USING CONSUMER PREFERENCES IN HEALTH CARE DECISION MAKING

The application of conjoint analysis

Mandy Ryan PhD (Economics)

OHE

Office of Health Economics
12 Whitehall London SW1A 2DY

Printed in England by White Crescent Press Ltd, Luton

Foreword

The idea that clients or users of public services might legitimately have opinions about how they should be delivered is a relatively new one in the United Kingdom, where producers' views have dominated decisions about how things should be done. This tendency can be observed not only in health care, but also in other public services such as education, the provision of social security benefits, policing, and the criminal justice system. Such neglect of users' views is predictable where services are provided (often for excellent reasons) in a non-market context. Compare, for example, the careful way in which private hospitals question their patients on the quality of service they have received with the lack of interest (until recently) in such matters on the part of many National Health Service providers.

Clearly there are many aspects of health care, as well as of education and other public services, where the users lack the knowledge to determine the substance of the service they receive. Patients are not always well placed to determine the form of medical intervention which best meets their medical condition. But a variety of other attributes of health care, especially those which deal more with quality of delivery, are susceptible to judgements on the part of customers or users, who in this respect have a good claim to be the experts. Dr. Ryan's paper provides a comprehensive and valuable review of one particularly promising method for eliciting consumers' preferences and of its application to health care, where she has herself made a major contribution.

The method in question has been employed by market researchers for a number of years under the name of conjoint analysis. Using conjoint analysis, respondents are asked to make hypothetical judgements or to express preferences between hypothetical alternatives. From this it is possible to look at the relative importance of different aspects of the service. Within the public sector, many of the earliest applications can be found in the area of transport, where the technique is often described as a form of 'stated preference' analysis. Use of conjoint analysis can now also be found in the environmental literature. However, to date it has only had limited use in health care.

Conjoint analysis is subject to a number of objections, which are reviewed in more detail in the paper. One objection common to many possible areas of application is that respondents may give answers that do not reflect how they would actually behave if faced with the same decisions. A second objection is that if price is included as an attribute to be traded off, then supporters of free health care may be uncomfortable about the implications of the analysis. In other areas than health, these and other issues have been investigated, with generally favourable conclusions about the value of the information – provided that the studies are properly designed. These advantages led a research group at Brunel University, in a study funded by HM Treasury, to conclude that the stated preference approach had great potential for valuing quality changes throughout the public sector, and should be widely trialled (Cave et al, 1994).

The study noted that an attraction of conjoint analysis is that the metric which it employs to value the attributes of health or other services need not be a monetary one. Exercises require respondents to express preferences among alternative bundles of service characteristics, which may or may not include price. The procedure shows the rates at which users trade-off one attribute against another – for example, two separate attributes of quality or an attribute of quality and the quantity supplied. Avoiding the use of price as an attribute has the disadvantage that the results require more elaborate interpretation, but it has advantages as well. For example, many public sector managers operate within fixed cash limits, and since they cannot expand their budgets, willingness to pay data are of little direct interest to them. But information about trade-offs may be directly applicable in decision making.

Early indications suggest that conjoint analysis is a very promising approach to eliciting consumers' preferences and I reiterate the Brunel study conclusion that it is 'the one most likely to yield fruitful results in the valuation of quality of delivery in the public services' (Cave et al, 1994). It appears to offer the best method yet available of answering the perennial question: how can we get user valuations of public services where, because of the nature of the services, we may not want users to pay for them? Dr. Ryan's review shows that it is possible to apply conjoint analysis to problems in health care. In health care little is currently known about consumers' preferences. If successfully applied conjoint analysis will provide a way of incorporating users' views into NHS decision making.

Martin Cave
Brunel University

Reference

Cave et al (1994)
The Valuation of Changes in Quality in the Public Services: Report prepared for HM Treasury by Brunel University. HMSO.

Office of Health Economics

The Office of Health Economics was founded in 1962 by the Association of the British Pharmaceutical Industry. Its terms of reference are:

To undertake research on the economic aspects of medical care.

To investigate other health and social problems.

To collect data from other countries.

To publish results, data and conclusions relevant to the above.

The Office of Health Economics welcomes financial support and discussions on research problems with any persons or bodies interested in its work.

About the Author

Dr Many Ryan is a research fellow at the Health Economics Research Unit, University of Aberdeen. She holds a first degree in economics from the University of Leicester, an MSc in Health Economics from the University of York and a PhD in Economics from the University of Aberdeen. She is currently looking at the development and application of conjoint analysis and contingent valuation to health care interventions.

Contents

Summary

Limited resources coupled with unlimited demand for health care means that decisions have to be made regarding the allocation of scarce resources across competing health care interventions. The NHS Management Executive, with the publication of its document Local Voices, has stimulated purchasers to take account of the wants of local people when setting health care priorities. Current techniques for eliciting community preferences, such as opinion polls and satisfaction type studies, are criticised in this report for failing to provide purchasers and providers with useful information that can be used in a policy context. Following this, the technique of conjoint analysis is proposed as a useful instrument for eliciting community values. This technique allows estimation of the relative importance of different attributes (that is characteristics or features) in the provision of a good or service, the trade-offs between these attributes and, thereafter, the total satisfaction or utility an individual derives from a good or service with a given set of attributes. This technique is described in this report, and case studies are provided showing how the technique can be used by policy makers to obtain community preferences in a manner that is useful for decision making. These case studies show that it is possible to apply conjoint analysis to problems in health care. It is concluded that conjoint analysis could be successfully used by health care purchasers and providers as a way of incorporating community values into their decision making.

I. Introduction

Limited resources coupled with unlimited demand for health care means that decisions have to be made regarding the allocation of scarce resources across competing health care interventions. Traditionally, the extent of consumer (patient) involvement in this decision making process has been minimal. However, with the advent of the recent reforms of the National Health Service (NHS), greater consumer involvement has been advocated (HMSO, 1989a; HMSO, 1989b; HMSO, 1991; NHSME, 1992). This raises the question of what methods should be used to elicit consumer preferences. The technique chosen should be able to establish which factors are important to consumers in the provision of health care and the degree of importance which consumers attach to those factors. Whilst there has traditionally been an assumption in the health economics literature that clinical outcomes are all that are important to consumers (as is evidenced by the debates that have taken place around Quality Adjusted Life Years (QALYs)), research from the health services literature (Hall and Dornan, 1988), and more recently the health economics literature (Mooney, 1994; Mooney and Lange, 1993; Ryan, 1995), show quite clearly the importance of 'process attributes' i.e. aspects of the way in which services are provided such as waiting time and location of treatment and non-health outcomes such as the provision of information and reassurance. Techniques to assess patient preferences, therefore, need to establish:

- preferences with regard to 'process attributes' and non-health outcomes e.g. how consumers trade-off such attributes as convenience of a clinic versus waiting time, and the value of providing information or reducing waiting times
- preferences for health outcomes
- the trade-offs that individuals make between process attributes, non-health outcomes and health outcomes.

To date, attempts by purchasers to establish consumer preferences in health care have taken the form mainly of opinion polls and satisfaction type studies (Hall and Dornan, 1988; HMSO, 1992; Bowling *et al*, 1993; Groves, 1993; Heyden, 1993). This report begins by criticising these approaches for failing to provide purchasers with information on which they can actually make decisions. From these criticisms the desired characteristics of an instrument designed to elicit individual values are derived. Following this, consideration is given to economic techniques for eliciting consumer preferences. Attention is first focused on current economic methods of eliciting consumer preferences and, following this, the technique of conjoint analysis is introduced as a method for eliciting consumer preferences. Whilst this technique has been widely used in transport economics, and is gaining support in the environmental economics literature, to date its application to health care issues by health economists is limited. The technique is first described in detail and its relative advantages over more traditional economic approaches considered. Following this case studies are provided to show how the technique can be used in a policy context. Finally, conclusions are drawn regarding the potential application of conjoint analysis for eliciting community values in the provision of health care.

2. Current non-economic approaches for eliciting consumer preferences

2.1 Opinion polls

Opinion polls have been used by purchasers to elicit consumer preferences (Groves, 1993; Bowling *et al*, 1993). Using opinion polls, respondents are asked to rank given health service interventions in order of priority for spending. Mean rankings for the health care interventions can then be estimated. For example, the study reported on by Groves (1993) asked a sample of 265 managers from purchaser and provider organisations, 800 doctors representing the national distribution of specialties, including general practitioners, and 2,012 members of the public to rank ten health service interventions in order of priority for spending. The mean rankings from this study are shown in Table 1.

Table 1 Results of the BMA Survey

Treatment	*Public*	*Doctors*	*Managers*
Childhood immunisation	1	1	1
GP care for everyday illness	2	2	2
Screening for breast cancer	3	7	5
Intensive care for premature babies	4	8	8
Heart transplant operations	5	9	9
Support for carers of elderly people	6	4	4
Hip replacements for elderly people	7	5	6
Anti-smoking education for children	8	3	3
Treatment for schizophrenia	9	6	7
Cancer treatment for smokers	10	10	10

Whilst the information collected from opinions polls has the advantage that it is relatively quick and easy to obtain, such studies have their limitations for purchasers wanting to make decisions regarding the allocation of scarce health care resources. For example, consumers may not be well informed when responding to opinion polls. It is impossible to tell how well informed consumers are. Thus elicited preferences may not reflect the true characteristics of the health care interventions covered but misconceptions about, say, survival rates or aspects of the health care interventions more generally.

Secondly, even if individuals were well informed about alternative health care interventions, the results of the survey indicate only the direction of people's preferences and not their strength of preference. That is, such surveys do not distinguish between someone who has a weak preference for childhood immunisation over GP care for everyday illness, say, and someone who has a strong preference over the same two interventions.

Third, the results provide little help in addressing policy questions, with the choices offered being so broad as to be meaningless. Assuming a low rank reflects a candidate for reduction (and this is by no means obvious) then if cancer treatment for smokers were to be reduced would this apply solely to cancers directly related to smoking, such as lung cancer, or would it also apply to cancers not normally caused by smoking? The survey also fails to address the issue of whether there are net costs associated with reduction or expansion. For example, if cancer treatment for smokers were reduced would more resources need to be devoted to palliative and terminal care for smokers? These, and other related issues, are not addressed by the results, thus rendering them virtually useless to policy makers for the purpose of priority setting.

Fourth, the results of opinion poll surveys do not address the real life situation facing purchasers. Health boards/authorities are faced with an existing mix of expenditure on health care services and have to make decisions on how much more to spend on some types of care and how much less to spend on others. It is *marginal* choices (i.e. changes) such as these that community values should address. For instance, opinion polls do not give any indication of how much more (if anything) should be spent on childhood immunisations, or from which programme the funds should come.

Fifth, related to the above point, and arguably most important, there is no concept of scarcity and the need to make sacrifices in the ranking process. Asking people simply to rank interventions in order of priority for spending is a reasonable starting point, but it is somewhat unrealistic in that no resource constraints are imposed. Obviously, in setting priorities, the purchasing authority is constrained by limited resources. Every purchasing decision involves some notion of sacrifice – in the language of economics, there is an *opportunity cost*. In order to reflect more fully the situation facing purchasing authorities, the elicitation of community values needs to incorporate the concepts of scarcity and opportunity cost, i.e. decision making under resource constraints.

2.2 Patient satisfaction surveys

Another method that is currently used to elicit consumer preferences is satisfaction surveys (Hall and Dornan, 1988; HMSO, 1991; Heyden, 1993). The main advantage of such studies is that they provide information on what is important to consumers in the provision of health care, and how satisfied they are with such factors. However, satisfaction surveys have similar problems to opinions polls. That is, they ignore crucial issues such as the intensity of consumers' preferences for the various factors that are identified as important in the satisfaction studies; they provide little help in addressing policy questions; the results of such surveys do not address the real decision-making issues that policy makers face, e.g. by how much should waiting times be reduced and; again, arguably the most important limitation, they incorporate no concept of opportunity cost. Asking people to simply state their level of satisfaction ignores scarcity of resources. Given limited resources and the fact that individuals prefer optimal levels of all factors important to them in the provision of health services, preferred levels of all factors cannot be provided. The important policy question then becomes what are the relative weights of the dimensions of satisfaction identified as important, and how do individuals trade off these dimensions?

2.3 Desired characteristics of an instrument to elicit community values

Summarising the above arguments in favour of going beyond opinion polls and satisfaction types surveys, exercises in eliciting community values should have the following characteristics if they are going to be useful in setting priorities in health care:

- they should provide information on attributes of the service, i.e. process attributes, non-health outcomes and health outcomes;
- they should provide information which reflects people's intensity of preference;
- they should address specific choices reflecting local health board/authority problems;
- values should be elicited in the correct marginal context, i.e. the scale of change should be realistic;
- the questions should incorporate the notion of sacrifice.

3. Economic techniques for eliciting consumer preferences

3.1 Current economic methods for eliciting consumer preferences

In health economics four methods have been commonly used to elicit patient preferences: visual analogue; standard gamble; time-trade off and willingness to pay. The first three have been used within the Quality Adjusted Life Year (QALY) framework. Using QALYs, expected life years gained from given health care interventions are estimated (usually by health care professionals) and combined with information on the quality of these life years (via the estimation of utilities) to obtain QALYs. For example, if a health care intervention results in a health state with a utility score of 0.85, and the individual would be in this health state for the remainder of life, say 10 years, then the number of QALYs would be 8.5. These QALYs gained from one health care intervention may be compared with QALYs obtained from alternative health care interventions, as well as from doing nothing.

Using visual analogue to estimate utilities within the QALY framework, individuals are presented with possible health state scenarios and asked to place them along a physical line such that their placing reflects their ranking and preferences for the scenarios. Zero is usually taken to be the worst health state and 1 the best. The utility score is taken as the point at which the outcome is placed on the line (Nord, 1991). With the standard gamble approach, individuals are presented with a number of paired comparisons in which they must choose between a certain outcome or a gamble which may result in either a better outcome than the certain outcome (with a probability of p) or a worse outcome than the certain outcome (with a probability of 1-p). The certain outcome is always intermediate in the sense that the better outcome is always preferred to it and the worse is less preferred to it. The probability of the best outcome is varied until the individual is indifferent between the certain outcome and the gamble (McNeil *et al*, 1978; McNeil *et al*, 1981). This probability is the utility score for the certain outcome. This technique is then repeated for all intermediate outcomes for which a utility score is required. In response to known difficulties of carrying out standard gamble exercises, the time trade-off technique was developed as a method for estimating utilities (Torrance *et al*, 1972). This approach involves presenting individuals with a paired comparison between living for a period t in a specified but less than perfect state (which is the state being valued) versus having a healthier life for a time h, which is less than t. Time h is varied until the respondent is indifferent between the alternatives. The utility score given to the less than perfect state is then h/t.

Willingness to pay is used to estimate utility in monetary terms. Economic theory argues that the maximum amount of money an individual is willing to pay for a commodity is an indicator of the utility or satisfaction to her of that commodity: The most obvious market where willingness to pay behaviour is revealed is in auctions. Here individuals are pushed to consider the maximum amount of money they are willing to pay for a given commodity with given attributes. If the auction bid exceeds their maximum willingness to pay they will drop out. When deciding on this, they will take account of the characteristics of the commodity that are important to them. For example, in a housing auction the individual will consider such attributes or characteristics as number of rooms, location, whether centrally heated, whether double glazed and house type. Similarly in a car auction individuals will consider such characteristics as model, engine size, colour and seating capacity when considering their maximum willingness to pay.

Most markets are not characterised by auctions. Instead individuals are presented with a given price, over which they have no influence, and faced with a 'take it or leave it' choice. In such a market revealed behaviour provides some information about utility derived, though not necessarily maximum willingness to pay. Occasionally the market may be characterised by a bidding type procedure between the buyer and seller. Again behaviour reveals some information about utilities, though not necessarily maximum willingness to pay.

Some commodities are not marketed, and therefore do not have an explicit money value in exchange. Health care is an example of such a good. Economists have used studies which introduce hypothetical markets to attempt to establish the value of non-marketed commodities. Such surveys are commonly called contingent valuation surveys. Within health economics, the methods most commonly used to establish maximum willingness to pay from hypothetical data are the open ended and the payment card technique. With the former technique respondents are asked directly what is the maximum amount of money they are prepared to pay for a commodity. In the case of the payment card technique, respondents are presented with a range of bids and asked to circle the amount which represents the amount they would be willing to pay. (For a review of the application of the willingness to pay technique in health care see Donaldson (1993)).

3.2 Conjoint analysis as a method for eliciting consumer preferences

A technique widely used in the transport economics literature to assess utility, and increasingly being used in environmental economics, is conjoint analysis. However, to date it has not been used widely by health economists (although it has been more widely used in the area of health care by non-economists). Conjoint analysis is a technique for establishing the relative importance of different attributes (that is, characteristics or features) in the provision of a good or a service. It assumes that any service can be defined as a combination of levels of a given set of attributes. The total satisfaction or utility that an individual derives from that good or service is thereby determined by the utility to the individual of each of the attributes. The aim of the conjoint analysis technique is to estimate, (i) the relative importance of the individual attributes; (ii) the trade-offs or marginal rates of substitution that individuals are willing to make between these attributes and (iii) the total satisfaction or utility scores for different combinations of attributes.

There are five stages in the design of a conjoint analysis study. These are described briefly here. Readers wanting more detail should see Appendix 1.

Stage 1: Establishing the attributes – The key features or characteristics of the service or good are identified. This can be done using literature reviews, group discussions, and individual interviews. Alternatively, a pre-defined policy question may determine the attributes.

Stage 2: Assigning levels to the attributes – Levels must be assigned to attributes. The levels must be plausible, actionable and capable of being traded-off.

Stage 3: Which scenarios to present – Individuals are then presented with hypothetical scenarios which combine different levels of attributes. The number of possible scenarios increases as the number of attributes and levels increases. Various methods can be used to reduce the number of scenarios for inclusion in the questionnaire.

Stage 4: Establishing preferences – Preferences for scenarios are obtained by surveying patients/service users/members of the community. The questionnaire design will use one of three methods: ranking; rating; or discrete choices between scenarios.

Stage 5: Analysis of data – This involves estimating a utility or satisfaction function which specifies the relationship between the service attributes and preferences using regression analysis. From the coefficients it is possible to identify whether the attribute influences the preferences for the particular good or service, the relative importance of individual attributes, the trade-offs or marginal rates of substitution between these attributes and the overall utility from a scenario (i.e. combinations of attributes).

3.3 Criteria for assessing the use of conjoint analysis to elicit community values

In this section consideration is given to the following criteria for assessing the use of conjoint analysis for assessing community values: whether the technique has the desired characteristics of an instrument for eliciting community values (as specified in section 2.3); the realism of the questions posed compared to traditional economic techniques used to elicit community values; and its reliability and validity.

Does conjoint analysis have desired characteristics

Conjoint analysis has the desired characteristics of an instrument designed to elicit community values (as specified in section 2.3). That is: information is provided on the attributes or characteristics of the service; estimated utilities reflect people's intensity of preferences; the questions posed in the study can be designed to reflect purchasers problem; and, following on from this, the questions posed are concerned with realistic changes; and finally, when using the discrete choice approach, the questions posed incorporate some notion of sacrifice.

Realism of questions posed

Conjoint analysis, when using the discrete choice approach, may be seen as posing more realistic questions than those posed by the more traditional methods currently used in health economics to elicit community values. For example, individuals are not use to rating goods or services on a visual scale (as required when using visual analogue); to stating their probability indifference level between a gamble and a certain outcome (as required under standard gamble) or to stating how many years of their life they would be willing to give up to achieve something they desire (as required using the time trade-off technique). In contrast, the choices posed by a conjoint analysis discrete choice type question reflect the type of decisions individuals make everyday of their lives. Further, it is becoming clear in health economics that there are attributes that are important to consumers beyond health outcomes: for example, waiting time, convenience and the provision of information (Mooney and Lange, 1993; Mooney; 1994; Ryan 1995). It may be less realistic to use standard gamble to take account of these attributes given that there is no uncertainty attached to them (as opposed to using it to value health outcomes where there is uncertainty attached to the outcome). However, conjoint analysis is easily equipped to take account of non-health attributes. A similar shortcoming may arise with the application of time trade-off to take account of attributes beyond health outcomes, i.e. the idea of giving up life years, days or even minutes for attributes such as information, preferred location or reduced waiting time may appear unrealistic.

Conjoint analysis has the further advantage that if cost is included as an attribute, willingness to pay can be indirectly estimated. Again, the type of question conjoint analysis poses to estimate willingness to pay may be seen to be more realistic than asking individuals directly an open ended or payment card type willingness to pay question. A recent report prepared for the UK Treasury (Cave *et al*, 1993) has recommended the use of conjoint analysis, over direct willingness to pay methods, for the valuation of changes in quality in public services generally. This report was commissioned in the light of the development of the Citizen's Charter. It considered a number of techniques for valuing the quality of public services, including market research techniques, willingness to pay and conjoint analysis. The services included were: acute hospital care, local authority development control, the police service, consultancy schemes operated by the Department of Trade and Industry and the Benefits Agency. For each public service the market research literature was identified to establish the attributes that were important to users in the delivery of the service. Willingness to pay and conjoint analysis were then considered as possible tools for assessing the utility from such attributes. Although no empirical work was carried out for this report, the authors gave considerable attention to the practicalities and potential problems of carrying out willingness to pay and conjoint analysis in each of the above areas. In doing this, contact was made with numerous individuals or groups involved in the provision of the above services.

Regarding health care, or more specifically acute hospital care, the authors conclude that:

> 'in the first instance it would be advisable to establish relative preferences using conjoint analysis, rather than to seek absolute monetary valuations using standard contingent valuation techniques.'

And they continue:

> 'We are convinced that there would be no difficulty in finding hospitals or purchasing authorities wishing to be involved, and see an added bonus in the real possibility that users of private and public health services could be questioned using a common approach to provide comparative data'.

The report concludes more generally that stated preference techniques:

> 'provide the most promising route to deriving clients' or users' valuation of improvements in the quality of delivery of public services, and noted that it is probable that the application of the conjoint analysis method will be subject to fewer biases than direct elicitation of willingness to pay.'

Reliability and validity

Any technique used to elicit community values should be both reliable and valid. Reliability refers to the extent to which the technique reproduces the same results within a given time period. Validity is concerned with the extent to which the instrument measures what it is intended to measure. Three types of validity will be considered: criterion validity; convergent validity and theoretical validity. Criterion validity (or external validity as it is sometimes called) is concerned with whether the technique measures what the researcher is trying to measure. Convergent validity refers to the extent to which the results from conjoint analysis are consistent with the results from other studies using different measurement techniques and theoretical validity the extent to which the results are consistent with economic theory, or sometimes, more generally, a priori expectations. This last form of validity is often referred to as internal validity.

Appendix 2 provides a review of the literature looking at the reliability and validity of conjoint analysis. The conclusion is that there is evidence showing the reliability and validity of this technique. To date, however, most of this has been collected outside the health care market. Tests of reliability and validity need to be employed in health care research if conjoint analysis is to become an accepted instrument for eliciting community values.

4. Examples of applications of conjoint analysis in health care

Appendix 3 provides a summary of the application of conjoint analysis in market research, transport economics, environmental economics, and health care research and Appendix 4 focuses on three case studies to illustrate how conjoint analysis studies can be used for policy purposes. This section highlights the key findings from these case studies and the decision making relevance of them.

4.1 Estimating the value of time spent on the NHS waiting list

Within the NHS waiting lists are used as a method of allocating health care. Such waiting time may impose costs to patients in terms of spending time in a less good state of health than 'normal', as well as provoking anxiety about the process and outcome of treatment. Thus, there may be some value to patients in having treatment sooner rather than later. Propper (1991) used conjoint analysis to look at:

- the potential benefits to consumers of reducing the time spent on the NHS waiting list for non-urgent treatment.

The results suggested that

- the average value of a reduction of one month in time on a waiting list for non-urgent treatment was in the order of £40. (For more details on this study see Appendix 4).

The results from this study provide policy makers with some guidance on the benefits of reducing waiting time. Such benefits can then be compared to costs of achieving a reduction in waiting times and decisions made concerning whether scarce health care resources should be allocated to reducing waiting times vis-à-vis some other health care intervention that will be competing for scarce health care resources.

4.2 Estimating the trade-offs between waiting time and convenience

Another problem often faced by health authorities and health boards in the provision of health care is the trade-off that exists between waiting times and convenience. That is, waiting times may be able to be reduced by introducing central clinics. However, local clinics may lead to longer waiting times. Grampian Health Board were considering whether to introduce local clinics in the provision of orthodontic services for both first and second (and all subsequent) appointments. Given fixed resources for this service, the introduction of local clinics would be accompanied by increased waiting times for treatment. In order to improve the service in line with consumer preferences the Board needed to know which of the two (waiting times or travel distances) was more important to patients and to what extent it was more important. Ryan and Farrar (1994) used conjoint analysis to elicit patient preferences with regard to whether patients would prefer:

- local clinics and longer waiting times

or

- a more centrally provided service with shorter waiting times?

The results suggested that

- Patients would prefer to have reduced waiting times rather then local clinics.
- Patients feel more strongly about the location of the second (and all subsequent) appointments than the first appointment.
- Patients are willing to wait an extra 6 days to have their first appointment at a local clinic, suggesting that a switch from central to local appointments for the first appointment will only lead to an increase in patient satisfaction if such an action increases waiting time by no more than 6 days.
- Patients are willing to wait an extra 19 days to have their second appointment at a local clinic, suggesting that a switch from central to local appointments for the second appointment will only lead to an increase in patient satisfaction if such an action increases waiting time by no more than 19 days.

The results also allowed ranking of various possible ways of providing orthodontic services (see Appendix 4). This ranking data can be used to inform the purchaser how to change the service. If a purchaser has more resources available for a service, it can use the results to support a case for giving priority to a particular aspect of the service (here, waiting time). If a purchaser wishes to improve a service but has no more resources with which to achieve this, it can use the conclusions to redistribute resources within the service Either way they would attempt to move as far up the ranking table as possible within the resource constraints.

In the light of the results from this study Grampian Health Board decided not to introduce local clinics but to concentrate on reducing waiting times.

4.3 Establishing patient preferences for health outcomes

Harwood *et al* (1994) used conjoint analysis to establish patient preferences for different handicap health outcomes. The intention was to develop a handicap measurement scale which would allow a utility score to be estimated for all possible health outcomes. From this it would be possible to evaluate new and existing services for people with chronic ill health and disability, as well as to assess need and to ensure quality assurance. These estimated utilities can therefore be used by policy makers in a number of ways:

- to measure outcomes of clinical trials of services and therefore compare the utility scores in the intervention and control groups.
- to compare outcomes between services that are currently available to estimate utility weights within the QALY framework (see section 3.1), so enabling comparisons between the cost-effectiveness of services in this area and other programmes for other groups of patients.
- to measure current health state and therefore potential to benefit from service provision.
- to assess whether services are achieving the health outcomes expected.

The attributes for the study were taken from the International Classification of Impairments, Disabilities and Handicaps (ICIDH). These were: mobility; occupation; physical independence; social integration, orientation and economic self-sufficiency. The study led to estimation of part-utilities for all possible attribute levels, and, from these, by establishing the relative importance of different attributes, utility scores for all possible health outcomes (see Appendix 4). In this study respondents valued social integration as less important than any of the other dimensions. Mobility, orientation and economic self-sufficiency were the most important dimensions. Thus, policy makers should concentrate on these in the provision of health care for people with chronic ill health and disability.

5. Conclusions

This paper has demonstrated the potential use of conjoint analysis, an instrument which, while widely used outside health economics, has had limited application in health economics, particularly by health economists. This tool appears to be attractive as a method for incorporating consumer preferences into decision making in the NHS. It overcomes the limitations of the techniques that are currently used to elicit community values (opinion polls and satisfaction surveys) since it provides information on intensity of preferences (via estimated regression coefficients, utility scores, willingness to pay and marginal rates of substitution more generally), can be designed to reflect specific choices facing health boards/authorities (via the design of the study), addresses realistic scales of change (via the levels set for the attributes) and involves the crucial notion of opportunity cost (via the discrete choice questions that are posed where individuals have to sacrifice one level of an attribute to achieve an increase in another). It was also shown to pose more realistic questions than current methods of utility assessment commonly used in health economics, and is likely to be more sensitive to taking account of non-health attributes and process attributes than these instruments. There is clearly potential therefore to apply conjoint analysis within the area of eliciting community values, though work is needed to ensure that the technique is as reliable and valid in healthcare as in other areas, where it has been used by economists and others for many years.

References

Acito F. (1977) *An investigation of some data collection issues in conjoint measurement.* In Contemporary Marketing Thought, Proceedings of American Marketing Association.

Ampt E. Bradley M. and Jones P. (1987) *Development of an interactive, computer-assisted stated preference technique to study bus passenger preferences.* Paper presented for the Transportation Research Board, Washington.

Anderson N. (1970) Functional measurement and psycho-physical judgment. *Psychological Review*, 77, 153-170.

Anderson N. (1971) Integration theory and attitude change. *Psychological Review*, 78, 171-206.

Axhausen K. and Polak J. (1991) Choice of parking: Stated preference approach. *Transportation*, 18, 59-81.

Bates J. (1988) Econometric issues in stated preference analysis. *Journal of Transport Economics and Policy*, 22, 59-69.

Bates J. (1986) Sensitivity to level of service: Evidence from stated preference work. *Behavioural Research for Transport Policy*, 17, 269-288.

Beesley M. and Hensher D. (1987) The consistency of choice using experimental design. *Journal of Economic Psychology*, 8, 445-456.

Bowling A., Jacobson B. and Southgate L. (1993). Health service priorities: explorations in consultation of the public and health professionals on priority setting in an inner London health district. *Social Science and Medicine* **37**, 851-857.

Bradley M. (1988) Realism and adaptation in designing hypothetical travel choice concepts. *Journal of Transport Economics and Policy*, 22, 121-137.

Bradley M. and Bovy P. (1986) Functional measurement of route choice behaviour: a study of commuting cyclists in the Netherlands. *Behavioural Research for Transport Policy*, 13, 289-305.

Cattin P. and Wittink D. (1982) Commercial use of conjoint analysis: a survey. *Journal of Marketing*, 46, 44-53.

Cave M., Burningham D., Buxton M., Hanney S., Pollitt C., Scanlan M. and Shurmer M. (1993) *The valuation of changes in quality in the public services.* HMSO, London.

Chakraborty G., Ettenson R. and Gaeth G. (1994) How consumers choose health insurance. *Journal of Health Care Marketing*, 14, 21-33.

Chakraborty G., Gaeth G. and Cunningham M. (1993) Understanding consumers preferences for dental service. *Journal of Health Care Marketing*, 21, 48-58.

Chapman R. and Staelin R. (1982) Exploiting rank ordered choice set data within the stochastic utility model. *Journal of Marketing Research*, 21, 288-304.

Desvousges W.H., Smith V.K. and McGivney M.P. (1983) *A comparison of alternative approaches for estimating recreation and related benefits of water quality improvements.* Washington DC. Office of Policy Analysis, US Environmental protection Agency.

Donaldson C. (1993). *Theory and practice of willingness to pay for health care.* Discussion Paper 01/93, Health Economics Research Unit, University of Aberdeen.

Green P., Carmone F. and Wind Y. (1972) Subjective evaluation models and conjoint measurement. *Behavioural Science*, 17, 288-299.

Green P. and Rao V. (1971) Conjoint measurement for quantifying judgmental data. *Journal of Marketing Research*, 8, 355-363.

Green P. and Wind Y. (1975) New ways to measure consumers' judgements. *Harvard Business Review*, 53, 107-117.

Green P., Wind Y. and Jain A. (1972) Benefit bundle analysis. *Journal of Advertising Research*, 12, 31-36.

Green P. (1974) On the design of choice experiments involving multifactor alternatives. *Journal of Consumer Research*, 1, 61-68.

Groves T. (1993). Public disagrees with professionals over NHS rationing. *British Medical Journal* **306**, 673.

Hall J. and Dornan M. (1988). What patients like about their medical care and how often they are asked: a meta-analysis of the satisfaction literature. *Social Science and Medicine* **22**, 935-939.

Hanemann W. (1984) Welfare evaluations in contingent valuation experiments with discrete responses: Reply. *American Journal of Agricultural Economics*, 69, 332-341.

Harwood R., Rogers A., Dickinson E. and Ebrahim S. (1994) Measuring handicap: the London handicap scale, a new outcome measure for chronic disease. *Quality in Health Care*, 3, 11-16.

Heyden V. (1993). Never mind the quantity. *Health Service Journal* 103(5352), 21.

HMSO (1989a) Secretaries of State for Health, Wales, Northern Ireland and Scotland. Working for Patients. HMSO, London.

HMSO (1989b) Secretaries of State for Health, Wales, Northern Ireland and Scotland. Promoting Better Health. HMSO, London.

HMSO (1991) Secretary of State for Health The Health of the Nation. HMSO, London.

HMSO (1992) The patient's charter: what users think 1992. HMSO, Edinburgh, Scotland.

Jain A.K., Acito F., Malhotra N.K. and Mahajan V. (1979) A comparison of the internal validity of alternative parameter estimation methods in decompositional multiattribute preference models. *Journal of Marketing Research*, 16, 313-22.

Kocur G., Alder T., Hyman W. and Aunet B. (1982) *Guide to forecasting travel demand with direct utility assessment*, US Department of Transportation, Washington DC.

Leigh T., Mackay D. and Summers J. (1984) Reliability and validity of conjoint analysis and self-explicated weights: a comparison. *Journal of Marketing Research*, 21, 456-462.

Lerman S. and Louviere J. (1978) Using functional measurement to identify the form of utility functions in travel demand models. *Transportation Research Record*, 673, 78-86.

Levin I., Louviere J. and Schepanski A. (1983) External validity tests of laboratory studies of information integration. *Organizational Behavior and Human Performances*, 31, 173-193.

Loader R. (1990) *Conjoint analysis of fresh fruit purchasing*. Unpublished Paper, University of Reading, Reading.

Louviere J. (1988) *Analyzing decision making: metric joint analysis*. Sage, California.

Louviere J. and Woodworth G. (1983) Design and analysis of simulated consumer choice or allocation experiments: An approach based on aggregate data. *Journal of Marketing Research*, 20, 350-67.

Louviere J. and Meyer R. (1981) A composite attitude behaviour model of traveller decision making. *Transport Research*, 15, 411-420.

Luce D. and Tukey J. (1964) Simultaneous conjoint measurement: A new type of fundamental measurement. *Journal of Mathematical Psychology*, 1, 1-27.

Magat W.A., Viscusi W.K. and Huber J. (1988) Paired comparison and contingent valuation approaches to morbidity risk valuation. *Journal of Environmental Economics and Management*, 15, 395-411.

Malhotra N.K. (1982) Structural reliability and stability of nonmetric conjoint analysis. *Journal of Marketing Research*, 21, 199-207.

Maas A. and Stalpers L. (1992) Assessing utilities by means of conjoint measurement: An application in medical decision analysis. *Medical Decision Making*, 12, 288-297.

Meyer R., Levin I.P. and Louviere J.J. (1978) Functional analysis of mode choice. *Transportation Research Record*, 673, 1-7.

Mooney G. (1994) What else do we want from our health services? *Social Science and Medicine*, 39, 151-154.

Mooney G. and Lange M. (1993) Ante-natal screening: What constitutes benefit? *Social Science and Medicine*, 37, 873-878.

McClain J. and Rao V. (1974) Trade-offs and conflicts in evaluation of health system alternatives: methodology for analysis. *Health Services Research*, 9, 35-52.

McCullough J. and Best R. (1979) Conjoint measurement: temporal stability and structural reliability. *Journal of Marketing Research*, 16, 26-31.

McFadden D. (1973) *Conditional logit analysis of qualitative choice behaviour*. University of California at Berkeley, California.

McKelvey R. and Zavoina W. (1975) A statistical model for the analysis of ordinal level dependent variables. *Journal of Mathematical Sociology*, 4, 103-120.

McNeil B., Weichselbaum R. and Pauker S. (1978) Fallacy of the five year survival in lung cancer. *The New England Journal of Medicine*, 299, 1397-1401.

McNeil B., Weichselbaum R., Stephen G. and Pauker G. (1981) Speech and survival. *The New England Journal of Medicine*, 305, 982-987.

Nord E. (1991) The validity of a visual analogue scale in determining social utility weights for health states. *International Journal of Health Planning and Management*, 6, 234-242.

NHS Management Executive (1992). Local voices. The views of local people in purchasing for health. NHSME, London.

Opaluch J., Swallow S., Weaver T., Wessells C. and Wichelns D. (1993) Evaluating impacts from noxious facilities: Including public preferences in current siting mechanisms. *Journal of Environmental Economics and Management*, 24, 41-59.

Parker B. and Srinivasan V. (1976) A consumer preference approach to the planning of rural primary health-care facilities. *Operations Research*, 24, 991-1025.

Piccolo M. and Louviere J. (1977) Information integration theory applied to real world choice behaviour: Validational experiments involving out-of-town shopping and residential choice. *Great plains/ricky Mountains Geographical Journal* (Special edition on Human Judgment and Spatial Behaviour).

Preston J. and Wardman M. (1988) *Demand forecasting for new rail services: a case study of a new service between Leicester and Burton-on-Trent.* Institute for Transport Studies Working Paper 260, University of Leeds, Leeds.

Propper C. (1991) Contingent valuation of time spent on NHS waiting list. *The Economic Journal,* 100, 193-199.

Rae D. (1981a) *Visibility impairment at mesa verde national park: An analysis of benefits and costs of controlling emissions in the four corners area.* Prepared for the Electric Power Research Institute, Charles River Associates, Boston, Massachussetts.

Rae D. (1981b) *Benefits of improving visibility at great smoky national park.* Draft report prepared for Electric Power Research Institute, Charles River Associates, Boston, Massachusetts, December.

Randall A., Hoehn J.P. and Brookshire D.S. (1983) Contingent valuation surveys for valuing environmental assets. *Natural Resources Journal,* 23, 637-648.

Ryan M. (1995) *Economics and the patient's utility function: an application to Assisted Reproductive Techniques,* PhD Thesis, University of Aberdeen, Aberdeen.

Ryan M. and Farrar S. (1994) A pilot study using conjoint analysis to establish the views of users in the provision of orthodontic services in Grampian. Discussion Paper 07/94, Health Economics Research Unit, University of Aberdeen.

Ryan M. and Hughes J. (1995) *Using conjoint analysis to value surgical versus medical management of miscarriage,* Health Economics Research Unit Discussion Paper No. 06/95, University of Aberdeen, Aberdeen.

Schulze W.P., Cummings R.G. and Brookshire D.S. (1983) *Methods development in measuring benefits of environmental improvements: experimental approaches for valuing environmental commodities.* US Environmental protection Agency.

Spoth R. and Redmond C. (1993) Identifying program preferences through conjoint analysis: Illustrative results from a parent sample. *American Journal of Health Promotion,* 8, 124-133.

Segal M. (1982) Reliability of conjoint analysis: contrasting data collection procedures. *Journal of Marketing Research,* 11, 139-143.

Sheldon R. and Steer J. (1982) *The use of conjoint analysis in transport research.* PTRC Summer Annual Meeting, Warwick.

Statistical Package for the Social Sciences (1989), *Statistical Package for the Social Scientist,* SPSS, Chicago, IL.

Timmermans H. (1981) Consumer choice of shopping centre: an information integration approach. *Regional Studies,* 16, 171-182.

Torrance G., Thomas W. and Sackett D. (1972) A utility maximization model for evaluation of health care programs. *Health Services Research,* 7, 118-133.

Verhoef C., Maas A., Stalpers L., Verbeek A., Wobbes T. and Daal W. (1991) The feasibility of additive conjoint measurement in measuring utilities in breast cancer patients. *Health Policy,* 17, 39-50.

Vick S. and Scott A. (1995) *What makes a perfect agent? A pilot study of patients' preferences in the doctor-patient relationship.* Health Economics Research Unit Discussion Paper No. 05/95, University of Aberdeen, Aberdeen.

Von Neumann J. and Morgenstern O. (1944) *Theory of games and economic behaviour.* Princeton University Press, Princeton.

Wardman M. (1986) *Route choice and the value of motorists' travel time: empirical findings.* Institute for Transport Studies Working Paper 224, University of Leeds, Leeds.

Wardman M. (1988) A comparison of revealed preference and stated preference models. *Journal of Transport Economics and Policy,* 22, 71-91.

World Health Organisation (1980) *International classification of impairments, disabilities and handicaps.* Geneva: WHO.

Wind Y. and Spitz L. (1976) Analytical approach to marketing decisions in health care organisations. *Operations Research,* 24, 973-990.

APPENDIX 1
Stages in a conjoint analysis study

Stage 1: Establishing the attributes – The first stage of a conjoint analysis study involves defining the attributes in which the study is interested. A number of methods exist for doing this. These include literature reviews, group discussions, individual interviews and direct questioning of individual subjects. Alternatively, it may be that the researcher is interested in given attributes from a pre-defined policy question. For example, if a health authority is concerned with the trade-offs that individuals are willing to make between the location of a clinic and the waiting time (i.e. whether to introduce local clinics at the expense of increased waiting time), then the attributes will be predefined by the policy question. Similarly, if the issue is one of the optimal way to provide maternity services, and possible management plans vary with respect to location, staff involved, continuity of care and choice involved for women (as in the current debate between obstetrician-led versus midwife-led care), then the attributes are again pre-defined by the research topic.

Stage 2: Assigning levels to the attributes – Having determined the relevant attributes, levels must be assigned to them. These must be plausible, feasible and capable of being traded-off against each other. Defining attribute levels will be easier for quantifiable variables (e.g. waiting times, cost, distance from home) than qualitative variables (e.g. attitudes of the medical profession, provision of information). Bradley (1988) notes that:

> 'Discrete qualitative variables are usually described in two or three levels – the current situation and some policy change of interest, in one or both directions.'

Stage 3: Which scenarios to present – Having established the relevant attributes and their levels, hypothetical scenarios with different combinations of attributes are presented to individuals and their preferences for these determined. The question arises of what scenarios to present. Clearly, the number of possible scenarios increases as the number of attributes and their levels increase. For example, a study with 4 attributes at 3 levels would result in 81 possible scenarios ($3^4=81$). More generally, the number of possible scenarios is a^n where a is the number of levels and n the number of possible attributes. If the number of levels varies across attributes then the number of possible hypothetical scenarios is $a^n \times b^m$ where a and b are the different attribute levels and n and m the different attributes.

If there were only two attributes, each having say three levels (giving a total of $3^2=9$ scenarios), then it would be possible to present each scenario separately and get the individual to state her preference. This is known as a *full factorial* design. However, such an approach would not be practical if there were a large number of attributes with various possible levels. There is a limit to the number of scenarios with which respondents can cope. There are a number of ways to deal with this problem. First, *fractional factorial* designs assume that some (or all) of the interactions between attributes are insignificant and can therefore be dropped from the analysis. There are different types of fractional designs that allow different interaction effects to be dropped in the analysis. Tables and computer packages have been devised to help in the design of fractional factorial designs (Kocur, 1982; SPSS, 1989). Second, one option is to remove dominant, dominated and unrealistic options. That is, options could be removed which are obviously superior or inferior on all attribute levels. Further, if it is assumed that individual preferences are transitive, this can also be done with subsets. For example, suppose the individual is presented with 4 options, A, B, C and D. If the individual prefers A to B and C to D and if the individual prefers A to C then the researcher may assume that A is preferred to D. Thirdly, another option is to have a block design. Here the hypothetical scenarios are divided into sub-sets or blocks, and different respondents are presented with a different sub-set of scenarios. Lastly, unrealistic options can be removed.

Stage 4: Establishing preferences – Having established the attributes, their levels and the scenarios that are going to be presented to individuals, preferences for these scenarios are then obtained. Three methods have been used in the conjoint analysis literature to do this: ranking exercises, rating exercises and discrete choices.

Ranking exercises. These involve presenting individuals with the scenarios that have emerged from the statistical design in stage 3 of the study, and asking respondents to rank them, in terms of all their attributes, from least preferred to most preferred. A mean ranking can then be obtained for each scenario.

Rating exercises. In these exercises individuals are presented with the scenarios that have emerged from the statistical design in stage 3 of the study. They are then asked to rate them individually using a scale i.e. from 1 to 5 where 1 represents strongly dislike and 5 strongly like.

Discrete choices. The development of conjoint analysis by economists has led to the introduction of the 'choices approach'. Here individuals are asked to state their preferred scenario from two or more scenarios. The pairwise comparison or discrete choice approach, where individuals are presented with two scenarios at a time, is most commonly employed. Pairwise comparisons exercises are more difficult to design than ranking or rating exercises because two types of design are required: one to reduce the number of possible options to a manageable number of scenarios (as in the ranking and rating exercises) and one to place these options into pairwise comparisons sets. For example, suppose a study which involved four attributes at three levels, and hence 81 possible scenarios, required the use of nine scenarios to estimate efficient parameters. If a pairwise comparisons approach were adopted, this would give rise to a large number of possible comparisons. Methods would then be needed to reduce such comparisons to a manageable number (Louviere and Woodworth, 1983). One method would be to compare all possible scenarios to the current scenario. For example, if there were 9 scenarios, and one of these scenarios represented the current situation, only 8 pairwise comparisons would then be necessary. An alternative method would be to choose one of the 9 scenarios randomly, and compare the other eight to this one.

Whilst the pairwise comparisons approach may be more difficult to design, it has the advantage that the type of question posed to individuals more accurately reflects the type of decisions that individuals make every day i.e. they are not use to carrying out ranking and rating type exercises, but regularly face choices between purchasing goods and services which involve different levels of given attributes. The pairwise comparisons approach also has the advantage that it is firmly rooted in economic theory (see Appendix 2).

Stage 5: Analysis of data –

Ranking and rating data

Ranking and rating data were traditionally analysed using simple *graphical techniques*. Using this approach, the relative importance of different attributes can be obtained by plotting the mean ranking or rating for given scenarios with given levels. A casual observation of this graph allows some conclusions to be reached concerning the relative importance of attributes.

Regression techniques allow estimation of part-utilities and the range of these for each attribute (i.e. highest part-utility minus lowest part-utility) provide some information on the importance of different attributes – the importance of an attribute is judged by the impact of a unit change in that attribute on the overall utility score. More specifically, the importance of a given attribute can be estimated as the difference in the utility range of any given attribute divided by the sum of the difference in utility ranges (Green and Wind, 1975). The total utility of any given combination of attribute levels is then calculated from the sum of the estimated individual utilities of this combination (Green and Rao, 1971; Green and Wind, 1975). An example of this is given in Appendix 4 of this document (the study by Harwood *et al*, 1994).

Regression technique used to estimate utilities in this way were originally *non-metric algorithms*, such as MONANOVA (Monotonic Analysis of Variance) and JOHNSON'S regression technique. Such techniques have been used extensively in the market research literature to estimate both marginal and overall utilities (Green and Rao, 1971; Green, Carmone and Wind, 1972; Green, Wind and Jain, 1972; Jain, 1975; Johnson, 1975; Cattin and Wittink, 1976; Segal, 1982; Leigh *et al*, 1984).

Economists have favoured *metric* methods to analyse conjoint analysis data. Here statistical testing for the significance of individual attributes can be carried out, and conclusions thereby made concerning the presence of the attributes in the patient's utility function. Given this, *ordinary least squares (OLS)* has been used to analyse ranking and rating data. Using OLS, the individuals' rating or ranking of the scenarios is the dependent variable and the attribute levels that are being rated or ranked are the independent variables. Total utility scores for different combinations of attributes are calculated by first estimating a regression equation, and then inserting the levels of the attributes for given combinations into this equation.

Discrete choices

Data collected from discrete choice type questions should be analysed by regression techniques designed for analysis of data where the dependent variable takes on only two possible values. The most common regression techniques used to analyse such data are *logit* and *probit*.

Ranking and rating data have also been analysed by transport economists using discrete choice regression techniques. To do this, ranking data are transformed (or exploded) into a set of discrete choices by creating simulated choices from the ranking data (Chapman and Staelin, 1982). This involves treating each ranked scenario (except the last) as a separate observation that is preferred over all scenarios ranked below it. Rating data are transformed by converting responses into a utility scale via the logit regression equation and analysed in the same manner as above (Bates, 1988). The conversion takes place by assuming that the higher the rating for a given scenario, the higher the probability that the individual would consume that scenario. For example, if possible responses on a rating scale range from 1 to 5, then a scenario that was rated at 5 would have a higher probability of being consumed than a scenario that was rated at 1. The probability of consuming each scenario is conveniently converted into a probability scale (p) which is quite arbitrary. For example, the 1-5 rating scale usually gives a probability of 0.1 to a scenario that was rated 1, 0.3 to a rating of 2, 0.5 to a rating of 3, 0.7 to a rating of 4 and 0.9 to a rating of 5. These probability levels can then be converted to a utility scale using the logit model which specifies that:

$$U_j = \ln (p/1\text{-}p)$$

Using this equation, the probability scale represented above is converted to the following utility scale: –2.197 (for probability 0.1); –0.847 (for probability 0.3); 0 (for probability 0.5); 0.847 (for probability 0.7); and 2.197 (for probability 0.9). Such data can then been analysed using the ordered probit/logit regression models (McKelvey and Zavoina, 1975).

Stage 6: Interpreting the results from estimated regression equation

In this section consideration will be given to results derived from metric regression techniques since these approaches have proved most popular amongst economists. Having collected data from either ranking, rating or discrete choice exercises, a utility function will be estimated from regression techniques which shows the utility or satisfaction that an individual obtains from a given combination of attribute levels. It is commonly assumed in the literature that this utility is a linear function such that:

$$U_i = a_0 + a_1X_1 + a_2X_2 + \ldots + a_nX_n + e$$

where

U_i = the utility from health care intervention i

$X_1, X_2,..X_n$ = level of attributes included in the model

a_0, a_1, a_n = coefficients which are estimated from the regression analysis

e = error term which is included to allow for factors that influence utility which have not been controlled for in the model.

The estimated coefficients from the regression model can be used in a number of ways. Firstly, the signs, relative size and significance level show *the relative importance of the different attributes on individual preferences.* A positive sign on the coefficient indicates that the higher that attribute level the higher the level of utility derived. Similarly a negative sign indicates that the higher the level of that attribute the lower the level of utility. The relative size of the coefficients indicate something about the relative importance of that attribute in determining overall utility, though consideration does have to be given to the different units of measurement of the attributes. The significance levels of the coefficients indicate whether the attributes have a significant impact on preferences or utility.

Secondly, *total utility scores* for different combinations of attributes can be calculated by inserting different combinations of levels of the attributes into the regression equation. The health board or health authority should aim to provide the combination of attributes with the highest level of utility given their limited resources.

Thirdly, the ratio of the coefficients of the attributes shows the *marginal rate of substitution* between these attributes i.e. the rate at which they are willing to give up one attribute for another. For example, the marginal rate of substitution of waiting time and location of clinic would show the number of additional days an individual is willing to wait to have a local clinic rather than a central clinic (assuming that a local clinic is preferred).

Further, if cost is included as an attribute in the conjoint analysis study it is possible to estimate maximum willingness to pay (willingness to pay) indirectly. For example, the marginal rate of substitution of money and location of clinic would show how much an individual would be willing to pay to have a local clinic rather than a central clinic (again assuming that a local clinic is preferred).

APPENDIX 2
Reliability and validity of conjoint analysis

Reliability

Relatively little work has been done on the reliability of conjoint analysis studies. The limited work available has taken place in the market research literature, concentrating on the reliability of ranking and rating exercises (Acito, 1977; McCullough and Best, 1979; Malhotra, 1982; Segal, 1982). Such studies have generally found a high level of reliability. For example, Acito (1977) investigated the reliability of the ranking procedure in the choice of cameras by administering the same questionnaire twice in one day. This study concluded that respondents could 'evaluate the 27 camera concepts in a consistent and reliable manner'. However, since the time interval was short, it is noted that 'the observed correlation coefficients can be considered as an upper limit'. Segal (1982) investigated the test-retest reliability of two ways of collecting conjoint analysis data: 'multi-factor evaluation' (MFE) where individuals are presented with information on all the attributes of a commodity and asked to rank all possible combinations, and 'two-factor evaluation' where individuals consider the attributes in pairs and rank all possible combinations. The results show that reliability measures were good for both procedures, though reliability was better for the MFE procedure.

To the knowledge of the author, there has been no research looking at the reliability of the discrete choice approach. While transport economists have been developing this technique, they appear to have concentrated on establishing the validity rather than the reliability of the technique. Tests of reliability will need to be employed in health care if the discrete choice approach is to become an accepted instrument.

Validity

Criterion validity

Criterion validity refers to the extent to which predictions from conjoint analysis reflect the choices individuals make in actual situations. This issue has been studied most extensively by transport economists concerned with forecasting demand from conjoint analysis models. Levin *et al* (1983) reviewed the extent to which conjoint models developed in hypothetical conjoint analysis questionnaires accurately predicted the behaviour of individuals not studied in a real market. The studies examined looked at choice of residential location (Piccolo and Louviere, 1977; Lerman and Louviere, 1978); out of town shopping destination (Piccolo and Louviere, 1977); transport mode (Meyer *et al*, 1978; Louviere and Kocur, 1983); and supermarket destinations (Louviere and Meyer, 1981). The authors conclude that conjoint analysis is a valid technique. Support for this conclusion is provided by Louviere and Woodworth (1983), who found a high correlation between predicted and observed behaviour when purchasing pet foods or modes of transport between Australia and Tasmania, and by Louviere (1986) who found a high correlation between observed and predicted market shares of agricultural chemical products. In their review of other studies where the criterion validity of conjoint analysis was established Louviere *et al* (1988) conclude that:

> 'there is considerable evidence to support the conclusion that appropriately designed, implemented and analysed conjoint studies can predict the real behaviour of real individuals in real markets.'

If this technique is to be applied to health care, work is needed to assess the criterion validity of the technique in this area. One of the difficulties will be that validity tests to date have been applied to markets where individuals have choice i.e. market goods or modes of transport. There will be a need to devise validity tests which are appropriate to health care, initially at least to health care interventions where individuals have some choice. Predicted behaviour from conjoint analysis models can then be compared to actual behaviour. Health care interventions where individuals may be considered to have some degree of choice include primary care (choosing general practice and general practitioner), dentistry (choice of dentist and practice) and assisted reproduction (choice of infertility clinic).

Convergent validity

Convergent validity refers to the extent to which the results from conjoint analysis studies are consistent with the results from other studies using different measurement techniques. Two studies (to the author's knowledge) have compared the results of conjoint analysis and willingness to pay studies, both within the environmental economics literature. In the first, Desvousges et al (1983) was concerned with the utility derived from improved water quality. He used the ranking technique and established that the willingness to pay study gave monetary values which were a third to a quarter of those given by the conjoint analysis study. A similar result was arrived at by Magat *et al* (1988) when looking at the utility from risk reductions associated with safer chemical products. He used the pairwise comparisons approach and found that willingness to pay gave monetary values of 58 per cent lower than the pairwise comparisons conjoint analysis method. The authors suggested two reasons for this; firstly, respondents may have thought that they would get a chance to revise their answers in the willingness to pay questions and, secondly, individuals tend to work up towards their maximum willingness to pay i.e. they start by establishing an acceptable price and then approach their maximum willingness to pay from below. They continue:

> 'In contrast to these reasons to suspect that willingness to pay responses are lower than reservation prices, the paired comparisons approach produces no incentives for subjects either to understate or to overstate their true valuations because of gaming considerations or the search process they use to determine their valuations.'

In support of this, both Schulze (1983) and Randall *et al* (1983) found that starting bids were less than final monetary values obtained from a bidding process. Thus, the one step approach may not result in individuals giving their maximum willingness to pay.

Magat *et al* (1988) conclude that the

> 'non-iterative willingness to pay approach may create incentives for respondents to state values which are somewhat below their true reservation prices for the commodities being valued, while the pairwise comparisons approach eliminates these incentives to understate preferences, and thus it seems to provide more accurate measures of willingness to pay.'

The reason for the inconsistency between the two approaches may lie in the way the willingness to pay study is designed. If the questions are phrased in terms of the bidding game, then individuals may reveal their maximum willingness to pay for the risk reduction. Alternatively, it will be interesting in future research to compare the results from applying the conjoint analysis technique with those from the closed ended willingness to pay approach.

Theoretical validity

Theoretical validity assesses the extent to which the results are consistent with economic theory, or sometimes, more generally, a priori expectations. *Ceteris paribus*, the higher the price of a given good or service, the lower will be the demand for that good or service. This has been supported by a number of applications of conjoint analysis. For example, in the market research literature a study by Green *et al* (1972) established that consumer preferences for retail discount cards were negatively related to their price and Green and Wind (1975) found that consumer preferences for carpet cleaners and tyres showed a similar relationship with price.

In the environmental literature, Opaluch *et al* (1993) discovered that preferences for location of sites for dumping noxious facilities were negatively and significantly related to the cost to the individual households. In a study applying conjoint analysis to the purchase of fresh fruit, Loader (1990) found that preferences for all five types of fruit considered were negatively and significantly related to price.

A large body of research in the transport literature has examined the monetary value of time savings. Such research has analysed preferences for alternative modes of transport as a function of the following attributes: cost; in-vehicle time; waiting time; walking time; and time spent in other travel. Evidence from this research supports the theoretical validity of the conjoint analysis technique, with all these attributes consistently being negatively and significantly related to preferences i.e. the lower the cost and time variables, the stronger the individual preference for that mode of transport (Bates, 1986; Wardman, 1986).

Propper (1991) used conjoint analysis to establish the monetary value of time on NHS waiting lists. Her results are also consistent with economic theory insofar as the monetary value of time of lower income groups is lower than that of higher income groups. Ryan (1995) used conjoint analysis to look at preferences for assisted reproductive technologies. Evidence of theoretical validity was found with respondents with a higher income having a lower marginal valuation of cost i.e. diminishing marginal utility of income was present. A similar result was found by Ryan and Hughes (1995) in looking at preferences for management of miscarriage.

APPENDIX 3
Application of conjoint analysis in market research, transport economics, environmental economics, and health economics

Table 1 Selection of application of conjoint analysis in market research

Study	*Product*	*Attributes*	*Design choice*	*Statistical analysis*
Acito (1977)	Instant picture cameras	Picture size (inches) Type Price	Ranking	MONANOVA
Beesley and Hensher (1987)	Consumer preferences for international expo in Australia to celebrate bicentenary	Type of expo Size of crowd What friends say Entrance fees Location (city) Time to get there	Ranking	Logit
Green, Carmone and Wind (1972)	Discount cards	Size of discount	Ranking	MONANOVA
Green, Wind and Jain (1972)	Floor cleaner	Floor fresh and new Maintains floor colour	Ranking	MONANOVA
Leigh , MacKay and Summers (1984)	Calculators	Algebraic parenthesis Rechargability Financial functions Statistical functions Warranty	Ranking Rating Paired comparisons	ANOVA MONANOVA
McCullough and Best (1979)	Apartments	Number of bedrooms Price Distance to campus Special features	Ranking	MONANOVA
McCullogh and Best (1979)	Soft drinks	Flavour Price Package type Sweetener	Ranking	MONANOVA
Segal (1982)	Apartments	Number of bedrooms Monthly rent Distance to campus	Ranking	MONANOVA
Timmermans (1981)	Shopping centre	Number of shops Travel time Time to find parking space	Rating scale	Ordinary Least Squares

Table 2 Selection of application of conjoint analysis in transport research

Study	*Objectives*	*Attributes*	*Design choice*	*Statistical analysis*
Ampt, Bradley and Jones (1987)	Bus passenger preferences	Access egress times Wait times In-vehicle times	Ratings Ranking Pairwise comparisons	Logit
Axhausen and Polak (1991)	Choice of parking	Access time Search time Egress time Parking cost	Pairwise comparisons	Logit
Bradley and Bovy (1986)	Cyclist route choice	Travel time Traffic level Surface quality Cycle facility	Pairwise comparisons	Logit
Preston and Wardman (1988)	Demand forecasting for new local rail service	In-vehicle time Out of vehicle time Cost	Pairwise comparisons	Logit
Sheldon and Steer (1982)	Demand for inter-city rail time	Travel time Fare Frequency Interchange	Pairwise comparisons	Logit
Sheldon and Steer (1982)	Seating performance trains	Onbay window Direction Dining Position	Pairwise comparisons	Logit
Wardman (1988)	Choice of mode of travel for commuters in North Kent – train or coach	In-vehicle time In-vehicle time Walk time Wait time Cost	Pairwise comparisons	Logit

Table 3 Use of conjoint analysis in environmental economics

Study	*Product*	*Attributes*	*Design choice*	*Statistical analysis*
Desvousges *et al* (1983)	Water quality	Water quality index Recreation possibilities Cost	Ranking	Ordered Logit
Magat *et al* (1988)	Morbidity risks	Cost per year Injury level	Paired comparisons	Logit
Opaluch *et al* (1993)	Locating sites for noxious facilities	Marsh acreage Woodland acreage Groundwater quality Wildlife habitat Pond acreage Cost to household	Paired comparisons	Logit
Rae (1981a)	Air quality	Visibility Fee Congestion	Ranking	Logit
Rae (1981b)	Air quality	Visibility Fee Congestion	Ranking	Ordered Logit

Table 4 Use of conjoint analysis in health care research

Study	*Product*	*Attributes*	*Design choice*	*Statistical analysis*
Chakraborty *et al* (1993)	Dental services	Convenience to work Convenience to home Scheduling an appointment Hours of operation Waiting time in office Appointment reminders Preventive care Parking Number of dentists Assigned dentists Helpfulness of staff Recommendation Years in practice Attitude of staff Dental office appearance Ease of directions Rescheduling appointment	Ranking	OLS
Chakraborty *et al* (1994)	Health insurance	Brand Waiting time in office Office hours Premium Emergency care Choice of doctors Prescriptions Convenience Office visits Out of town emergency cover Dental coverage Quality of affiliated hospitals Choice of hospital Travel time to hospital Travel time to physician Time to make routine appointment Coverage of alcohol substance and mental health Psychologist/psychiatrist Wellness and education programmes Vision health care Communication to participants Preventive care Hospitalization Medical consultation by phone	Discrete choice	Multinomial logit
Harwood *et al* (1994)	Utility weights within a handicap measurement scale	Mobility Physical independence Occupation Social integration Orientation Economic self sufficiency	Ratings	MONANOVA

Table 4 *(continued)* Use of conjoint analysis in health care research

Study	*Product*	*Attributes*	*Design choice*	*Statistical analysis*
Mass and Stalpers (1992)	Treatment for laryngeal cancer	Type of cancer Length of life	Ranking	Non-metric (MONANOVA)
McClain & Rao (1984)	Primary health care system	Opening hours Cost Insurance Payment plan available Range of dental care Explanation of treatment	Ranking	Non-metric (ANOVA)
Parker and Srinivasan (1976)	Rural primary health care facility	Travel time Time to get appointment Waiting time Opening hours Type of health care facility	Ranking	Non-metric (LINMAP)
Propper (1991)*	Choice of health care facility for operation	Cost Time of admission Uncertainty	Pairwise comparison	Probit
Ryan and Farrar (1994)*	Orthodontic services	Waiting time Location of first appointment Location of second appointment	Pairwise comparisons	Logit
Ryan (1995)*	IVF services	Attitudes of staff Continuity of contact with staff Time on waiting list Cost Success rate Follow-up support	Pairwise comparisons	Logit
Ryan and Hughes (1995)*	Miscarriage management	Level of pain Time in hospital Time taken to return to normal activities Cost Complications	Pairwise comparisons	Logit
Spoth and Redmond (1993)	Preferences for family focused prevention programs	Meeting time Meeting location Facilitator background Program duration Research base Program focus Distance Program format Meeting length Endorsements Support type	Ratings	Non-metric (specific CONJOINT ANALYSIS software)
Verhoef (1991)	Treatment for breast cancer	Type of treatment Length of life	Ranking	Non-metric (MONANOVA)

Table 4 ***(continued)*** **Use of conjoint analysis in health care research**

Study	*Product*	*Attributes*	*Design choice*	*Statistical analysis*
Vick and Scott (1995)*	Doctor-patient relationship		Pairwise comparisons	Logit
Wind and Spitz (1976)	Consumers' choice of hospital	Type of hospital Physical appearance Proximity Access/parking Assignment of physician Prestige of physician Respected specialist Price of room per day	Ranking	Non-metric (MONANOVA)

*Researchers are health economists

APPENDIX 4
Three case studies of the application of conjoint analysis in health care

1 Establishing the value of time on the NHS waiting list

The first conjoint analysis study carried out in the UK within the context of the NHS was conducted by Propper (1991) to establish the monetary value of time spent on the waiting list for non-urgent medical treatment. The attributes in the study, determined by the policy question being addressed (the value of time on the NHS waiting list) were cost and waiting time. Uncertainty concerning time on the NHS waiting list was also included as an attribute. Given that cost was included as an attribute this study provides a good example of how conjoint analysis can be used to estimate willingness to pay indirectly. Individuals were asked to imagine that they had a medical condition which required an operation and were given a hypothetical choice between immediate treatment at some positive cost in a NHS hospital or treatment after some wait in the same NHS hospital at zero monetary cost, with some level of uncertainty regarding this wait. The levels of the waiting time and cost were chosen to both cover a wide range of possibilities and to limit the number of choices respondents faced. The attribute uncertainty took on a value of zero if there was no uncertainty and one if there was uncertainty. Propper also attempted to take account of the fact that different individuals are likely to value time and money differently, according to their employment status and income. She did this by segmenting the model according to these characteristics. Variables were also included in her model to allow for preferences varying across income groups and attitudes towards private health insurance. Propper adopted the discrete choice approach, and individuals were presented with 14 pairwise choices. To allow for preferences varying according to the levels of the attributes two sets of pairwise choice questions were included, with the levels of time and cost being higher in one than the other (though the ratio of these attributes remained the same). The response data was analysed using Probit regression techniques.

The regression results from the study are shown in Table 1. They were used by Propper to estimate the value of time, or willingness to pay to reduce waiting time. This was achieved by dividing the coefficients on time for the various employment categories by the coefficient on cost for the two income groups. (Due to rounding off, dividing the coefficients given in Table 1 on T1, T2, T3 and T4 by C12 and C3, respectively, will not give the

Table 1 Probit regression results and estimates of willingness to pay

	Pink set (n=341)[1]		*White set (n=344)*[1]	
Variable	*Coefficient*	*Estimated value of time (£/month)*	*Coefficient*	*Estimated value of time (£/month)*
Constant	1.02		1.042	
D1	–1.09		–1.023	
D2	–0.51		–0.45	
P1	–0.44		–0.40	
P2	–0.19		–0.14	
C12	–0.28 E–02		–0.27 E–02	
C3	–0.24 E–02		–0.22 E–02	
T1	0.11	Income < £350 – 36.51	0.97 E–01	Income < £350 – 41.90
		Income > £350 – 44.73		Income > £350 – 49.43
T2	0.96 E–01	Income < £350 – 43.07	0.12	Income < £350 – 35.70
		Income > £350 – 52.75		Income > £350 – 42.11
T3	0.55 E–01	Income < £350 – 32.93	0.88 E–01	Income < £350 – 20.40
		Income > £350 – 40.33		Income > £350 – 24.06
T4	0.12	Income < £350 – 43.22	0.16	Income < £350 – 43.43
		Income > £350 – 53.01		Income > £350 – 49.90
U	–0.82		–0.17 E–01	
LogL	–2,575.9		–2,777.9	

D1 = 1 for lowest income group, 0 others: *D2* = 1 for middle income group, o otherwise: *P1* = 1 if stated no private health sector should exist, o otherwise: *P2* = 1 if stated limited private sector should exist, o otherwise: C12, Cost x lowest and middle income group dummy: *C3*, Cost x highest income dummy: *T1*, Time x full time employed dummy: *T2*, Time x part time employed dummy: *T3*, Time x housewife dummy: *T4*, Time x retired dummy: *U* = 1 if admission date uncertain, o otherwise.

1. The results from the Pink Set refer to results for the 14 discrete choices that involved the lowest level of time and cost, and the White Set for the 14 discrete choices that involved the highest levels of these two attributes.

exact values of time presented in Table A41). The resulting figure is what individuals are willing to pay in £s to reduce the waiting time by a month. This varies from £33 to £53, with an average value of £43 per month. This information will be useful to policy makers concerned with whether they should devote scarce health care resources to reducing time spent on the NHS waiting list vis-à-vis some other health care intervention that will be competing for scarce health care resources.

2 Establishing the trade-offs between convenience and waiting time

Whilst it is possible to include cost as an attribute in the conjoint analysis study, and indirectly estimate maximum willingness to pay for a given attribute, for studies relating to NHS health care services, the inclusion of cost as an attribute may prove controversial. That is, it may be felt by purchasers that, given that NHS health care is free at the point of consumption, it is somehow 'wrong' to ask individuals to consider cost. Ryan and Farrar (1994) applied conjoint analysis to estimate utilities and marginal rates of substitution without including cost as an attribute. They were concerned with the trade-offs that individuals make with regard to location of treatment and waiting time in the provision of orthodontic services. Given the policy question, three attributes were included: location of first appointment; location of second (and subsequent) appointments; and waiting time. Although the alternatives presented to individuals are hypothetical, they must be kept as realistic as possible to ensure that respondents take the exercise seriously. They must also be feasibly within the capability of the provider. At the time of the study the waiting time was 8 months, and this was included as a possible level. Alternative waiting times were specified as 4, 12 and 16 months. Levels for location of clinic were hospital (current) versus local (where respondents were allowed to define what they meant by local. Data were also collected to allow for preferences varying according to respondents' perceptions of their ease of travelling to the central clinic and their experience with the clinic as well as their education level, age and sex. The attributes and levels chosen gave rise to 16 possible scenarios ($4^1 \times 2^2$). The current scenario was used as a basis for comparison for the remaining 15. As a result, all 16 possible scenarios were presented and the subjects had to make 15 different choices. Individuals attending three orthodontic clinics in Grampian were presented with the 15 pairwise choices and asked to state their preference within each choice. All 15 choices involved the individual comparing the current situation (central clinic for both first and second appointment, and a waiting time of 8 months) with alternatives that varied with respect to these three attributes. Possible responses for each choice were: 'definitely prefer current'; 'probably prefer current'; 'no preference'; 'probably prefer alternative'; and 'definitely prefer alternative'. The regression results are shown in Table 2.

Table 2 Regression analysis results
Dependent variable = utility or satisfaction

Attribute	*Coefficient*	*p-value*
Constant	–1.14	0.001
Waiting Time	–0.21	0.001
Location of first appointment (1 = central, 2 = local)	0.04	0.576
Location of second appointment (1 = central, 2 = local)	0.13	0.048
Ease of travelling to clinic – 1 to 5 scale where 1 = easy and 5 difficult	0.34	0.001
Experience with clinic – continuous variable representing number of appointments at clinic	–0.01	0.087
Education level – 1 to 5 scale where 1 = secondary school and 5 = university	0.12	0.007
Age	0.00	0.177
Sex	–0.07	0.315
R2	0.37	

Observing the regression coefficients, waiting time was found to be significant, suggesting that patients consider this an important attribute in the provision of orthodontic services. The negative sign indicates that the higher the waiting time in the alternative style of care relative to the current, the less likely individuals are to choose the alternative. Location of first appointment was not found to be significant, while location of second appointment was. The positive sign suggests that if the clinic for the second appointment was located locally, respondents would be more willing to choose it. Ease of travel was found to be a significant predictor of preferences, with the positive sign indicating that respondents who found it difficult to travel to the appointment were more likely to value the alternative location. Individuals who had more experience with the service were more likely to value the current style of care, whilst those with a higher level of education were more likely to value the alternative style of care.

In the same way that the study carried out by Propper allowed estimation of the monetary value of reducing waiting time, this study allowed estimation of how long individuals are willing to wait for an appointment in order to have a local clinic. This is estimated by dividing the coefficients on first and second location by the coefficient on waiting time. These ratios (which are percentages of a month) are then converted into days by multiplying by 30. The results are shown in Table 3. This suggests that individuals are willing to wait an extra 6 days to have their first appointment at a local clinic and 19 days to have their second appointment at a local clinic. Thus, respondents felt more strongly about having a local second appointment.

Table 3 Marginal rates of substitution of time and location

Marginal rate of substitution of local clinic for first appointment for waiting time	0.19	0.19 x 30 days = **6 days**
Marginal rate of substitution of local clinic for second appointment for waiting time	0.62	0.62 x 30 days = **19 days**

The regression model estimated in Table 2 can be used to estimate utility scores or satisfaction scores for the scenarios presented to individuals in the questionnaire. This allows a ranking of the alternative scenarios as shown in Table 4. These scores are changes in utility from the current service (8 months waiting time and all appointments at a central clinic). One may expect the current scenario to score zero as it constitutes no change. However, as shown in Table 4, the current scenario has a negative score of –0.13. This implies that respondents had a positive bias for the status quo – they would choose the current scenario even when the alternative was rationally 'better' because they had a positive preference for no change. Scenarios which are preferred to the current score greater than –0.132 and scenarios less preferred to the current received utility scores less than that figure. Purchasers should attempt to provide the scenario that results in the highest utility scores within the available resources.

Table 4 Effects of changing location of clinic and waiting time from current situation on utility[1]

Change in waiting time from current situation (months)	*Location of first appointment*	*Location of second appointment*	*Utility (Satisfaction) Score*	*Ranking*
–4	Local	Local	0.88	1
–4	Central	Local	0.84	2
–4	Local	Central	0.75	3
–4	Central	Central	0.72	4
0	Local	Local	0.02	5
0	Central	Local	–0.01	6
0	Local	Central	–0.10	7
0*	**Central***	**Central***	**–0.13**	
+4	Local	Local	–0.82	8
+4	Central	Local	–0.85	9
+4	Local	Central	–0.94	10
+4	Central	Central	–0.98	11
+8	Local	Local	–1.67	12
+8	Central	Local	–1.70	13
+8	Local	Central	–1.79	14
+8	Central	Central	–1.82	15

1 Utility = –1.14 + 0.04 x FA + 0.13 x SA – 0.21 x WT + 0.35 x EASETRAV – 0.01 x EXP + 0.12 x EDU + 0.004 x AGE – 0.07 x SEX. To calculate this some of the independent variables were given their average values so that EASETRAV = 1.92, EXP = 1.49 and EDU = 1.76, SEX = 1.72, AGE = 31.96 throughout. FA, SA and WT vary throughout the choices
*Current situation

In conclusion, this study concentrated on establishing the importance of location and waiting time in the provision of orthodontic care. As was expected, patients would prefer local clinics for both types of appointments and shorter waiting times. However, given limited resources, trade-offs have to be made. Within the current budget, the introduction of local clinics would have to be accompanied by longer waiting times. The study shows that waiting time is more important than location in determining patient satisfaction. Moreover, the results indicate what service users are willing to trade-off in terms of waiting times to have local clinics.

3 Establishing the importance of different health attributes

The two studies reported above have applied conjoint analysis to look at the relative importance of what we have called 'process attributes'. It is also possible to use the technique to estimate the utilities associated with different health outcomes. An example of this is the study by Harwood *et al* (1994) which applied conjoint analysis to develop utility weights for a handicap measurement scale. This study was concerned with developing a measurement scale to allow quantification of various handicap outcomes on an interval scale from ordinal data. The attributes, derived from the International Classification of Impairments, Disabilities and Handicaps (WHO, 1980), were mobility, physical independence, occupation, social integration, orientation and economic self-sufficiency. Each attribute had 6 possible levels, where 1 represented the best level and 6 the worst level. Individuals attending two General Practices in different areas of London were presented with 30 hypothetical health scenarios and asked to rate them. Each scenario could have a rating of between zero and 14, where zero represented no disadvantage and 14 the worst imaginable disadvantage. Responses were analysed using non-metric regression techniques. Using this technique part-utilities are estimated directly for each level of each attribute by regression techniques. To estimate these part-utilities the total utility score (or rating in this example) is regressed on the attribute levels. (For more on this method of analysis see SPSS, 1989). Table 5 shows the estimated part-utilities associated with each level of each attribute.

Table 5 Part-utilities for dimensions of handicap

Attributes	*Part utilities associated with levels of disadvantage**					
	1	2	3	4	5	6
Mobility	0.071	0.038	0.000	–0.036	–0.072	–0.108
Physical inde-pendence	0.102	0.011	–0.021	–0.053	–0.057	–0.061
Occupation	0.099	–0.014	–0.014	–0.024	–0.035	–0.060
Social integration	0.063	0.035	0.007	–0.022	–0.029	–0.041
Orientation	0.109	–0.008	–0.038	–0.051	–0.063	–0.075
Economic self sufficiency	0.100	0.067	0.033	–0.023	–0.067	–0.111

*1 = no disadvantage, 6 = the most severe disadvantage

These part utilities are then combined to estimate total utility for any given combination of attribute levels, as well as to estimate the relative importance of different attributes. To estimate total utility scores some assumption has to be made about the relationship between part utilities and total utility. In this study a linear model was assumed whereby:

$$\text{Total Utility} = C + U_m + U_{pi} + U_{oc} + U_{si} + U_{or} + U_{ess}$$

where C is a constant term that is estimated by the model and U_m, U_{pi}, U_{oc}, U_{si}, U_{or} and U_{ess} are the part-utilities that are estimated by regression analysis for each level of each attribute (m=mobility, pi=physical independence, o=occupation, si=social integration, or=orientation and ess=economic self sufficiency). The estimated constant and part-utilities initially gave rise to utility scores that varied from –0.25 for the worst possible outcome (i.e. all 6 attributes taking on level 6) to 0.75 for the best outcome (i.e. all attributes taking on the best level). The estimated constant term was thus adjusted (to have a value of 0.456) to give a range of utilities of 0 for the worst possible outcome to 1 for the best possible outcome. The best outcome (i.e. all attributes taking on a level of 1) has a utility level of one and the worst outcome (i.e. all attributes taking on a value of 6) zero. Utility scores can be estimated for any other combination of attribute levels. For example, the utility attached to the health outcome where all attributes take on a level of 4 would be:

$$\text{Total Utility} = 0.456 - 0.036 - 0.053 - 0.024 - 0.022 - 0.051 - 0.023 = 0.247$$

From these estimated part-utilities it is possible to establish the relative importance of the different attributes in estimating overall utility. This is done by taking the utility range for each attribute (highest part-utility – lowest part-utility) and dividing it by the sum of all the utility ranges. The SPSS programme used here estimates this relative importance of the individual attributes. In this study respondents valued social integration as less important than any of the other dimensions - the best level contributed only 0.063 to total utility (the lowest part-utility for all dimensions at level 1) and the worst level reduced utility by only 0.041 (the lowest part-utility for all dimensions at level 6). Mobility, orientation and economic self-sufficiency were the most important dimensions. Thus, policy makers should concentrate on these in the provision of health care for people with chronic ill health and disability.

The information provided by this study can also be used to measure outcomes of clinical trials and therefore compare the utility scores in the intervention and control groups, to compare outcomes between services that are currently available and to estimate utility weights within the QALY framework (see section 3.1).