

**Pick and Mix:
Obtaining health state values for economic evaluation from the literature (the case
of osteoporosis)**

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Abstract

Obtaining health state values from the literature is an important method for populating economic models. This paper presents a review of health state values (HSV) for an economic model of treatments for established osteoporosis. The review sought to identify the best available utility estimates for health states associated with osteoporosis and make recommendations about their use. It was based on a systematic search of the main literature databases. The HSVs were reviewed in terms of the appropriateness of the valuation technique, the validity of the descriptive system (if one was used), the number and type of respondents, and overall quality of the study.

Twenty three estimates of health state values were found across the four conditions from five studies. These empirical estimates were found to differ significantly from the commonly used assumptions in economic evaluation, but with a wide variation between estimates for the same state (0.31 to 0.81 for vertebral fracture states). This variation can be partly explained by the valuation technique, health state description and the background and perspective of respondent, and leaves scope for considerable discretion that could be abused. The review also identified problems in using values obtained from the study populations to those in economic models, including the estimation health state values in those who avoid a fracture and the extrapolation from a study population to the model population.

INTRODUCTION

The increasing use of modelling to assess cost-effectiveness has placed an increased demand on the need for health state values. This paper is concerned with the identification of health state values (sometimes referred to as health state utility values) for use in economic models. It draws on a review conducted to populate an economic model of treatments for osteoporosis.

There are several strategies for determining health state utility values: 1) to use expert opinion, 2) to use indices obtained from the literature and 3) to directly measure the preferences of an appropriate population (Torrance, 1986). The first strategy has been widely adopted in the field of osteoporosis where economic evaluations have used judgements either by the authors or by expert panels, or have extracted values from previous studies using these approaches. There is evidence that experts may focus on different aspects of health to patients and hence may be inappropriate for use in economic evaluation (Jachuk et al, 1982). The third approach is usually regarded as better, but it is often impractical to conduct the necessary empirical studies as part of the construction of a model. Analysts may also prefer to use existing values from the literature in order to promote consensus.

The recent publication of a set of tables of all published health states utility values covering most conditions (Tengs and Wallace, 2000) is likely to further promote the use of the literature as a source of values. For many conditions there are now multiple values available with considerable variation in published health state values. This leaves considerable scope for discretion in the selection of values for an economic model that could be abused. It is therefore important to understand the reasons for these variations. They may partly result from the choice of respondent (whether they were obtained from a patient population or the general population), the technique used to elicit values (e.g. visual analogue scaling, standard gamble or time trade-off), the variant of the preference elicitation technique, the perspective of the task (e.g. whether it was to value one's own health or someone else's), sample size and overall quality of the study. These issues need to be systematically reviewed in order to promote good practice in the research community to develop economic models and ultimately to support policy makers in the assessment of cost-effectiveness of interventions.

This paper draws on a recent review of health state values conducted for the purpose of populating a model to examine different treatments for established osteoporosis (Kanis et al, 2001). The review attempted to identify the best available empirical values for the empirical model and to consider how they can be applied to the model. This review also provides an opportunity to consider the issues around obtaining values from the literature.

CASE STUDY

Osteoporosis

The cost-effectiveness of the treatment and prevention of osteoporosis has been a comparatively poorly researched area with 20 published studies in the last two decades (Sculpher et al, 1999; Torgerson and Reid, 1997). Moreover, an important weakness of these economic evaluations has been a dependence on the use of assumption or judgement rather than on empirical evidence for the utility values of key health events associated with osteoporosis such as hip, vertebral and wrist fracture. Yet, the cost per

QALY estimates of these economic models has been found to be highly sensitive to the values of these states in the models (Sculpher et al, 1999).

There are a number of reasons for opting to obtain health state values from the literature for osteoporosis. Firstly, there are multiple clinical outcomes associated with the condition including vertebral, hip and wrist fractures and the state of established osteoporosis itself, each with different consequences for morbidity. Secondly, these outcomes occur over a long time frame of 20 years or more. To conduct empirical studies to obtain values for these states would be too costly and time consuming within the time frame of this project. Finally, there have been a number of studies that report health state values (HSVs) using recognised preference elicitation techniques.

Systematic search

This review has been based on a systematic search of the key literature databases, including Medline, EMBASE, SCI, and NEED for the years 1980-1999. The search identified papers reporting economic evaluation of the prevention and treatment of osteoporosis and those reporting quality of life, health state values, QALYs, preference-based measures and so forth in osteoporosis related conditions. This was a very broad search strategy that identified papers well beyond the interests of this study and was designed to ensure that no papers were missed. Studies were also identified by hand searching, citation searching, reference list checking and those known to researchers involved in the study.

This broad search strategy found a total of 1014 papers. The abstracts were initially sifted in order to identify those with any potential to be relevant to this review and the number of papers was thereby reduced to 173. These papers were ordered and reviewed to identify those papers presenting HSVs. It was found that most of the papers were concerned with measuring quality of life in general and did not present health state utility values. Just four published papers (Gabriel et al, 1999; Dolan et al, 1999; Salkeld et al, 2000; Oleksik et al, 2000) were found to report HSVs for one or more of the osteoporosis related conditions (Table 1). A number of papers reported more than one state and elicited valuations from different groups of respondents and/or used more than one valuation technique. As a result, there were 23 HSVs in all, with two health state valuations for established osteoporosis, seven for hip fracture in general, one for hip fracture resulting in home confinement, 12 for vertebral fracture and one for wrist fracture. These were supplemented by one unpublished study containing a hip fracture valuation (Brazier et al, 2000).

Results

Table 1 presents the study, the health state descriptions, the mean and standard deviation of the values, the valuation technique employed and the source of the valuations for each of the osteoporosis related conditions. For comparison, normative HSV data have been presented by age group for the UK. These values were obtained from the EQ-5D being administered to over 3,000 representative members of the UK general population (Kind et al, 1998). The values used by the National Osteoporosis Foundation (NOF) (1998) have also been presented for comparative purposes, since these are the values commonly being used in current economic evaluations.

The 23 empirically derived HSVs for the four conditions (i.e. hip, vertebral and wrist fracture and established osteoporosis) differ considerably from the NOF values obtained

by a panel of experts. For example, the NOF judged the value for vertebral fractures of 0.97 and this compares with values obtained empirically that range from 0.31 to 0.80. There is a considerable range of values for each condition, probably due to differences in the derivation of the estimates. The methodological differences include what is being valued, the valuation technique, who did the valuing and the anchor states used in the valuation task.

REVIEW

Basis of review

The review aims to identify the most appropriate values for use in an economic model of treatments for osteoporosis (Kanis et al, 2002). Given there is likely to be a range of HSVs it is also necessary to understand the methods for deriving the estimates in order to begin the process of selection. This section sets out the issues addressed by the review.

Theoretical and methodological issues

How health states should be described

This is in part an issue of perspective. Estimates can be obtained by asking patients to value their own health state or by asking an appropriate population of respondents (who may or may not be patients) to value hypothetical descriptions of the states. Having patients value their own health has the advantage of avoiding the need to describe health states and may ensure they have a better understanding of the impact of the state on their lives. However, for reasons considered later it is often deemed appropriate to obtain the values from a broader sample of people.

Using the hypothetical perspective raises the problem of how to describe the states of health for valuation. Health states can be specially constructed to describe the condition (Gabriel et al, 1999) or based on generic health state descriptions that are not specific to the condition, such as the EQ-5D (Brooks, 1996). The generic measures are administered to a patient population and come with a tariff of values based on the values the general population. Condition specific vignettes have the advantage of being more relevant and sensitive to the condition than the generic measures (Fitzpatrick et al, 1993). The disadvantage is that the descriptions are less flexible and cannot be used in clinical trials. The descriptions cover a few states associated with or thought to be typical of the condition, and indeed in some cases there is only one such health state. These may poorly reflect the range of states found in the population and any changes found in a trial may not be well reflected in these vignettes. The advantage of the generic approach is that health state questionnaires can be administered in trials in the same way as other measures of health related quality of life, and hence there is a direct link between the descriptive data being valued and the clinical evidence. Commonly used examples of generic instruments for obtaining health state utility values are the EQ-5D (Brooks, 1996) and the HUI-III (Torrance et al, 1995). There is a third way that involves developing preference-based condition specific measure that can be used in clinical studies (Brazier and Dixon, 1995), but this approach has not been widely used to date. The decision regarding the best descriptive system is ultimately an empirical question requiring psychometric and qualitative evidence.

Any intervention seeking to reduce the number of clinical events such as fracture raises an additional descriptive question concerning the health state that the person avoiding the event will experience. An economic evaluation is concerned with estimating the

health loss for each individual from a clinical event which is the difference between the HSVs before and after the event. When evaluating a new treatment for a symptomatic condition, this can be assessed by undertaking health assessments before and after treatment. However, economic models of interventions in osteoporosis are typically driven by events, such as hip fractures, where there are limited pre-event data. In economic models it is often assumed that the pre-event HSV is either 1.0, or that of some control group, or some matched age and sex-matched average. These methods at least control for the fact that the prevalence of fractures is related to age and sex, but they do not provide true assessments of the likely health state of those who avoid a fracture. People who have a hip fracture probably have a poorer health status than average before the fracture. This has important implications for the use of health state valuation data, and the nature of the control is considered in this review.

How to value health states

Another important difference between estimates has been the valuation technique used to elicit HSVs, whether for patients to value their own states or to value hypothetical condition specific or generic states. The techniques used to value health states are visual analogue scales, standard gamble and time trade-off. It is currently recommended for economic valuation, that health state utility values should be obtained using a choice-based technique such as standard gamble or time trade-off rather than a rating scale (Brazier et al, 1999). However, there is no consensus as to which of these two should be used. It has been suggested that for a range of reasons SG would be expected to generate higher values than TTO across the entire severity range and this has been found in a number of studies (Green et al, 2000). A study undertaken in York comparing TTO and SG, however, found evidence for a cross-over. SG values exceeded TTO up to VAS values of 0.4, but then there was a cross over with TTO values exceeding SG values (Dolan and Sutton, 1997). However, this finding was restricted to the variants of SG and TTO that used props to assist the respondent undertake the valuation task. For the different variants of these techniques that did not use props the two techniques generated similar values for VAS values over 0.4. The size and pattern of the difference between TTO and SG may depend, therefore, on the severity of the condition and the variants of the two techniques being used

For use in cost utility analysis, valuation exercises must have the reference (or 'anchor') states of full health and death. Full health needs to be defined in an agreed manner as one of the possible outcomes of the choices presented in SG and TTO and the other must be immediate death. Where this is not done, for example full health is replaced by best imaginable for age (and there are instances of this in this field) then the valuations should be 'chained' onto the full health-death scale using a value for this best imaginable state on the full health - death scale for use in economic evaluation.

Whose values

Values may be obtained from patients, professionals or other experts, members of the general population or some other population deemed appropriate. These constituencies have been found to yield different valuations. Though the picture is mixed, there is evidence that patients value poor health states more highly than members of the general population trying to imagine the same states (Sackett and Torrance, 1978; Boyd et al, 1999; Lenert et al, 1999). This has been explained in terms of adaptation to disabilities, a change in reference point (Lenert et al, 1999) or perhaps a more insidious lowering of expectations (Dolan, 2000).

Whatever the source of the difference between patients and the general population, this can have important implications when valuing changes. For dramatic changes, such as those that may arise from a hip fracture where the patient moves from near full health to substantially less, then the change in HSV is greater when made by the general population than by patients. However, where the change is rather less dramatic, such as where a patient moves between severely disabled states, then general population values are poor at distinguishing between them and may result in lower valuations of the change (Lenert et al, 1999).

There are arguments both ways regarding which values to use in economic evaluation. Having patients value their own health ensures they have a better understanding of the impact of the state on their lives. However, the appropriateness of current patient values has been questioned for future health services since this ignores the views of future patients. More generally, it has been argued that for the purposes of informing resource allocation we require the values of society at large and hence those studies using a representative sample of the general population would be more appropriate (Gold et al, 1996).

Practical issues of using values in economic models

There are some practical problems that have arisen from trying to use empirical values from clinical studies in economic models and these are briefly explained below.

A fundamental problem with taking a result from a clinical study and using it in an economic model is that the original study was not designed to populate the particular model of interest. The clinical population, for example, is often different from the population being modelled. It is also likely that an economic model will be interested in the time course of a condition, but clinical studies are usually conducted at one point in time or have little follow-up over time. To *extrapolate* the findings from the clinical studies to the modelled population usually requires some assumptions to be made.

A final consideration is that models increasingly require a distribution around mean health state values in order to model the impact of uncertainty. Having identified the best HSV estimate in the literature, the analyst may be able to use the uncertainty estimated in the study. However, where results are being extrapolated to the model population other methods may be necessary.

Review

Hip fracture

The seven HSVs in Table 1 range between 0.28 to 0.72. Two were generated using VAS and have been excluded from further consideration. The lowest values of 0.28 and 0.31 were for condition specific states, but the health state descriptions were very different: 'disabling' (Gabriel et al, 1999) and 'good' (Salkeld et al, 2000) respectively. Both were elicited using TTO, with the former anchored against best imaginable and the latter a good health state typical for their age. Adjusting for these anchors would increase the values to some extent. It is interesting to note that the valuation of the disabling state by those who were experiencing a worse state was significantly higher at 0.65.

The remaining two cross-sectional HSVs were very similar. The HUI-II valuation for those who had a hip fracture in the last five years was 0.68 compared to the TTO own HSV of 0.70. The similarity of these two values may have arisen from conflicting influences. Whilst the patient-derived value might have been expected to be higher, this may have been partly offset by the fact that TTO values are often lower than SG valuations (Dolan, 2000). The TTO is more difficult to interpret since the TTO question for own value was anchored against the state of ‘best imaginable for age’ and therefore should be chained in order to place it on the full health-death scale. A value for ‘best imaginable’ is not known and hence it is not possible to undertake such chaining. These own health valuations can be used to obtain QALYs.

Brazier and colleagues collected HSVs using the TTO weighted EQ-5D before and after hip fracture in a population recruited into a clinical trial (Brazier et al, 2000). This prospective data set offers a more valid estimate of the loss in health status associated with a hip fracture. The mean HSVs at 6 and 12 months after hip fracture were 0.49 and 0.48 respectively. These figures are lower than those reported by Gabriel et al (1999) for the HUI-II and this could be due to the use of TTO rather than SG and/or the fact that the population is significantly older. The study also found that prior to the fracture, patients had a significantly lower HSV compared to the average for their age of 0.60 compared to 0.731 (Kind et al, 1998). The estimated proportionate loss using these figures is comparable to that indicated by comparing the HUI estimate of 0.68 to the age/sex norm found in Canada of 0.82 (Roberge et al, 1999).

Whichever estimate is used, these results all imply a significant impact for hip fracture on HSVs. These results support the usual finding that patients give higher valuations than non-patients. It was also found that an explicit description of a state seems to elicit a lower value. However, there is no empirical evidence for distinguishing between the first and subsequent years. The Gabriel et al (1999) results were for those who had experienced a fracture in the last 5 years and the Brazier et al (2000) study is currently limited to a 12 month follow-up.

Nursing home

There is only one published estimate for hip fracture cases in a nursing home. Salkeld and colleagues asked a group of elderly respondents to value a ‘bad’ hip fracture state that included being in a nursing home (Salkeld et al, 2000). The estimated HSV of 0.05 compared to the NOF assumption of 0.4. The upper anchor used in the TTO question was anchored by a state regarded as good for respondents of their age, which given they were an elderly population is not the same as full health. Another concern with using this HSV is the prevalence of this particular health state description in a nursing home population. Without this information it cannot readily be incorporated into an economic evaluation.

Vertebral fracture

Nine of the 10 preference-based HSV estimates for vertebral fracture lie between 0.31 and 0.81 and are considerably below the NOF assumption of 0.97. The EQ-5D data from the study by Oselsik and colleagues (2000) found evidence of a relationship between number of fractures and HSV. Thoracic fractures had lower values than fractures located at the lumbar spine. TTO own health values were not higher than the HUI value, again possibly due to the different valuation technique (0.81 vs. 0.80), but higher than the estimates by Oleksik and colleagues based on a general population TTO

valuation of the EQ-5D. The TTO value suffers from the same problem as the hip value in that it was obtained using 'best imaginable for age' as the upper anchor state. The other value of 0.31 was obtained from non-fracture respondents for a hypothetical state of 'multiple' fractures. It would seem that once again, an explicit description of the condition has resulted in a lower value than the generic descriptions.

After allowing for the expected HSV in the age groups prone to vertebral fracture, the apparent difference to the NOF assumption is considerably reduced for some of the estimates. The HUI-II estimate for those who had a fracture in the last 5 years of 0.8, for example, compares to the normative value based on Canadian data of 0.82 for a comparable age group. The study by Oleksik and colleagues produced values of 0.66-0.81 compared to general population norms of 0.81.

One concern with these studies is that they recruited patients who had had a fracture up to 5 years ago. There are no HSV estimates against time of fracture and hence no separate estimates for year one and subsequent years. Furthermore, these studies used cross-sectional controls. The control cases in the study by Oleksik and colleagues were patients who met the same inclusion criteria of age and T score (< -2.5), but the authors found the controls were significantly younger (by 2.5 years), had a higher lumbar spinal Bone Mineral Density (BMD), and a lower prevalence of non-vertebral fractures. The consequences of these differences for EQ-5D score before fracture (or as would have pertained if the fracture had not occurred) is not known.

Wrist fracture

Some earlier economic evaluations have assumed that a wrist fracture has no impact on health status. The NOF model had values of 0.96 for year 1 and 0.98 for subsequent years for long term dependency in a small proportion of cases. The single empirical study of wrist fractures has found a significant impact over short periods of time (Dolan et al, 1999). The researchers administered the EQ-5D at admission and at final visit to A&E and were able to estimate a mean loss in HSV over this period from the wrist fracture by assuming a linear progression between the first and last visit of 0.982.

A concern with this estimate is whether the EQ-5D is sensitive to some of the problems associated with wrist fracture, particularly the longer-term complications found in a small proportion of patients as indicated by the NOF estimate.

Established osteoporosis

Gabriel and colleagues (1999) compare health state TTO valuations by patients who have experienced a non-traumatic fracture in the last five years (that is not multiple) and the valuation of a hypothetical case by a sample of non-fracture cases. The health state values were 0.84 and 0.43 respectively. This large difference can be partly accounted for by the fact that the former is a health state valuation by patients and the latter is for a hypothetical state by a group who have not experienced a fracture. However, there were also differences in the state being valued since the hypothetical state did not describe any particular type of fracture but included a discussion of future risk, whilst own health was valued using an anchor of best imaginable for age. For the economic models, it was decided to value established osteoporosis using the value of the worst fracture experienced by the patient.

DISCUSSION

Selecting a reference case set of values

There was a wide range of preference-based HSVs for each condition primarily due to differences in the descriptive systems, the valuation technique and the sample of respondents used in the valuation. One recommended solution in such a situation is to have a reference case of values for all analysts to use. This does not imply that analysts should only use the reference case in future economic evaluation, but they should be used in at least one analysis of each economic evaluation of an intervention for osteoporosis.

The influential Washington Panel on Cost-Effectiveness recommends the use of a generic instrument with social valuations of health states obtained using a preference-based instrument (Gold et al, 1996). This allows comparison between health care programmes, such as cardiac or cancer versus osteoporosis, as well as within programme. The problem to date with the condition specific approach has been that this has been limited to one or two vignettes, and these do not necessarily reflect the full range of states associated with each condition. Furthermore, they can not be easily linked to patients in trials. Generic instruments can be administered to patients in trials or other clinical studies and hence provide a more accurate quantitative basis to the descriptive results. Whilst accepting there may be problems with generic health state classifications for some condition, such as insensitivity to the consequences of wrist fracture, another approach would be to produce a preference-weighted condition specific measure.

This review found two generic preference-based measures being used, the EQ-5D and the HUI-II. There are few data on their relative performance in osteoporosis, and no methodological basis for preferring one to the other (Brazier et al, 1999; Dolan, 2000). Currently the EQ-5D has the advantage of being available on more osteoporosis related conditions than the HUI-II and hence was chosen for populating the Sheffield Osteoporosis model. This decision limits the choice of HSVs for the reference case to: 1) hip fractures – Brazier and colleagues (2000), which has the additional advantage of providing an estimate of the health loss; 2) vertebral fractures – Oleksik and colleagues (2000) using the value for a single fracture, though an analyst could also use values for multiple fractures 3) Wrist fractures – Dolan and colleagues (1999). The hip and vertebral figures apply to all years following fracture. Due to lack of evidence it is not possible to distinguish between first and subsequent year, as done by the NOF. The reference selection of values is shown on Table 2.

Using the HSVs in economic models

Extrapolation

The HSVs found in this review do not cover all possible age groups. Some studies are limited to one age group (e.g. Brazier et al, 2000) and others are based on small numbers and it has not been possible to estimate reliable age specific values. To extrapolate the findings from these studies to specific age groups, one approach would be to assume a constant absolute reduction regardless of age. Another is to assume a constant proportional effect on HSVs. There is no evidence to support one assumption or the other. The latter approach has been used for the reference case data set since it assumes that the better your health status the more you have to lose and this was thought to be the most realistic assumption. Table 2 presents the multipliers for the

proportionate effect of a fracture on HSVs in the first year. For hip fractures, for example, the mean HSV at 12 months is divided by the baseline value (i.e. $0.477/0.597=0.799$).

Health state valuations for subsequent years

Economic models have often assumed that the impact on health state utility values from a fracture is less after the first year, presumably to allow for a process of recovery. It is also likely that the speed and extent of recovery will vary with age. The studies reviewed in this paper did not provide separate values for different years following any of the fractures. In order to extrapolate these results beyond the first year, it is necessary to assume values for subsequent years. It can either be assumed that fractures have the same relative degree of impact in subsequent years or that there some process of recovery in those who survive. An example of the latter based on previous economic models would be to assume that hip fractures have half the impact in subsequent years (i.e. 0.90) and for consistency the same assumption has been made about vertebral fractures (i.e. 0.955). However, wrist fracture would probably have no impact beyond the first year and hence we do not suggest any decrement for subsequent years. An important area for future research would to obtain empirical estimates for subsequent years.

Uncertainties around the mean health state values

The final selection of HSVs for the reference case are shown in Table 2, including the mean ‘multiplier’ for the proportionate effect the fracture has on HSV. This multiplier should be applied to the age/sex HSV of patients without a fracture being used in the model. There has been little said in this paper about the stochastic uncertainty associated with the estimates. The studies report standard deviations, however these can not be used since the final parameters for the model are ‘multipliers’. It has been necessary to estimate 95% confidence intervals using Feiller’s theorem (Brigg and Gray, 1999).

CONCLUSION

An extensive search of the literature revealed only five studies on the impact of osteoporosis related conditions on HSV and these generated 23 values. These values differed significantly from the assumptions used in previous economic models, such as the NOF model. These have been critically reviewed in order to understand the reasons for the wide range of values and to select values to recommend for use in economic evaluation. Many of the differences seem to reflect the source of value (e.g. patient’s own values or social values) or the descriptive system used in the valuation (e.g. condition specific vignettes or generic preference-based measure). The selection of values for an economic model was undertaken by recommending a reference case of values for use in all economic evaluation (Table 2), though it is recognised that analysts may wish to use other values as well, such as those obtained directly from patients.

The empirical studies reviewed in this paper were not designed for the economic model being developed by Kanis et al (2002). This is likely to be a common problem in economic modelling. This review identified shortcomings in existing evidence in osteoporosis that could be met by further research. To improve the reference case values, for example, would require the administration of a preference-based generic health status measure to a large prospective population cohort prior to the fracture occurring and long-term follow-up. Such preference-based measures could include the

EQ-5D, HUI-III or the recently developed SF-6D that utilises SF-36 data (Brazier et al, 2002). The choice should depend on evidence of their validity across these conditions. It would be possible to estimate the actual loss in HSV over time following each of the fractures (including multiple fractures) by age and generate measures of variance. These data could be collected as apart of large clinical trials and observationally. International studies would also allow for cross-national comparisons.

Even for a well researched condition like of osteoporosis, it is unlikely that many of the data requirements of economic models will be met due to the constraints of time and cost. This review has raised some real practical problems of how to take values from one study and use them to populate a model involving extrapolations to different groups and over time and the estimation of loss without good controls. These are additional problems to the well-known methodological controversies surrounding the descriptive systems, the valuation technique and the source of values.

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Table 1: Empirical estimates of utility values for osteoporosis related health states

Condition	Study	Health state description	Health state value	How valued	Who valued	
Normative	NOF		1.0	Judgement	Panel of experts	
	Kind et al, 1998	EQ-5D completed by general population		TTO	General population (n=3381)	
		45-49	0.840			
		50-54	0.850			
		55-59	0.802			
		60-64	0.829			
		65-69	0.806			
		70-74	0.747			
75-79		0.731				
		80-85	0.699			
		85+	0.676			
Hip fracture	NOF Review	First year: assumes time spent in acute care, rehabilitation and so forth	First year: 0.3817	Judgement	Expert panel	
		Assumed distribution across defined disability states	Subsequent years: 0.855			
	Gabriel et al 1999	37 Patients mean age 76 with hip fracture in the last 5 years completing:				
		HUI-II	0.68 (0.18)	SG (estimated from a transformation of VAS).	Parents of school children from Hamilton, Canada (n=203)	
		QWB	0.61 (0.08)	VAS	Representative sample of the general population of San Diego	
Own health state	0.72 (0.16)	VAS	Patients			
Own health state	0.70 (0.41)	TTO anchored by best imaginable for their age and death	Patients			

		Disabling hip fracture state	0.65 (0.45) 0.28 (0.37)	TTO anchored by best imaginable health for age and death TTO anchored by own health and death with former transformed by own health state valuation (itself anchored against best imaginable for age and death)	Patients (n=33, mean age 76) who regarded their own state as worse than hypothetical state Recent clinic attendees who have never had a fracture (n=198, mean age 68)
	Salkeld et al, 2000	Life after a 'good' hip fracture.	0.31 (IQR=0.0-0.65)	TTO anchored by a typical health state of someone of similar age to the respondent and death	Older people at risk of fracture (n=194, mean age 81)
	Brazier et al, 2000	39 Patient completed EQ -5D before and after fracture (mean age 76)	6 mths: 0.49 (0.32) 12 mths: 0.48 (0.38)	TTO	General population (n=3381)
4. Confined to a nursing home due to a hip fracture	NOF Review	Nursing home	0.4	Judgement	Expert panel
	Salkeld et al, 2000	Life after a 'bad' hip fracture that included being in a nursing home	0.05 (no range given)	TTO anchored by a typical health state someone of similar age to the respondent and death	Older people at risk of fracture (n=194)
Vertebral fracture	NOF Review	Assumes 33% experience no change, 57% QoL reduced by 0.5 for 1 month, 10% experience complete loss and then 0.5 loss for 7 weeks	0.97	Judgement	Expert panel
	Gabriel et al, 1999	94 Patients with vertebral fracture in the last 5 years completed: HUI-II QWB	0.80 (0.16) 0.66 (0.09)	SG (estimated from a transformation of VAS). VAS	Parents of school children from Hamilton, Canada (n=203) Representative sample of the

		Own health state			general population of San Diego
		Own health state	0.76 (0.17)	VAS	Patients (n=94)
			0.81 (0.32)	TTO anchored by 'best imaginable for age' and death	Patients (n=94)
		Multiple vertebral fracture state	0.68 (0.4)	TTO anchored by best imaginable health and death	Patients (n=24) who regarded their health as worse than the hypothetical state
			0.31 (0.38)	TTO anchored by own health state and death with the former transformed by own health state valuation (it self anchored against best imaginable for age and death)	Clinic attendees with no fracture in last two years (n=199)
	Oleksik et al, 2000	Patients with radiographically confirmed fracture in the last 5 years completed the EQ-5D		TTO	General population (n=3381)
		No. # n			
		0 293	0.82 (0.21)		
		1 130	0.75 (0.23)		
		2 69	0.74 (0.25)		
		3 36	0.81(0.18)		
		≥4 60	0.66 (0.30)		
		Lumbar 42	0.78 (0.20)		
		Thoracic 145	0.68 (0.34)		
Wrist fracture	NOF Review	Assumes 0.7 for 7 wks. Assumes long term dependency for 2% of cases with QoL reduction to 0.7	Yr. 1 0.96 Subsequent yrs 0.98	Judgement	Expert panel

'Established osteoporosis'	Dolan et al (1999)	EQ-5D completed by 50 wrist fracture cases (mean age 72) in outpatient clinic at first and final visit (average 48 day interval). QALY loss over a year assuming a linear progression between initial and last assessment 0.018 (0.014)	0.982	TTO	General population (n=3381)
	Gabriel et al 1999	Own health: Patients with non-traumatic vertebral fracture in last five yrs (excluding multiple fractures) Health state constructed from clinician views and focus groups (including reference to future risk)	0.84 (±0.29) 0.43 (±0.40)	TTO anchored by best imaginable for age and death TTO anchored by current health and death, transformed by valuation of own health against perfect health and dead	Patients (n=75, mean age 76). Clinic attendee with no fracture in last 2 years (n=199, mean age 68)

Where: TTO, time trade-off; SG, standard gamble; VAS, visual analogue scale; QWB, Quality of Well-being Scale; HUI, Health Utility Index.

Table 2: Reference case health state values to be applied to population norms¹

Health state	Value	Source
Established osteoporotic	Use values associated with the type of fracture (see below)	
Hip fracture	0.797 95% CI 0.651-1.012	Brazier et al, 2000
Nursing home	0.4	NOF
Vertebral fracture	0.909 95% CI 0.84-0.97	Oleksik et al, 2000
Wrist fracture in first year	0.981 95% CI 0.978-0.986	Dolan et al, 1999
Proximal humerus	0.981 95% CI 0.978-0.986	As for wrist

1. These values are the multipliers for the proportionate effect of a fracture on a HSVs in the first year. For subsequent years, see suggestions in text.

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