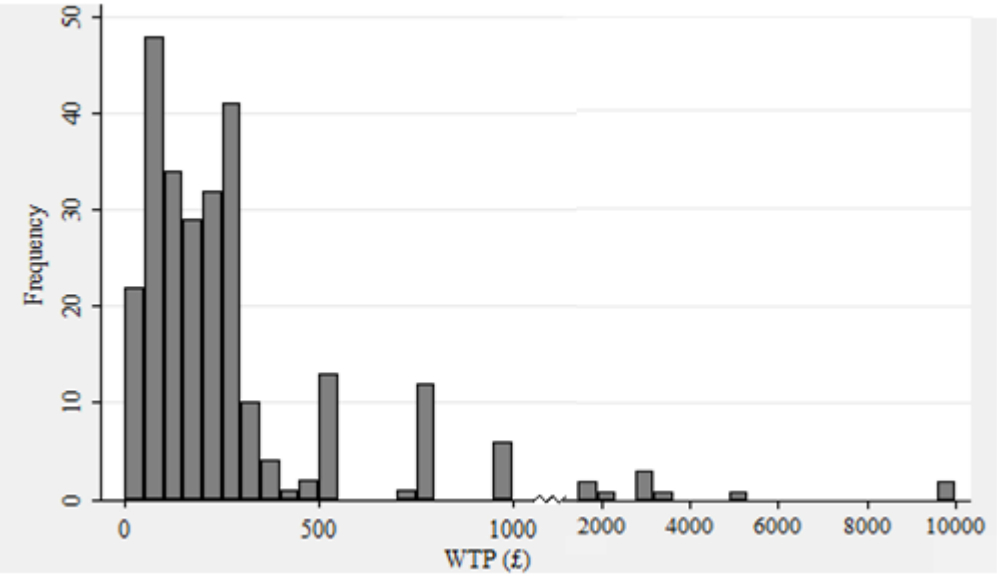

Figure 1 Frequency distribution plot of WTP values for those whose initial preference was RCT (N.B. Broken x axis)