Final Report to the National Highway Traffic Safety Administration:

Uncertainty Analysis of Quality Adjusted Life Years Lost

Prepared by -

Rebecca S. Spicer, Ph.D., M.P.H. -

Ted R. Miller, Ph.D. -

Pacific Institute for Research and Evaluation, Calverton, MD -

February 5, 2010 -

TABLE OF CONTENTS -

Executive Summary

Quality-adjusted life years (QALYs) are a measure used to account for the impact of a health state on both quality and quantity of life. It is the product of life expectancy and quality of life changes. Loss of one year of QALY is equivalent to losing a year of quality of life due to premature mortality. Currently, the National Highway Traffic Safety Administration (NHTSA) uses QALY estimate in cost-utility analysis of injury prevention measures.

A variety of "preference-based" instruments have been developed to measure health status or QALY losses. These instruments put preference weights on different health dimensions to reflect the value of social preferences and perceived relative importance of each dimension. The Injury Impairment Index (III) is a preference-based instrument that applies functional losses in six health dimensions to compute QALY losses from injury. Within each dimension in the III there are four levels of severity. Uniquely, the preference weights used in the III are derived from a review of preference weights used in other instruments. The first generation of III preference weights is based on Miller et al.'s (1995) review.

This report updated the Miller et al. (1995) III preference weights using the most recent literature. The variability was analyzed and then applied in sensitivity analysis to examine the resulting range of QALY loss estimates for injury.

We identified instruments used in the public health field to assess quality of life. Using a systematic literature review, we then compiled the published preference weights from other instruments for dimensions and levels found in the III. Based on this collection, median and interquartile ranges were computed to represent the uncertainty range of preference weights within each III dimension and level. We then applied the III algorithm to compute QALY losses using the updated weights.

Some instruments corresponded better with the III than others, primarily because the dimensions were similar and there was enough detail in the level descriptions to match to one III level. The most common dimensions within the reviewed instruments were mobility and activities of daily living. Few studies provided cosmetic-related utility weights, one of the six III dimensions. In general, the first generation of III utility weights fell in the low end (greater functional loss) of the range of utility weights from comparable dimensions and levels in other instruments.

Average QALY losses per injury by maximum Abbreviated Injury Score (MAIS) were computed using the updated preference weight ranges applied to seven years of the most recent crash data available (2000-2006). These averages were then compared to average QALY losses based on the first generation of preference weights according in Blincoe et al (2002). The updated QALY estimates are slightly lower than those from Blincoe et al. (2002). Differences are due in large part to 1) a change in case mix from the one year of 2000 data used in Blincoe et al. (2002) to the seven years used in this report and 2) the updated utility weights.

This report presents tables of average QALY losses by MAIS, injury type, and body region injured. These averages can be applied to future and existing injury data in order to estimate the impact of injury on quality of life and measure health status.

I. Introduction

A. Background

Quality-adjusted life years (QALYs) are a measure used to account for the impact of a health state on both quality and quantity of life. It is the product of life expectancy and quality of life. Thus, the concept of a QALY incorporates the quality of life impact from an injury or illness and is derived from a comprehensive model of health that accounts for multiple dimensions such as physical, psychological and social well-being. Loss of one year of QALY is equivalent to losing a year of quality of life due to premature mortality. Currently, the National Highway Traffic Safety Administration (NHTSA) uses QALY estimates in cost-utility analysis of injury prevention measures. This report provides input on the utility weights used in computing these QALYs and the statistical uncertainty that surround them. This report is one component of the greater QALY sensitivity analysis that NHTSA is conducting.

A variety of instruments have been developed to measure health status and QALYs. These are "preference-based" instruments that put utility weights (or preference weights, preference scores) on different health dimensions to reflect the value of social preferences and perceived relative importance of each dimension. Preference-based instruments yield a value between 0 and 1 to score a person's health state. The advantage of using a preference-based instrument is the ability to convert a score into a measure of health-related utility such as quality adjusted life years (QALYs). Converting all outcomes (morbidity and mortality) into one uniform unit provides a measure for use in cost-utility analysis.

Nonpreference-based instruments, on the other hand use a survey to create a profile of health status based on a total score. Like preference-based instruments, the final score is based on scores within multiple dimensions of health.

B. The Injury Impairment Index

In its regulatory analyses, NHTSA uses QALYs derived from a preference-based instrument called the Injury Impairment Index (III) (Miller 1993, Miller et al. 1995). The III was originally developed for physician use to rate the consequences of injury (Hirsch et al., 1983). The III estimates were built in five steps. First, a six-dimensional scale was developed for rating the functional capacity losses that typically result from an injury over time (Hirsh et al. 1983). The scale assessed impacts on mobility, cognitive, activities of daily living, pain, sensory, and cosmetic aspects of functioning. Second, four physicians with expertise in orthopedics, neurology, surgery and plastic surgery rated the typical losses due to injury, collectively generating loss ratings for each AIS 2-5 injury diagnosis in the Occupant Injury Code/Abbreviated Injury Score 1985 (OIC/AIS85)[1] system (Hirsch et al. 1983). AIS85 (and later generations in 1990 and 2005) rates an injury's threat-to-life

[1] See Appendix A for a description of coding systems.

with scores ranging from 0-uninjured to 6-virtually unsurvivable (AAAM 1985, 1990). Hirsch et al. (1983) rated losses by days for the first year, as an average for years 2-5 post-injury, and as an average beyond 5 years, noting any variation by patient age. In addition to rating losses in function within each dimension, the panel estimated the amount of time the average patient would spend in an impairment level within a dimension for each time period. Third, estimates were added for new AIS-85 diagnoses (Carsten 1986) and for victims with a maximum AIS across their injuries of 1 (derived from the work-loss impacts of the injuries). Fourth, data on the probability of permanent total work-related disability and the probability and severity of permanent partial work-related disability were estimated from a 452,000-person sample of occupational injury victims and added for each injury. Fifth, the seven dimensions of impairment were converted into a single measure of lost utility (an economic measure of something's value) by applying published population survey estimates of the perceived utility associated with different dimensions of functional loss. These weights were derived from a systematic review of the literature completed in 1989 (Miller et al., 1993). This step yielded estimates of the functional loss within each period post-injury.

C. Other preference-based instruments

Other survey instruments exist that measure health status and are segmented into multiple dimensions of functioning. In some cases the scale was developed to measure functional outcomes for specific illnesses or injuries. For example, the Health Utilities Index-2 was developed for the pediatric cancer population and includes a dimension for fertility. The Functional Capacity Index was developed to measure functional outcomes after injury and includes detailed dimensions for activities of daily living (such as eating and going to the bathroom independently).

Comparisons of instruments have found varying estimates of quality of life impact for the same illness or injury (e.g. Sintonen, 1994; Hawthorne et al, 2001). Because the III relies on utility weights derived from the existing literature, the sources of these discrepancies are the basis for the sometimes wide range of utility weights incorporated into the instrument. Discrepancies can be attributed to varying degrees to several factors:

1) Differences in dimensions covered by the different instruments and/or the selection of levels within each dimension. Some selections are as simple as "none", "a little" or "a lot" (the EQ-5d) and others allow more options (the HUI-3 has up to 6 levels within each dimension). More options will allow for greater differentiation ("sensitivity") between health states;

2) Differences in the underlying valuation task that determines preference weights are also responsible for discrepancies. Valuation methods include (a) Visual Analog Scale (VAS) where the respondents indicate the desirability of a health state along a line with defined endpoints; (b) the standard gamble (SG) where respondents choose how much in terms of risk of death or some other worse outcome they are prepared to accept in order to avoid the certainty of the health state being valued; and (c) the Time Tradeoff (TTO) where the choice is years in full health versus years in the health state being valued;

3) Differences in functional form when combining the multiple dimensions to compute an overall health state. The linear additive functional form assumes there is no interaction in

preferences among dimensions – they are independent. The multiplicative functional form allows for a single type of preference interaction among the dimensions – dimensions are either preference complements with some overlap or they are preference substitutes. The form with the fewest assumptions is the multi-linear functional from where dimensions can be complements, substitutes, or independent.

and 4) Validation studies of the preference- and nonpreference-based instruments vary in quality and are based on different populations. Many values of preference weights are based on respondents in other countries and are therefore not calibrated to U.S. populations. In addition, studies may involve only a small number of respondents or are not representative of the U.S. population; some are more than fifteen years old.

Increasingly, sensitivity analysis is being incorporated into regulatory analyses. Because QALY savings are a major saving in many rule-makings, sensitivity analysis needs to account for the variability in these savings estimates.

II. Objectives

We examine the variability in preference weights associated with the different health dimensions and levels within the III by updating the preference weights in Miller et al. (1995) using values found in the more recent literature. The variability is analyzed and then applied in sensitivity analysis to examine the resulting range of QALY loss estimates for injury.

We present and discuss the mapping of dimensions/levels from other instruments to the III. Through a systematic literature review we identify preference weights from other instruments for dimensions found in the III. Median and interquartile ranges are computed to represent the uncertainty range of preference weights within each III dimension and level. We then apply the III algorithm to compute QALY losses using the updated preference weights.

Finally, the new generation of QALY estimates is compared to the original estimates in Blincoe et al. (2002) and we attempt to identify the magnitude of the impact on average QALY loss estimates of the following factors: 1) a change in case mix from the one year of 2000 data used in Blincoe et al. (2002) to the seven years of cases (2000-2006) used in this report, 2) the change in utility weights, and 3) the more detailed and updated mapping procedure used in this report.

We present average QALY losses by MAIS, injury type, and body region injured. These averages can be applied to future and existing injury data in order to estimate the impact of injury on quality of life and measure health status.

III. Methods

A. Literature Review

Preference-based instruments used to measure quality of life, like those used to estimate QALY losses in the III, were identified: the Health Utilities Index – 1 (HUI1), Health Utilities Index – 2 (HUI2), Health Utilities Index – 3 (HUI3), EuroQoL (EQ-5D), Disability Adjusted Life Years

(DALYs), Quality of Well-Being Scale (QWB), 15D, Assessment of Quality of Life (AQoL), and Functional Capacity Index (FCI).

Nonpreference-based instruments were also of interest to us because studies have transformed the scores from some of these non-preference-based instruments (the Short Form-6D (SF-6D), Short Form-12 (SF-12), and Short Form-36 (SF-36)) into preference-based utility losses by modeling the non-preference-based scores on scores from a preference-based instrument. In addition, we identified studies that, rather than scaling functional losses, provided utility loss estimates directly for one or more of the dimensions described in the III (e.g., hearing loss, disfigurement).

We identified the dimensions of functioning for each instrument and, like the III, each dimension is rated for the amount of functioning either remaining or lost. The first step in collecting preference weights for the III dimensions was to map, where possible, the dimensions and levels of other instruments to those of the III. The III is composed of six dimensions: mobility, cognitive, activities of daily living, pain, sensory, and cosmetic/disfigurement. Within each dimension of the III there are four levels of functioning and an associated utility weight of functional loss from 0 to 1 (0=perfect health and 1=dead).

We searched the literature for studies that validated preference-based instruments and presented utility weights by dimension or, as in many cases, present the regression model coefficients from which utility weights can be deduced. We included all studies that were amenable to extracting preference values. The search involved using the combination of the key phrases "preference weight" or "utility weight" or "preference scores" with all the different quality of life assessment instruments (e.g. HUI-3, SF-36) or with the phrases "quality of life" or "functional capacity". Some of the literature identified through this search then identified other relevant literature.

Utility weights were recorded for each III dimension and level to which they mapped. If the study included standard errors or standard deviations, these were also noted. Some studies of utility losses for specific health states (e.g. blindness, hearing loss, scarring, pain) that mapped directly to a dimension and level in the III were also included in the analysis. To locate values of states that mapped directly, we relied heavily but not exclusively on two systematic reviews (Tengs and Wallace, 2000; Harvard Center for Risk Analysis, 2004). To be consistent, all utility weights were transformed into a 0 (dead) to 1 (perfect health) scale. The analysis allowed for states worse than death.

B. Description of Instruments Reviewed in Our Study

The *Quality of Well-Being Scale* (QWB) (Bush et al., 1973; Kaplan et al., 1976; Kaplan, 1982; Fryback et al., 1993; Anderson et al., 1989), originally known as the Index of Well-Being, evolved from a health status index that was based on reviews of a wide variety of questionnaires used in health-related surveys. The instrument was first calibrated with a San Diego survey conducted in the early 1970s. Scales were developed for three dimensions: mobility, physical activity, and social activity. A fourth component weights various symptoms and problems. The "symptom/problem

complexes" are assessed as present or absent and only the most severe complex is scored. The levels within the dimensions describe relatively minor and moderate functional limitations making it difficult to rate very severe injuries or illnesses. Though the QWB was recalibrated for the Oregon Medicaid health rationing experiment, this problem was not fully resolved. Also, the weights for the symptom-problem complexes were regression based. Many were based on coefficients that were not statistically significant at the 90% confidence level and some are illogical (e.g., a cough involves a larger loss than a cough plus a fever).

The *Health Utilities Index* (Drummond et al., 1987; Torrance 1982; Torrance et al., 1992; Feeny et al, 2002) includes three versions: HUI-1, HUI-2, HUI-3. Each was used for a different study purpose (population and disease) and they were not meant to replace each other. The earliest, the HUI-1, was originally developed to evaluate outcomes in low birth weight infants. It was calibrated (developed with preference weights) with a survey of 112 parents of school-aged Canadian children and included only four dimensions and 960 health states. The HUI-2 was next developed for pediatric cancer patients and included 7 dimensions and 24,000 health states. A broader HUI-2 scale was re-calibrated through interviews with injured workers (Torrance et al., 1992). The most comprehensive HUI, the HUI-3, has more descriptive power with 8 dimensions and describes more than 972,000 health states, with 1,130 reported among the 16,920 Canadian subjects in the National Population Health Survey and with 1,076 reported among the Canadian 1,555 subjects in the institutional sample (Feeny et al., 1995). HUI scales are easily applied to a wide range of diagnoses. The HUI-3 has been used in every Canadian national health survey since 1990. Miller, Calhoun, and Arthur (1989) found that HUI-based TTO estimates of QALY loss compare reasonably well with direct survey estimates of utility losses for selected conditions.

Also known as the *EuroQol*, the *EQ-5D* (Dolan, 1997; Hakim and Pathak, 1999; EuroQol Group, 1990; Brooks et al, 1991; Nord, 1991; Williams et al., 1995; Devlin et al., 2003; Shaw, 2005) has been calibrated with national sample surveys in many countries, including the United States (Hakim and Pathak, 1999; Shaw, 2005), making its estimates more representative than any other scale developed to date. The scale only offers a total of 245 health states, however, so it is less detailed than other scales. Because the responses within dimensions are simplified to "a little" or "a lot" or "none", it also lacks the sensitivity to differentiate between alternative health states that cause moderate impairments. Substantial ceiling effects have been identified for the EQ-5D. For example, Houle and Berthelot (2000) found that 26.1% of respondents in a Canadian population-based health survey were in "perfect health" according to the HUI-3, while, among the same sample, 47.8% were in "perfect health" according to the EQ-5D. Luo et al. (2005) found that 50.1% of respondents in a U.S. population-based survey were classified at "perfect health" by the EQ-5D, while only 19.9% were similarly classified according to the HUI-2 and 19.5% according to the HUI-3.

The *Functional Capacity Index* (FCI) (MacKenzie et al., 1994; MacKenzie et al., 1996) is a preference-based instrument that maps Abbreviated Injury Severity scores (a measure of an injury's threat to life; originally AIS 1990) into a score that reflects expected levels of reduced functional capacity in the first year after injury. The index includes ten dimensions of function with

up to seven levels in each dimension. A convenience sample of 114 individuals rated the relative severity of different levels of function in terms of their impact on daily living.

The *15D* (Sintonen, 1994) is a preference-based instrument that, unlike most of the instruments reviewed above, assumes that the underlying structure of preferences is linear and therefore uses an additive (rather than multiplicative) functional form. The additive form does not allow for quantitatively important interactions in preferences among the dimensions and improperly quantifies non-additive impairment due to multiple injuries. The instrument is based on 15 dimensions of health with five levels in each dimension.

The *Assessment of Quality of Life* (AQoL) is the most recently developed preference-based instrument (Hawthorne et al., 2000). In the development of this instrument, much effort focused on developing non-redundant dimensions. Time-tradeoff was used for determining preference weights. The final score reflects a 15-dimensional health state. The instrument allows for states worse than death with a score below zero.

Some non-preference-based instruments are widely used to measure health status. One popular example is the *Short Form 36 Health Survey* (SF-36) (Ware and Sherbourne, 1992). The SF-36 is a shortened version of the health status instrument originally developed in the 1970s for the RAND health insurance experiment. The *SF-12* is an abbreviated form of the SF-36. Non-preference-based instruments have been modeled on preference-based scales in order to translate a score into a preference-based score (Nichol et al., 2001; Fryback et al., 1997; Sengupta et al., 2004). For example, the Short-form 36 (SF-36) responses have been modeled to predict QWB scores (Fryback et al., 1997).

The *SF-6D* (Brazier et al., 2002) is the result of an effort to derive a preference-based scoring formula for the SF-36. Brazier et al. (2002) restructured the SF-36 into sets of ranked items. Using the standard gamble technique with respondents from a representative sample of the UK population, they valued these ranked items.

The *Health Related Quality of Life* (HRQoL) is an instrument used by the Centers for Disease Control (Moriarty et al., 2003). The instrument is a set of questions called the "Healthy Days Measures". A standard 4-item set of Healthy Days core questions has been used in the State-based Behavioral Risk Factor Surveillance System, the National Health and Nutrition Examination Survey, and the Medicare Health Outcome Survey. Standard Activity Limitation and Healthy Days Symptoms modules were added in 1995. When both the core 4 questions and the Activity Limitation and Healthy Days Symptoms are used together, they comprise the full CDC HRQoL-14 Measure. The HRQoL measures health status based on the number of unhealthy days during the previous 30 days when the respondent felt that either his or her physical or mental health was not good

Disability Adjusted Life Years (DALYs) (Murray and Lopez, 1996) is the scaling used by the World Health Organization and the World Bank in their Burden of Disease analysis (Murray and Lopez, 1996). On a DALY scale, perfect health is 0 and dead is 1. Thus a DALY equals one minus a QALY. The original DALY loss scale was based on quality of life loss estimates by an expert panel for

a small group of diseases. Other DALY loss estimates, notably for the Netherlands, are based on EQ-5D. We only included utility weights from the former (World Bank) study. Rather than have separate dimensions, the DALY framework assigns one of six classes of disability which assign increasing weights associated with the extent of loss of physical functioning. These classes are rather broad, but mostly deal with activities of daily living. It is unclear who and how many people were involved in assigning the weights. Murray and Lopez (1996) simply state that "weights for the six classes have been chosen by a group of independent experts".

C. Computing Utility Weight Ranges by III Dimension and Level

The next step was to develop recommended best estimates and uncertainty ranges for each III dimension and level. In deciding whether the "best estimates" should be the means or medians of the estimates retrieved from the literature review, we considered the distribution of the data. Though the estimates are on a continuous scale, they are bounded on each end by 0 (dead; with the exception of the states scored worse than death) and 1 (perfect health). We explored the data and found that their distribution was skewed near the bounds, in particular for estimates close to 1. We examined the effect of transforming the data by taking the natural log of the estimates, but this procedure does not work well with skewed data. To appropriately log-transform the data we would need the original individual respondent data which were not available. Working with a non-normal distribution breaks an assumption that is made in meta-analysis when computing the standard deviation of the means. In our case, estimates near the boundary of 1 will be positively skewed and estimates near the boundary of 0 will be negatively skewed, while estimates around 0.5 will be the most likely normally distributed. Means and standard deviations are often poor measurements of location and spread for skewed data as they are influenced by the extreme values. In addition, adding and subtracting standard deviations can result in ranges that go beyond the actual data range, in particular for a small group of values near the boundary with one or two outliers. For example, where utility weights were, for the most part, close to the boundary of 1 (perfect health) but with one or two outliers, adding one standard deviation to the mean value resulted in a value greater than one. Given the asymmetry and distribution of the data it is advisable to use the median value rather than the mean (Tomlinson and Beyene, 2004). For the median there is no statistic similar to the standard error of the mean. However, the interquartile range is a good summary of data dispersion.

We did not weight the median scores by the number of respondents because that would give more weight to larger studies. Number of respondents does not necessarily reflect the quality of the resulting value. Studies that used a small but knowledgeable number of respondents or an unusually sound elicitation technique could produce more reliable values. Indeed, not all studies included in the literature review were of equal rigor. However, we did not make value judgments; all study values included in this report were given the same weight. We did follow up with a sensitivity analysis that used a criteria for "best studies" to compute medians using only the "better" studies (see Methods, F).

D. Developing QALY uncertainty ranges

The range of utility weights for each III dimension and level were transformed into a QALY uncertainty range by MAIS based on the most recent distribution of motor vehicle-related injuries reported to NHTSA.

1. Merging utility weights onto motor vehicle-related injury data (Figure 1)

We started with the median utility weights (and interquartile range) that were computed based on the literature review on the possible unique Injury Occupant Injury Codes (OIC)[2] using the 1985 version of the Abbreviated Injury Scale (AIS-85) [3] that were listed in the Hirsch et al. (1983) and Carsten (1986) reports. Included, then, for each injury code were also the physician functional loss ratings from Hirsch et al. (1983) and Carsten (1986). Each injury code was repeated four times in order to account for different impairment ratings for different age groups (<16, 16-45, 46-65, 65+). (see Ia. of Figure 1)

The challenge was to map these utility weights and functional loss ratings to current motor vehicle-related injury data coded with the OIC in the 1990 version of the Abbreviated Injury Scale (AIS-90) in order to produce estimates of average QALY losses by Maximum Abbreviated Injury Scale score (MAIS-90). To achieve this we translated OIC/AIS-85 codes into ICD-9-CM codes so the utility weights and impairment ratings could be merged onto motor vehicle injury cases in ICD9-CM coded health care data: the 1996-1998 National Hospital Discharge Survey (NHDS) and the 1987-1996 National Health Interview Survey (NHIS).

The basic ICD9[4] description is a 3-digit code. An injury can be coded with an additional 4th or 5th digit depending on the amount of detail needed or available. For example, code 881 indicates an open wound of the elbow, forearm or wrist. The fourth digit indicates whether there were additional complications (such as tendon involvement) and the fifth code indicates whether the wound occurred on the elbow forearm or wrist.

In order to map the OIC/AIS-85 code that is used with the original Hirsch et al. (1983) data file of functional loss ratings to the ICD9-CM codes on motor vehicle-related injury cases in NHDS and NHIS data, an intermediary step had to be taken because no direct map from OIC/AIS-85 to ICD9-CM exists. We used a pre-existing map (Miller et al., 1995) from OIC/AIS-85 to the US Consumer Product Safety Commission's NEISS code[5] which classifies the person's injury according to the injury type (fracture, sprain, etc) and body part injured (see Ib. of Figure 1). We then used a second pre-existing map from NEISS codes to the ICD9-CM codes (Miller et al., 1995) (see Ic. of Figure 1).

At this point, these data list for every ICD9-CM code and age group combination: the utility values for every III level and dimension along with the physicians' functional loss ratings.

---

[2] See Appendix A for a description of coding systems.
[3] See Appendix A for a description of coding systems.
[4] See Appendix A for a description of coding systems.
[5] See Appendix A for a description of coding systems.

This file was then merged, by ICD9-CM, onto NHDS data by 5-digit ICD code. The file was merged by 3-digit ICD9-CM (see Id. of Figure 1). Often several OIC/AIS-85 codes mapped to an ICD9-CM code. When this happened, the MAIS-85 score on the utility weight/functional losses file was matched to the health care case's AIS-85 code on NHDS or NHIS in order to narrow the possible OIC/AIS-85 codes that map to the specific ICD9-CM diagnosis.

The National Hospital Discharge Survey (NHDS) (1996-1998) includes fatal and hospitalized injuries. The National Health Interview Survey (NHIS) (1987-1996) includes injuries that required medical attention but were not hospitalized. We excluded all fatalities in the NHDS and hospitalized cases in the NHIS to avoid double-counting. This analysis considers only cases coded as motor vehicle-related. The combined data sources included 345,958 raw unweighted cases; 216,748 in the NHDS and 129,210 in the NHIS.

The next step was to make the health care data compatible with motor vehicle-related injury data collected kept by NHTSA (NASS and CDS), where injuries are coded by OIC in AIS version 90. To make ICD9-CM codes compatible with OIC/AIS-90 we retained the mapped AIS-85 score (AIS as defined in the 1985 codebook, AAAM, 1985), the AIS-90 score (from the 1990 codebook, AAAM, 1990), the body part and body region for each injury for each case in the NHDS and NHIS (see II. In Figure 1).

Prior to this analysis, AIS-85, AIS-90 were mapped and body part, body region and fracture/dislocation were determined for each injury. AIS85 was mapped using ICDmap-85 (MacKenzie et al, 1989). This map lists AIS by each ICD9-CM code up to the 5th digit level of detail. NHIS includes only non-hospital-admitted cases and uses almost exclusively (85.5% of the data set) codes within the basic 3-digit level. In many cases there were different AIS scores mapped to the 4- and 5-digit ICD9-CM codes within each basic 3-digit group. When this was the case we selected the lowest AIS score among all the ICD9-CM listed codes within each basic 3-digit group was selected. The rationale for selecting the lowest AIS is that the non-admitted cases tend to be less life-threatening than admitted cases. Conversely, if a hospitalized injury mapped to multiple AIS levels, we assigned the highest AIS level.

AIS90 was mapped using ICDmap-90 (Johns Hopkins University, 1997). ICDmap-90 uses artificial intelligence and guidelines from injury coding experts to translate ICD9-CM codes into AIS90 injury codes and severity scores. This map is more complex than ICDmap-85 and considers up to 6 ICD9-CM codes plus age of the victim. It also assigns AIS90 body region codes (which accurately classify AIS85 body region as well). Body part (22 categories) was mapped to AIS90 from previously collapsed ICD groupings in the hospitalization data (Miller et al., 1995) and fracture or dislocation was identified with the ICD9 codes.

The ICD/AIS90 mapping was developed by consensus and contains many assumptions related to the assignment of AIS90 codes to ICD rubrics (Miller et al. 1995). Since the NHIS uses almost exclusively 3-digit ICDs, the body part for its non-fracture ICDs often is unknown; non-fracture body part tends to be coded in the fourth or fifth digit. For NHIS cases, using the ICDmap-90 software, we therefore assigned a body region (8 regions) rather than a body part category.

Several severe but now survivable injuries were recoded from 6 to5 (complete cervical spinal cord lesions, lacerations of the heart, cerebral laceration). There were 205 raw cases that were recoded out of 216,748 in the National Hospital Discharge Survey data.

The original analysis was inadequate at differentiating between severe spinal cord injuries and acknowledged differences only according to location of the injury and whether the laceration of the cord was complete or partial. Consequently, the same impairment was assigned to a type of spinal cord injury, regardless of whether it was MAIS 4 or 5. In order to compute QALY losses due to MAIS 4 and MAIS 5 spinal cord injuries with more detail, we searched for and examined reports and the literature. We found several sources from which we incorporated impairment estimates into our analysis.

We extracted the Functional Capacity Index (FCI) ratings that were assigned to AIS 2004 descriptions of complete and incomplete spinal cord injuries by a panel of experts. The following were incorporated into the computation of QALY losses for spinal cord injuries. FCI scores reflect functional losses based on a preference-based measure where 100=perfect health.

Cervical: incomplete cord laceration (AIS 5) = 42

Cervical: incomplete cord syndrome (AIS 4) = 28

Dorsal: incomplete cord laceration (AIS 5) = 85

Dorsal: incomplete cord syndrome (AIS 4) = 40

Therefore, according to the FCI scores, though survival is more likely for AIS 4 spinal cord injuries, the functional losses estimated for these cord syndromes are rated as more severe than AIS 5 injuries

Further modifications relevant to spinal cord injuries included adding lines in the Hirsch et al. (1983) file (e.g. adding unique Occupant Injury Codes, OIC) that describe AIS 3 “back” injuries. The original Hirsch file did not include these injuries and therefore NEISS and, later, ICD9-CM codes that are relevant to the “back” did not map to any of the OIC codes in Hirsch. This resulted in the loss of any possible impairment estimates for these injuries. Hirsch had MAIS 3 “back” injuries for “nervous system” but not for the spinal cord. We assumed that the impairments would be similar and assigned the same values for the back nervous system injuries to the respective back spinal cord injuries. Hirsch did have estimations for neck cord MAIS 3 injuries. The result of this adjustment was that we were able to incorporate estimates of MAIS 3 spinal cord injuries into the analysis.

Another area where fine-tuning adjustments were necessary was among MAIS 6 survivors. An MAIS 6 coding indicates that the injury is “unsurvivable”. However, there is the theory that more AIS 6 injuries are surviving due to quicker response and treatment. We examined AIS 6 survivors in CDS data from 1993 through 2005. We examined those cases where the victim has suffered an AIS 6 injury but the treatment variable indicated the victim was admitted to the hospital for at least one

overnight. We then retrieved the cases from the online NASS/CDS data system and examined the full report to get additional information from the narrative.

It was unclear for most cases that were transported to the hospital, whether they actually survived the injury. For one case, the narrative indicates that twenty days after the crash the family took the victim off of life support and the victim died.

It is difficult to tell if MAIS 6 injuries are more likely to be survived currently using the CDS data due to the small sample sizes. And even though we are not sure these cases are survivors, we can deduce that currently there are two types of AIS 6 survivable injuries: complete cervical cord lacerations and thoracic aortic lacerations.

We also examined the motor vehicle crash survivors in the National Hospital Discharge System (NHDS). AIS-90 was merged onto these data based on diagnosis codes using the software ICDMAP-90. The program requires that the user stipulate in cases where there is more than one possible AIS code to assign either the highest or the lowest value. Given that these were hospitalized cases where the injuries are likely to be severe, we indicate that the software should choose the highest value. In reviewing the MAIS 6 survivors we found that most of these victims survived the following injuries (ICD-9-CM codes): Complete cervical spinal cord lesion with (80601) and without (95201) fracture. We consequently recoded MAIS 6 injuries that were survived to MAIS 5.

2. Computing Impairment and QALYs

Once the value ranges for each III dimension and level were mapped to the health care data we computed impairment fractions. An impairment fraction measures the fraction of functional capacity typically lost to an injury, taking into account losses from the six dimensions discussed above plus the value that people assign to the ability to work. No additional utility weights beyond the two used in the original III were found in the literature for this seventh dimension (work). Miller et al. (1995) included in their impairment loss estimates the probability of disability and lost work. They adjusted that rate down (from 17% to 6.85%) in order to exclude work loss and include only the value people assign to the ability to work. The computation to arrive at this fraction was .17 * VSL - lifetime after-tax productivity/VSL = .0685 * VSL (where VSL=Value of a statistical life).

Based on the methods in Miller et al. (1995) we computed impairment fractions for year 1, years 2-5 and years 6 and greater by combining the physician-rated functional losses per injury from Hirsch et al. (1983) and the median utility weights compiled from the literature review. The valuation system of the III is based on an application of the multi-attribute utility theory. We assume the underlying structure of preferences is non-linear and therefore use a multiplicative functional form. This assumes the percentage of utility lost on each dimension to be a percentage of the utility remaining after the losses on prior dimensions are accounted for. This allows for important interactions in preferences among the dimensions and does the best job in quantifying non-additive impairment due between multiple dimensions. The weighted seven-dimensional impairment (IMP) equals:

IMP = 1-[1-WGT1(LOSS1)] x [1-WGT2(LOSS2)] x …x [1-WGT7(LOSS7)]

Where,

WGTi = utility loss fraction associated with dimension i (i=1 to 7)

LOSSi = the rated impairment level on dimension i (i=1 to 7)

Finally, the impairment fractions were used to compute the Quality Adjusted Life Years (QALYs) lost due to an injury.

If,

IMP1=Impairment fraction for the first year following the injury

IMP2=Impairment fraction for the second through fifth years following the injury

IMP6=Impairment fraction for the sixth year and on following the injury

a=discounted sum of one year at mid-year

at a 3 percent discount rate, $a=1/(1.03)^{0.5}= 0.99$ -

at a 4 percent discount rate, $a=1/(1.04)^{0.5}= 0.98$ -

at a 7 percent discount rate, $a=1/(1.07)^{0.5}= 0.97$ -

at a 10 percent discount rate, $a=1/(1.10)^{0.5}= 0.96$ -

b=discounted sum of one year per year for years two through five at mid-year

at 3 percent, $b=[1/1.03^{1.5}+1/1.03^{2.5}+1/1.03^{3.5}+1/1.03^{4.5}]= 3.66$

at 4 percent, $b=[1/1.04^{1.5}+1/1.04^{2.5}+1/1.04^{3.5}+1/1.04^{4.5}]= 3.56$

at 7 percent, $b=[1/1.07^{1.5}+1/1.07^{2.5}+1/1.07^{3.5}+1/1.07^{4.5}]= 3.27$

at 10 percent, $b=[1/1.10^{1.5}+1/1.10^{2.5}+1/1.10^{3.5}+1/1.10^{4.5}]= 3.02$

c=discounted sum of one year per year for years six through the average expected remaining life span. The average expected remaining life span was computed from a standard life table and based on the sex and age distribution of motor vehicle crash victims in the combined NHDS and NHIS data.

at a 3 percent discount rate = 18.35 -

at a 4 percent discount rate = 14.74 -

at a 7 percent discount rate = 8.54

at a 10 percent discount rate = 5.54

The NHDS data show that most patients received multiple injuries. To account for non-additive impairment due to multiple injuries we based the final impairment on the most severe utility loss in each functional dimension (i.e. mobility, cognitive, activities of daily living, etc.) among all the injuries listed for that case. Thus, the overall QALY loss will be a function of the maximum functional loss within each dimension.

Finally, we estimate QALYs lost as: -

QALY lost = a*IMP1+b*IMP2+c*IMP6. -

3. Merging QALY losses onto motor vehicle-related injury cases in NHTSA data sets

At this point in the analysis we have QALY loss estimates for individual motor vehicle crash victims reported in the 1996-1998 NHDS and the 1987-1996 NHIS. These were collapsed into two files: average QALY loss by MAIS, body part, and fracture/dislocation (for hospitalized injuries) and average QALY loss by MAIS, body regions and fracture/dislocation (for nonhospitalized cases) so that they could be merged onto weighted 2000-2006 motor vehicle crash-related injury data collected by NHTSA.

The best estimate of comprehensive 2000-2006 motor vehicle-related injury cases was done by combining several data sources collected by NHTSA in a manner similar to Blincoe et al. (2002). The data sources included the 2000-2006 Crashworthiness Data System (CDS), the 2000-2006 General Estimates System (GES), and the 1984-1986 National Automotive Sampling System (NASS). The CDS contains detailed information on police-reported injuries incurred by occupants of towed passenger vehicles. These crashes typically involve the most serious injuries to vehicle occupants.

Injuries that occur in crashes that do not fall under CDS's scope (injuries to victims in crashes where no passenger vehicle was towed away; injuries to occupants of large trucks, buses, motorcycles, bicyclists or to pedestrians) must be derived from other sources. The GES provides estimates for crash and vehicle types. Unfortunately, detailed information regarding injury severity (MAIS) is not provided. Instead, injuries are coded on the police-reported injury severity, commonly referred to as "KABCO". To estimate injury frequency for injuries not in the CDS data set, we used 1984-1986 NASS case data that are adjusted to reflect the case mix for 2000-2006 using 2000-2006 GES data and taking into account seat belt use, alcohol involvement and police-reported injury severity. To do this we identified non-CDS cases in the 2000-2006 GES files and computed total weighted cases ("GESwgt") by safety belt use, alcohol involvement, and KABCO injury severity. These were important factors to control for because belt use and alcohol involvement have significant impact on injury profiles and both have changed considerably since the 1984-86 period We did the same with the NASS 1984-1986 data ("NASSwgt"). "GESwgt" was merged onto the NASS 1984-1986 data by safety belt use, alcohol involvement, and KABCO injury severity. The 1984-1986 NASS individual case weights were then adjusted to reflect the annual 2000-2006 case mix, controlling for safety belt use, alcohol involvement, and KABCO, as follows:

Individual NASS case weight * (GESwgt/7 years)/NASSwgt

A comprehensive estimate of 2000-2006 nonfatal motor vehicle-related injures was obtained by combining the non-CDS strata crashes (non-towaway, non-passenger car) in 1984-86 NASS (adjusted to the 2000-2006 crash mix) with the 2000-2006 CDS data.

The average QALY loss estimates were merged onto NHTSA's CDS/NASS data from NHDS and NHIS in two steps, depending on hospitalization status indicated in the CDS case report. For hospitalized cases the average QALY losses were merged using the more-detailed body part code, fracture/dislocation, and MAIS. For nonhospitalized cases, average QALY losses were merged using the less-detailed body region, fracture/dislocation, and MAIS.

E. Average QALY loss per injury

After merging the average QALY loss estimates, we collapsed the data into average QALY loss per injury by hospitalization status, MAIS, body part or body region, and fracture/dislocation. Because NHTSA uses a variety of discount rates in regulatory analysis for OMB, we present the results in four different rates: 3%, 4%, 7%, and 10%.

We also compute the quality-adjusted percentage of remaining life lost due to injury by dividing the discounted sum of the number of years remaining in the expected life span of a U.S. population with the age and sex distribution of the motor vehicle crash victims in the NHDS an NHIS data set.

Discounted remaining life years=a+b+c

The quality-adjusted percentage of remaining life lost due to an injury=(QALYs lost)/(discounted remaining life)=(a*IMP1+b*IMP2+c*IMP6)/(a+b+c)

F. Supplementary sensitivity analysis using only the "best" studies

The studies and instruments reviewed for this project varied widely in several ways. First, not all studies were used preference-based methods, like the III, to estimate utility weights. Second, preference-based methods used varying valuation methods, including Visual Analog Scale, the standard gamble, and Time Tradeoff. Third, there were dissimilarities in the dimensions covered by the different instruments and/or the selection of levels within each dimension. Finally, the validation studies vary in quality and are based on different populations: many values of preference weights are based on respondents in other countries and are therefore not calibrated to U.S. populations; studies may involve only a small number of respondents or are not representative of the U.S. population; some are more than fifteen years old.

With these limitations in mind, we conducted a separate sensitivity analysis to examine the impact on QALYs if only utility weights from the "best" studies were used. The "best" studies were ones that met at least two of the three criteria: 1) the instrument used valued utility weights using preference-based methods, 2) used large population-representative samples, and 3) the instrument used dimensions and levels within those dimensions that were easily matched to those of the III. The studies meeting this requirement are highlighted in grey in Table 4.

G. Comparison of Generation 1 QALY Loss Estimates (Blincoe et al. 2002) to Generation 2 Estimates

Finally, we compared the average QALY losses by MAIS as estimated in this report (QALY08, Generation 2) with those estimated from Blincoe et al. (2002; QALY02, Generation 1). We attempted to identify the magnitude of the impact of the following factors: 1) a change in case mix from the one year of 2000 data used in Blincoe et al. (2002) to the seven years of cases (2000-2006) used in this report, 2) the change in utility weights (Generation 1 versus Generation 2), and 3) the more detailed and updated mapping procedure used in this report. To examine the role of the change in utility weights and the change in case mix we held one of these factors constant while the other varied. The contribution of each factor was explored by comparing the changes due to the isolated factor to the overall difference.

First, we applied the new average QALY estimates (QALY08) to the cases in the year 2000 data used in Blincoe et al. (2002). Just as in this report, we merged average QALY08 losses (computed in NHDS and NHIS – see III in Figure 1, in this report) by hospitalization status, body part (body region for nonhospitalized injuries), and fracture/dislocation onto the data of year 2000 cases. One limitation was that we were not able to identify hospitalized cases in the year 2000 data so we made the assumption that all injuries with MAIS 3 or more were hospitalized. There is support for this assumption: more than 80% of AIS 3-5 motor vehicle crash injuries are hospitalized (Miller et al., 1995).

Then, vice versa, we merged average QALY02 losses by hospitalization status, body part (body region for nonhospitalized injuries), and fracture/dislocation onto the data used in the current report. QALY02s were computed from the Quality of Life costs in the Blincoe et al. (2002) report using the value of $114,791 per QALY (year 2000 dollars).

The most meaningful way to examine the impact of the new generation 2 utility weights on the change in the QALY estimates was to apply the original utility weights used with the III in Miller et al. (1995) (see Table 5 in the revised Final Report above). The process of merging the updated utility weights onto motor vehicle-related injury data described in this report above was repeated using the original utility weights instead. Thus, all factors were the same with the exception of the utility weights.

Teasing out the role of the enhanced mapping system was not possible. However, the analysis of case mix and change in utility weights informed us of the unexplained differences remaining that could be explained by enhanced mapping.

IV. Results

Table 1 describes the number of functional levels by dimension for selected instruments. Most instruments include mobility and pain dimensions. Most have some measure of ability to do activities of daily living. Many include a dimension for cognitive functioning, an important dimension of impairment in injury. The III is one of the few instruments that include dimensions for cosmetic and sensory functions.

Table 2 presents the levels and dimensions of instruments as they mapped to corresponding dimensions and levels in the III, including a detailed description of each level within each dimension for every instrument. For the most part, other instruments use a scale of function remaining where utility weights range from 0=dead to 1=perfect health. Most instruments reviewed for the study include dimensions for mobility, pain, and activities of daily living. A few include cognitive and sensory. Almost none include a dimension for cosmetic.

Some instruments were easier to map to the III than others, primarily because the dimensions were similar and there was enough detail in the level descriptions to fit within one III level. The HUI, in particular the HUI-3, was most similar to the III. The FCI, like the III, was developed primarily for use with motor vehicle injuries and mapped fairly well to the III. Because of the detail in the FCI, multiple FCI dimensions often mapped to one III dimension. Instruments with little detail in the levels within dimensions were difficult to map to the III. The EQ-5D, for example, has dimensions that were very similar to the III dimensions but used the very general responses of "none", "a little" and "a lot" as levels, precluding accurate scoring of the six levels per dimension within the III. The SF-6D and the non-preference-based SF-36 and SF-12 also had similar dimensions to the III, but the levels, though detailed, were somewhat different from those of the III and therefore difficult to map. The DALY uses six "disability classes" to adjust life years. The "classes" were difficult to map to III because they described impairment at the general whole-body level and, in general, in the activities of daily living dimension.

Table 3 summarizes the literature retrieved that presents QALY or health-related utility weights across a spectrum of health states. No one type of valuation method dominates and a wide range of respondent types was polled across the studies (e.g., provider, patient, or general public). The majority of the instruments used a multiplicative functional form. The notes column describes the source of the utility weights within the paper. Not listed in this table are a multitude of individual illness and injury studies that provided a value for a single level of a single III dimension. Utility weights of these health states mapped directly to a dimension and level; most frequently hearing and sight loss to the III levels in the sensory dimension. References to these studies are found in Table 4.

Table 4 presents the individual utility weights retrieved in the literature review based on the mapping presented in Table 2. Because of the many illness studies of sight and hearing loss, the sensory dimension references over twenty studies. Because of the many instruments that included a mobility and/or a daily living dimension, these dimensions also reference numerous studies. On the other hand, very few studies provided cosmetic-related utility weights.

Table 5 summarizes Table 4 and compares the resulting median values and interquartile ranges by dimension and level to the values used in the III. In general, III utility weights (and the older literature) fell in the low end (greater functional loss) of the range of utility weights from comparable dimensions and levels in other instruments.

When the analysis was limited to the better quality studies (the "best" studies meeting the criteria listed in the methods section) the values on which the medians were based were obviously more limited (see Table 4 for the list of studies included). The median values by dimension and

level among "best" studies tended to be lower, indicating lower percent functioning remaining. Consequently, the resulting estimated median average QALY loss values (Table 8), when compared with the values based on the full range of studies (Table 6), were slightly higher. Quartile ranges varied to a greater degree but were still not dramatically different.

Table 6 presents the median, quartile 1 (Q1) and quartile 3 (Q3) QALY losses per injury by discount rate based on weighted motor vehicle-related injury cases, years 2000-2006. Table 7 presents QALY loss as a percentage of discounted years of life remaining[6].

Tables 8 and 9 present QALY estimates using "best" studies only. Table 8 presents the median, quartile 1 (Q1) and quartile 3 (Q3) QALY losses per injury by discount rate based on weighted motor vehicle-related injury cases, years 2000-2006, using "best" studies only. Table 9 presents QALY loss as a percentage of discounted years of life remaining based on QALY estimates using "best" studies only.

More detailed tables that break out QALY losses by injury type (fracture/dislocation versus non-fracture/dislocation) and body region are presented in Appendix B. Tables B1 to B4 are based on the main analysis that includes utility weights from all literature reviewed. Tables B5 to B8 are based on the "best studies" analysis that includes utility weights only from those studies that met at least 2 of 3 criteria for study quality.

Table 10 presents a direct comparison of estimated QALY lost from this report (QALY08) versus Blincoe et al. (2001) (QALY02). The differences are due in large part to several factors: 1) a change in case mix from the one year of 2000 data used in Blincoe et al. (2002) to the seven years of cases (2000-2006) used in this report, 2) the change in utility weights used when computing impairment estimates, and 3) a more detailed and updated mapping procedure used in this report.

After holding case mix constant while varying utility weights, and vice versa, the resulting average QALYs are presented in Table 11a where:

QALY08 = average QALY loss per injury based on the new generation of utility weights (Spicer and Miller, 2008)

QALY02 = average QALY loss per injury used in Blincoe et al. (2002), where $114,791 (year 2000 dollars) in Quality of Life losses is equal to one QALY.

QALYiii = average QALY loss per injury based on the original utility weights in Miller et al. (1995)

---

[6] While total QALYs lost decreases with increasing discount rate (see Tables 6 and 8), the percentage of discounted years of life remaining increases with increasing discount rate. This is due to the fact that, as the discount rate increases, year 1 of remaining life increases as a proportion of total years remaining. (e.g., at 3%, .99/23=.04 and at 7%, .97/12.78=0.08). Most of the impairment occurs in the first year following the injury and, therefore, QALY losses as a proportion of total remaining life increases as the discount rate increases.

wt08 = weighted by the 2000-2006 case mix used in Spicer and Miller (2008)

wt02 = weighted by the 2000 case mix used in Blincoe et al. (2002)

According to the analysis in Table 11b, about 35% of the difference between average QALY08 and average QALY02 is due to a change in the case mix. The remaining 65% is probably mostly due to the change in utility weights, however, other factors such as an enhanced mapping process may also play a role and cannot be teased out with this analysis. There are limitations to this comparison. Quality of Life costs in Blincoe et al. (2002) were converted to QALYs – not directly calculated. In addition, in merging QALY08 onto the year 2000 case data, we had to assume that MAIS 3 or greater were hospitalized. There is support for this assumption: more than 80% of AIS 3-5 motor vehicle crash injuries are hospitalized (Miller et al., 1995).

Holding all factors constant, Table 11c presents the analysis of the impact of the update in utility weights on average QALY estimation. QALY08 utility weights resulted in QALY estimates slightly lower than QALY02 utility weights. In general, the magnitude of the change (% change) decreases with increasing MAIS.

Logic would dictate that QALYiii/wt08 estimates should match the QALY02/wt08 estimates (see Table 10a). However, there are several reasons this is not the case: mapping procedures differed; the computation of QALY02 was indirect; and the current analysis computed a QALY value for MAIS if impairments were mapped to the injury (the old analysis assigned only the QALY value on not being able to work).

Finally, Table 11d compares the updated estimated average QALY losses by MAIS to average QALY losses using the original Miller et al. (1995) utility weights where these original weights were merged onto the same 2000-2006 motor vehicle-related injury data using the same method described in this report. Thus, all factors were the same with the exception of the utility weights. In general, the new QALY loss estimates are slightly lower than those calculated with the original Miller et al. (1995) utility weights. It is important to note that the original QALYs do fall close to the middle of the estimated uncertainty ranges.

V. Discussion

The literature revealed that utility weights for dimensions and levels from preference-based instruments that mapped to the III were somewhat consistent (Table 4). In addition, numerous studies published in the past decade derive preference weights for non-preference-based instruments (such as the SF-36) by modeling the non-preference-based instrument's scores on the preference-weighted scores of another instrument (such as the HUI-3).

In general, III utility weights fell in the low end (greater functional loss) of the range of utility weights based on comparable dimensions and levels in other instruments (Table 5). Therefore, we would expect analyses based on the uncertainty ranges presented in this report will yield QALY values slightly lower than those based on the original III. One exception was in the cosmetic/disfigurement category where III values tended to fall in the upper end (less functional loss) of the uncertainty range. This dimension was problematic because very few instruments had a

cosmetic dimension and most of the values mapped to this dimension were from individual illness and injury studies.

We had to decide on the summary measurement. Most meta-analyses, even pseudo-meta-analyses like this study, use means and standard deviations. However, the distribution of utility weights in this study was difficult to define. The decision to use medians and the interquartile range was made, for the most part, because medians do not assume any particular distribution and can be used with continuous data bounded on each end. We compared means and medians and found that they differ very little. However, adding and subtracting 0.674 times the standard deviation to the mean, even with log-transformed data, resulted in utility weights beyond the boundaries, in particular for values near the boundary of 1 (perfect health). Further examining the resulting uncertainty range (mean +/- .0674*SD) we found that, after forcing the boundary to 1 for the impairment fractions where mean plus 0.674*SD was greater than one, the range around the mean QALYs was asymmetrical. The interquartile range was also asymmetrical due to the skew of the data (Table 6). Further notable, the interquartile and uncertainty ranges (mean +/- .0674*SD) for QALYs were similar.

VI. Limitations

Several limitations deserve mention. Because we did not have access to the original data in the literature review, a true meta-analysis was not possible. In addition, only about one-third of studies provided standard errors or standard deviations of their individual estimates. Therefore, the methods used to calculate the uncertainty ranges of the individual study estimates did not include an allowance for this error.

As can be seen in Table 2, the mapping of dimension and levels to the III from other instruments is imperfect. Factors contributing to the difficulties in this mapping included definitions that are not an exact match, definitions in an instrument being more general or, less common, more specific than those in the III, and levels in an instrument overlapping several levels in the III. Some dimensions in the III (e.g. mobility, activities of daily living) had many corresponding matches in other instruments. Others had very few (e.g. cosmetic, pain, work). In addition, the studies were done in a variety of countries and did not always poll the general population. It is unclear if the responses are generalizeable to the US population.

No one single study supplied all the estimates for all of the dimensions and levels. Therefore, inconsistencies between studies will affect the final certainty ranges. One of the more important inconsistencies between studies is the valuation method used. For the most part, three methods were used: standard gamble (SG), visual analog scale (VAS), or time trade off (TTO). Studies have shown that the response will vary by method used (McCabe et al., 2005; Nord, 1991; Robinson et al., 1997). Research suggests that though the VAS provides ranking information comparable to the SG and the TTO, it is not a good measure of preference across health states.

The III is likely to have preference complementarity, where the overall functional loss of two combined dimensions is less than the sum of the functional loss for each dimension alone. The III also draws utility weights from instruments that likely suffer from preference complementarity.

Therefore, summing the loss represented by each dimension will overstate the overall loss. We attempt to mitigate this problem by using a multiplicative functional form. The percentage utility lost on each dimension is a percentage of the utility remaining after the losses on prior dimensions are accounted for.

Like many algorithms that compute QALY losses, the III algorithm assumes that people are in perfect health before applying the functional loss due to the injury. This assumption ignores chronic and acute conditions that may have been in place at the time the injury occurred. In reality, most people are not in perfect health when injured and the older the person the lower the health state. Therefore, QALY loss estimates using the III algorithm may be overestimated.

Including the regression-based scores from studies that impute scores in non-preference-based indices (such as QWB and SF-36) based on the relationship between the non-preference-based QALYs and the preference-based QALY could be considered double-counting. The HUI-2 and -3 are both used in these studies and therefore contribute, indirectly, more to our average weighting. We have included these values because they give us values for scale points and conditions that are not included in many of the indices. In addition, we found there was a benefit to having multiple utility weights within each level on which to base the average. However, because of the limitations, these studies of non-preference-based instruments were not included in our "best studies" sensitivity analysis.

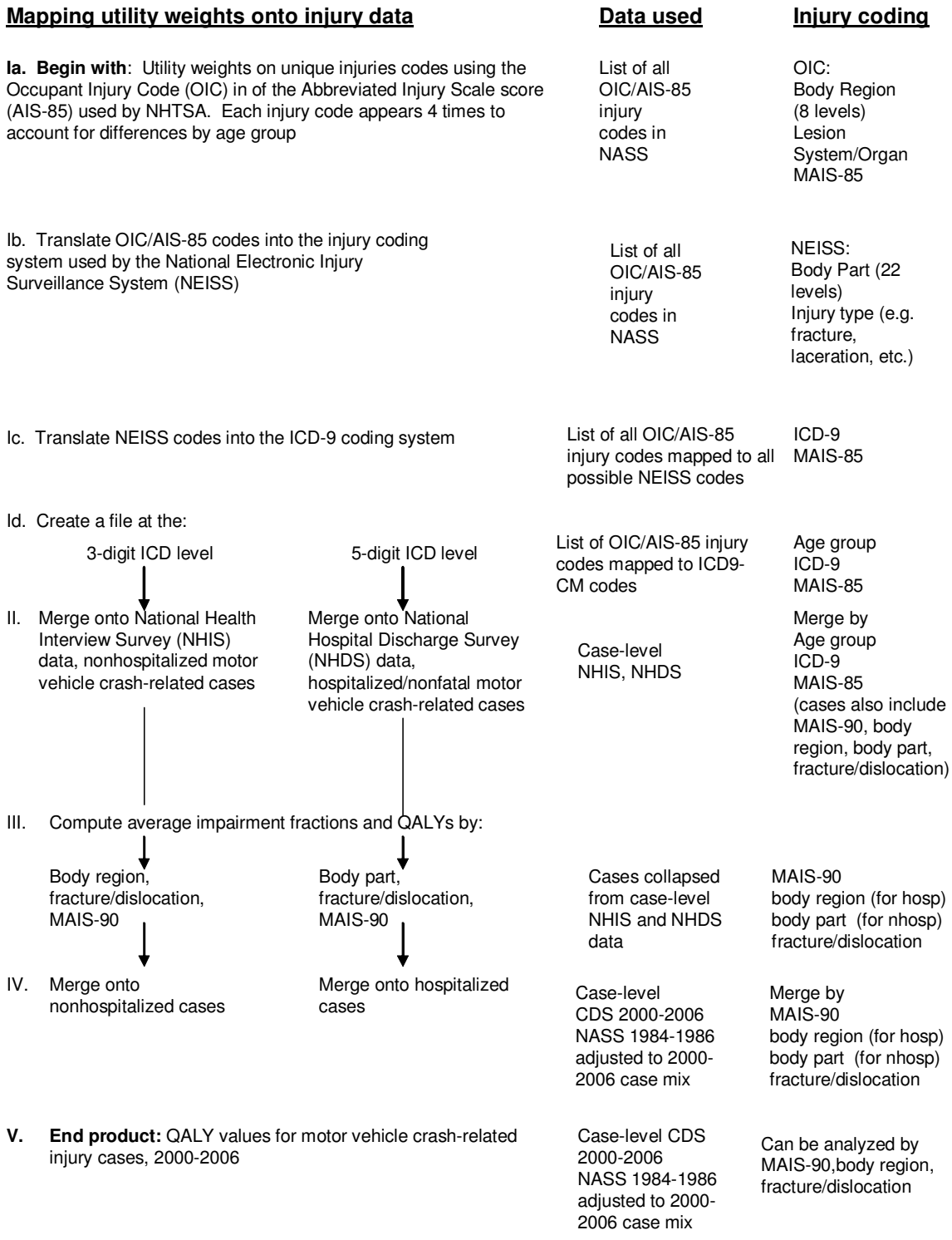
The "best studies" sensitivity analysis found QALY estimates similar to those in the main analysis. However, limiting the analysis to only those that met all three criteria resulted in a very small sample of utility weights for some dimensions (e.g. Disfigurement/Cosmetic levels1-3).

An unknown level of error underlies the two-stage method of mapping from OIC to NEISS to ICD9 code. We attempted to limit this error by matching the AIS85 code in the original OIC code to the AIS85 code on the ICD9 coded cases wherever possible.

For hospitalized cases with multiple injuries, the analysis accounts for multiple injuries. However, for nonhospitalized injuries where multiple injuries per case are also possible, only one diagnosis was listed in the NHIS data file. Therefore the impairments for nonhospitalized cases are an underestimate because they only take into account the primary diagnosis.

Finally, we applied the mid-year discount rate in the first year. Because the greatest impairment from an injury occurs in the first three to six months, this procedure slightly underestimates the first year impairment

Figure 1: Process of merging utility weights onto motor vehicle crash-related data and computing Quality Adjusted Life Years (QALYs) lost (See Appendix A for a description of coding systems)



Tables

Table 1: Number of levels by dimension for selected instruments that value health states

Domain	EQ-5D	FCI	HUI-1	HUI-2	HUI-3	III	QWB	AQoL	15D	HRQoL	SF-36#	SF-12	SF-6D	DALY$
Mobility	3	6	6	5	5	5	4	4	5		13	3	4	
Cognitive		6	2	4	6	5	2		5					
Self Care	3		2	3		5	2	8	5	31**	3	2	2	6
Hand/Arm		6			4						3			
Bend/Lift		4									5	3		
Sensory			4	4		5								
Seeing		7			5		2	4	5					
Hearing		5			5			4	5					
Speech		4	2		5	2			5					
Fertility				3										6
Sexual		3							5					
Eating		3				2			5					6
Excretory		4							5					
Pain	3		2	5	5	5	6	4	5		12	5	6	
Emotional	3		4	5	5		2	4	10	31**	22	16	5	
Work/Social/Role Functions	3		5			*	11	16			18	7	9	6
Cosmetic			2			5	3							
Other Symptoms							7	4	10					
Perceived Health							5		5	31**	14	5		
Energy/Vitality									5		24	6	5	

EQ-5D = EuroQol Scale, FCI = Functional Capacity Index, HUI = Health Utilities Index, III = Injury Impairment Index, QWB = Quality of Well-Being Scale, SF-36 = Short Form 36 health survey, AQoL = Assessment of Quality of Life, HRQoL = Health Related Quality of Life measure, SF-12 = Short Form 6 health survey, SF-6D = Short Form 6 health survey, DALY = Disability-Adjusted Life Years; See text below for references.

* = continuous variable, based on vocational assessment of percentage work-related disability. -
** = continuous variable, range 0-30 days -
# = Validated abbreviated versions exist (e.g.SF-12, SF-6D) -
$ = Uses only six “disability classes”, each covers a broad range of domains -

Table 2: Mapping of dimensions and levels from instruments used to value health states to dimensions and levels of the Injury Impairment Index (III).

The III (Injury Impairment Index) Def by Physicians in Hirsch et al. 1983	**EQ-5D*Revised classification (Patrick and Erickson, 1993, p.404-5)**	**SF-6D**	**HUI-I**	**HIU-II**	**HUI-III**
Mobility	**Mobility**	**Physical Functioning**		**Mobility**	**Ambulation, Dexterity**
1. Impaired Mobility with intact functional ability		2. your health limits you a little in vigorous activities	**P**2. Being able to get around the house, yard, neighborhood, etc. without help from another person; and having some limitations in physical ability to lift, walk, run, jump, or bend	2. Walks, bends…. But does not require help	**Ambulation**: 2. Able to walk around the neighborhood with difficulty; but does not require walking equipment or the help of another person
2. Impaired mobility with mildly abnormal function. Partially dependent on mechanical assistance. Unable to lift reasonable-size objects. (needs crutches, walker)	2. Some problems in walking about	3. your health limits you a little in moderate activities	**P**3. Being able to get around… without help from another person; and needing mechanical aids to walk or get around **P**4. Needing help from another person in order to get around the house, etc; and having some limitations in physical ability to lift, walk, run, jump, or bend	3. Requires mechanical equipment to walk or get around independently	**Ambulation**: 3. Able to walk around the neighborhood with walking equipment, but without the help of another person
3. Severely impaired mobility with abnormal function. Dependent on mechanical assistance and wheelchair; occasionally needs attendant.			**P**5. Needing help from another person in order to get around…. And needing mechanical aids to walk or get around. **P**6. Needing help from another person in order to get around ….and not being able to use or control the arms and legs.	4. Requires help of another person to walk or get around and requires mechanical equip as well	**Ambulation**: 4. Able to walk only short distances with walking equipment, and requires a wheelchair to get around the neighborhood. **Ambulation**: 5. Unable to walk alone, even with walking equipment. Able to walk short distances with the help of another person, and requires a wheelchair to get around the neighborhood.
4. Entirely dependent on attendant or otherwise confined to bed	3. Confined to bed			5. Unable to control or use arms and legs	**Ambulation**: 6. Cannot walk at all.

The III (Injury Impairment Index) Def by Physicians in Hirsch et al. 1983	**EQ-5D*Revised classification (Patrick and Erickson, 1993, p.404-5)**	**SF-6D**	**HUI-I**	**HIU-II**	**HUI-III**
Cognitive/Psychological				**Cognitive**	**Cognition**
1. Mild inappropriate behavior, neurotic, depressed, increased irritability, intermittent confusion, occasional swings into elation-depression, increased errors in language and arithmetic				2. Learns and remembers schoolwork more slowly than classmates	2. Able to remember most things, but have a little difficulty when trying to think and solve day to day problems. 3. Somewhat forgetful, but able to think clearly and solve day to day problems.
2. Often disoriented, loss of ability to do simple arithmetic, slight impairment of language or memory, may be psychotic but not committable			**H**5. Needing to go to a special school because of trouble learning or remembering	3. Learns and remembers very slowly and usually requires special educational assistance	4. Somewhat forgetful, and have a little difficulty when trying to think or solve day to day problems 5. Very forgetful, and have great difficulty when trying to think or solve day to day problems
3. Severe memory impairment, severe impairment of language processing and/or psychotic/committable behavior			**H**7. Having trouble being understood by others **S4**. Being anxious or depressed some or a good bit of the time and having very few friends and little contact with others.	4. Unable to learn and remember	6. Unable to remember anything at all, and unable to think or solve day to day problems.
4. Vegetative, total amnesia, no purposeful response to stimuli	Unconscious (Devlin et al., 2003)				
Daily Living	**Usual Activities**	**Social Functioning, Physical Functioning, Role limitations**		**Self-care**	**Some of the ambulation and dexterity codes may fit in this category**
1. Inability to do some normal nonessential activities.	2. Some problems with performing usual activities		**R**2. Being able to eat, dress, bathe, and go to the toilet without help; and having some limitations when playing, going to school, working, or in other activities.	2. Eats bathes, dresses, or uses the toilet independently with difficulty	**Dexterity**: 3. Limitations in the use of hands or fingers, is independent with use of special tools
2. Inability to do most nonessential and/or some essential activities	**Self Care:** 2. Some problems washing or dressing myself	**Physical Functioning**: 4. Your health limits you a lot in moderate activities **Role limitations**: 2. You are limited in the kind of	**R**3. Being able to eat , dress, bathe, and go to the toilet without help; and not being able to play, go to school, or work.		**Dexterity**: 4. Limitations in the use of hands or fingers requires the help of another person for some independent tasks.

The III (Injury Impairment Index) Def by Physicians in Hirsch et al. 1983	**EQ-5D*Revised classification (Patrick and Erickson, 1993, p.404-5)**	**SF-6D**	**HUI-I**	**HIU-II**	**HUI-III**
		work or other activities as a result of your physical health **Role limitations**: 3. You accomplish less as a result of your emotional problems			
3. Partially dependent on assistance for essential activities.		**Physical Functioning**: 5. Your health limits you a little in bathing and dressing **Physical Functioning**: 6. Your health limits you a lot in bathing and dressing **Role limitations**: 4. You are limited in the kind of work or other activities as result of your physical health and accomplish less than you would like as a result of emotional problems.	**R**4. Needing help to eat, dress, bathe, and go to the toilet; and having some limitations when playing, going to school, working, or in other activities	3. Requires mechanical equipment to eat, bathe, dress, or use the toilet independently	**Dexterity**: 5. Limitations in use of hands or fingers, requires the help of another person for most tasks.
4. Totally dependent on assistance for most activities and functions	3. Unable to perform usual activities **Self Care:** 3. Unable to wash or dress self		**R**5. Needing help to eat, dress, bathe and go to the toilet; and not being able to play, go to school, or work.	4. Requires the help of another person to eat, bathe, dress, or use the toilet	**Dexterity**: 6. Limitations in use of hands or fingers, requires the help of another person for all tasks (not independent even with use of special tools)
Sensory				**Sensory**	**Vision, Hearing**
1. Ten percent to 25 percent loss to special senses or limbs					**Vision**: 3. Able to read ordinary newsprint with or without glasses but unable to recognize a friend on the other side of the street, even with glasses **Hearing**: 3. Able to hear what is said in a conversation with one other person in a quiet room with hearing aid, and able to hear what is said in a group conversation with at least three

The III (Injury Impairment Index) Def by Physicians in Hirsch et al. 1983	**EQ-5D*Revised classification (Patrick and Erickson, 1993, p.404-5)**	**SF-6D**	**HUI-I**	**HIU-II**	**HUI-III**
					other people with a hearing aid.
2. Twenty-six percent to 50 percent loss to special senses of limbs				2. Requires equipment to see or hear or speak	**Vision**: 4. Able to recognize a friend on the other side of the street with or without glasses but unable to read ordinary newsprint, even with glasses. **Hearing**: 4. Able to hear what is said in a conversation with one other person in a quiet room, without a hearing aid, but unable to hear what is said in a group conversation with at least three other people even with a hearing aid.
3. >50% loss to special senses or limbs				3. See, hears, or speaks with limitations, even with equipment	**Vision**: 5. Unable to read ordinary newsprint and unable to recognize a friend on the other side of the street, even with glasses **Hearing**: 5. Able to hear what is said in a conversation with one other person in a quiet room with a hearing aid, but unable to hear what is said in a group conversation with at least three other people even with a hearing aid.
4. Total loss to special senses or limbs.			**H**8. Being blind or deaf or not able to speak.	4. Blind, deaf, or mute	**Vision**: 6. Unable to see at all. **Hearing**: 6. Unable to hear at all
Pain	**Pain/Discomfort**			**Pain**	**Pain**
1. Normal function with no or occasional non-narcotic drugs and/or other noninvasive therapy				2. Occasional pain. Discomfort relieved by nonprescription drugs or self-control activity without disruption of normal activities.	2. Mild to moderate pain that prevents no activities.
2. Normal function only with use of non-narcotic drugs and/or other	2. Moderate pain			3. Frequent pain. Discomfort relieved by	3. Moderate pain that prevents a few activities

The III (Injury Impairment Index) Def by Physicians in Hirsch et al. 1983	EQ-5D*Revised classification (Patrick and Erickson, 1993, p.404-5)	SF-6D	HUI-I	HIU-II	HUI-III
noninvasive therapy				oral medicines with occasional disruption of normal activities.	
3. Can function normally only with narcotic drugs and/or invasive therapy				4. Frequent pain. Frequent disruption of normal activities. Discomfort requires prescription narcotics for relief.	4. Moderate to severe pain that prevents some activities
4. Cannot function normally even with narcotic drugs and/or invasive therapy	3. Extreme pain			5. Severe pain. Pain not relieved by drugs and constantly disrupts normal activities.	5. Severe pain that prevents most activities
Disfigurement/Cosmetic					
1. Normally covered, amenable to cosmetic cover-up. Readily covered orthotics					
2. Can be effectively covered by cosmetics and/or forces a change in dress habits. May require orthosis, but does not require prosthesis.					
3. Prosthesis or cover-up required.					
4. Readily observable; not amenable to cosmetic prosthetic, or clothing cover-up			**H**2. Having a minor physical deformity or disfigurement such as scars on the face.		

The III (Injury Impairment Index) Def by Physicians in Hirsch et al. 1983	**SF-12**	**SF-36**	**FCI**	**DALY**
Mobility		**Role limitations due to physical functioning** (doesn't capture severe very well)	**Ambulation, Bending/Stooping/Lifting,**	
1. Impaired Mobility with intact functional ability	Climbing stairs: limited a lot	Limited a little in lifting or carrying groceries Limited a lot in climbing one flight of stairs Limited a little in walking one block		
2. Impaired mobility with mildly abnormal function. Partially dependent on mechanical assistance. Unable to lift reasonable-size objects. (needs crutches, walker)		Limited a lot in lifting or carrying groceries Limited a lot in climbing one flight of stairs Limited a lot in walking one block	**Ambulation**: D. Can walk long distances but only with device or help, has some limitations walking, can walk at least 150 yards but only with help from another person or device.	
3. Severely impaired mobility with abnormal function. Dependent on mechanical assistance and wheelchair; occasionally needs attendant.			**Ambulation**: D. Can walk long distances but only with device or help, has some limitations walking, can walk at least 150 yards but only with help from another person or device. **Ambulation**: E. Walking limited to short distances with or without device or help, cannot walk 150 yards even with help or device, but can walk shorter distances (i.e. < 150 yards) with or without help from another person or device.	
4. Entirely dependent on attendant or otherwise confined to bed			**Ambulation**: F. Cannot walk at all, cannot walk even short distances; requires wheelchair all the time to get around.	
Cognitive/Psychological			**Cognitive Function; Speech**	
1. Mild inappropriate behavior, neurotic, depressed, increased irritability, intermittent confusion, occasional swings into elation-depression, increased errors in language and arithmetic			**Cognitive:** B. Minor limitations. Minor difficulties with reasoning/solving problems, memory, concentration/thinking and/or attention; can live independently (i.e. does not require assistance with either ADL or IADL activities due to cognitive deficits)	
2. Often disoriented, loss of ability to do simple arithmetic, slight impairment of language or memory, may be psychotic but not committable			**Cognitive:** C. Moderate to severe limitations. Moderate to severe difficulties with reasoning/solving problems, memory, concentration/thinking and/or attention; can live independently (i.e. does not require assistance with ADL activities) but (due to cognitive deficits) may need assistance	

The III (Injury Impairment Index) Def by Physicians in Hirsch et al. 1983	SF-12	SF-36	FCI	DALY
			with some IADL activities of daily living. **Speech**: B, Minor limitations in everyday situations. Can be understood by most everyone; may get stuck, stutter, stammer, slur	
3. Severe memory impairment, severe impairment of language processing and/or psychotic/committable behavior			**Cognitive:** D. Unconfined dependence. Cannot live independently due to cognitive deficits but 24 hour supervision is not required. **Cognitive:** E. Confined dependence. Cannot live independently due to cognitive deficits; 24 hr supervision is required. **Speech:** C, Major limitations. Can only be understood by people who know person well.	
4. Vegetative, total amnesia, no purposeful response to stimuli			**Cognitive:** F. Minimally responsive or vegetative state. Cannot respond to simple commands except possibly with eye movement.	
Daily Living		**Role limitations due to physical functioning**	**Bending/Stooping/Lifting, Hand and Wrist Function, Eating**	**Disability Class**
1. Inability to do some normal nonessential activities.	Moderate activities such as pushing a table, bowling, playing golf: limited a little	Limited a little in lifting or carrying groceries Limited a little in moderate activities (moving a table, pushing vacuum cleaner, bowling, playing golf)	**B/S/L**: B. Minor difficulty lifting and carrying 50 lbs (a small child), but can lift at least 10 lbs (a bag of groceries) with no or little difficulty and/or has difficulty lifting arms over head but can do it at least 5 times in a row.	1. Limited ability to perform at least one activity in one of the following areas: recreation, education, procreation or occupation
2. Inability to do most nonessential and/or some essential activities	Moderate activities such as pushing a table, bowling, playing golf: limited a lot	Limited a lot in lifting or carrying groceries Limited a lot in moderate activities Limited a little in vigorous activities (running, lifting heavy objects, strenuous sports) Limited a little in bending, kneeling, or stooping	**B/S/L**: C. Major difficulty bending, stooping, lifting. Has difficulty lifting and carrying at least 10 lbs, including not being able to do it at all. May or may not have difficulty lifting arms over head but can do it at least 5 times in a row. **B/S/L**: D: Complete or near complete loss of upper body function. Has difficulty lifting and carrying at least 10 lbs, including not being able to do it at all AND has difficulty lifting arms over head at least 5 times in a row, including not being able to do it at all. **H/W Function**: D1 and D2: Near complete loss of hand function in one (D1) or two (D2) hands. Difficulty grasping and handling large and small objects. Requires the help of another person for some, but not all tasks necessary for daily living.	2. Limited ability to perform most activities in one of the following areas: recreation, education, procreation or occupation 3. Limited ability to perform activities in two or more of the following: recreation, education, procreation or occupation
3. Partially dependent on assistance for essential activities.		PF max Limited a little in bathing and dressing	**Eating** C: Tube feeding and/or gastrostomy required **Excretory Function** C2: Severe Incontinence. Accidents every day or continuous use of catheter or colostomy pouch.	4.Limited ability to perform most activities in all of the following areas:

The III (Injury Impairment Index) Def by Physicians in Hirsch et al. 1983	**SF-12**	**SF-36**	**FCI**	**DALY**
		Limited a lot in bending, kneeling, or stooping Limited a lot in lifting or carrying groceries Limited a lot in vigorous activities Limited a lot in moderate activities		recreation, education, procreation or occupation 5. Needs assistance with instrumental activities of daily living such as meal prep, shopping or housework
4. Totally dependent on assistance for most activities and functions		Limited a lot in bathing and dressing Limited a lot in bending, kneeling, or stooping Limited a lot in lifting or carrying groceries Limited a lot in vigorous activities Limited a lot in moderate activities		6. Needs assistance with activities of daily living such as eating, personal hygiene or toilet use
Sensory			**Hearing, Vision**	
1. Ten percent to 25 percent loss to special senses or limbs			**Hearing** B: Minor difficulty hearing. With or without hearing aid has some difficulty hearing, but only when listening conditions are less than ideal **Vision** B: Minor or moderate difficulty reading small and large print, driving and going about daily activities with or without glasses/contacts.	
2. Twenty-six percent to 50 percent loss to special senses of limbs			**Hearing** C: Moderate difficulty. With or without hearing aid has difficulty hearing under everyday listening conditions **Vision** C: Severe difficulty reading small and large print, driving and going about daily activities with our without glasses/contacts; includes blind with light perception only	
3. >50% loss to special senses or limbs				
4. Total loss to special senses or limbs.			**Hearing** D: Profound to total loss of hearing; non-correctable. Cannot hear even with the use of a hearing aid. **Vision** D: Blind without light perception	
Pain	**Pain interfered with work**	**Avg of these 2 questions:** **How much physical pain have you had**		

The III (Injury Impairment Index) Def by Physicians in Hirsch et al. 1983	**SF-12**	**SF-36**	**FCI**	**DALY**
		during the past 4 weeks?		
1. Normal function with no or occasional non-narcotic drugs and/or other noninvasive therapy	A little bit	Very mild		
2. Normal function only with use of non-narcotic drugs and/or other noninvasive therapy	Moderately	Mild, Moderate		
3. Can function normally only with narcotic drugs and/or invasive therapy	Quite a bit Extremely	Severe, Very Severe		
4. Cannot function normally even with narcotic drugs and/or invasive therapy				
Disfigurement/Cosmetic				
1. Normally covered, amenable to cosmetic cover-up. Readily covered orthosis				
2. Can be effectively covered by cosmetics and/or forces a change in dress habits. May require orthosis, but does not require prosthesis.				
3. Prosthesis or cover-up required.				
4. Readily observable; not amenable to cosmetic prosthetic, or clothing cover-up				

The III (Injury Impairment Index) **Def by Physicians in Hirsch et al. 1983**	**AQoL**	**15D**
Mobility	**Independent Living, question 6: Thinking about how easily I can get around my home and community**	**Mobility**
1. Impaired Mobility with intact functional ability		2: I am able to walk without difficulty indoors, but outdoors and/or on stairs I have slight difficulties.
2. Impaired mobility with mildly abnormal function. Partially dependent on mechanical assistance. Unable to lift reasonable-size objects. (needs crutches, walker)	B: I find it difficult to get around my home and community by myself.	3: I am able to walk without help indoors (with or without an appliance), but outdoors and/or on stairs only with considerable difficulty or with help from others.
3. Severely impaired mobility with abnormal function. Dependent on mechanical assistance and wheelchair; occasionally needs attendant.	C: I cannot get around the community by myself, but I can get around my home with some difficulty.	4: I am able to walk indoors only with help from others.
4. Entirely dependent on attendant or otherwise confined to bed	D: I cannot get around either the community or my home by myself	5: I am completely bed-ridden and unable to more about.
Cognitive/Psychological		
1. Mild inappropriate behavior, neurotic, depressed, increased irritability, intermittent confusion, occasional swings into elation-depression, increased errors in language and arithmetic		
2. Often disoriented, loss of ability to do simple arithmetic, slight impairment of language or memory, may be psychotic but not committable		
3. Severe memory impairment, severe impairment of language processing and/or psychotic/committable behavior		

The III (Injury Impairment Index) **Def by Physicians in Hirsch et al. 1983**	**AQoL**	**15D**
4. Vegetative, total amnesia, no purposeful response to stimuli		Comatose, unconscious
Daily Living	**Independent Living, question 4 (ILq4): Do I need any help looking after myself?** **Independent Living, question 5 (ILq5): When doing household tasks (for example, preparing food, gardening, using the video recorder, radio, telephone or washing the car):**	**Usual Activities**
1. Inability to do some normal nonessential activities.	ILq4, B: Occasionally I need some help with personal care tasks. ILq5, B: Occasionally I need some help with household tasks.	2: I am able to perform my usual activities slightly less effectively or with minor difficulty.
2. Inability to do most nonessential and/or some essential activities	ILq4, C: I need help with the more difficult personal care tasks. ILq5, C: I need help with the more difficult household tasks.	3. I am able to perform my usual activities much less effectively, with considerable difficulty, or not completely.
3. Partially dependent on assistance for essential activities.	ILq4, D: I need daily help with most or all personal care tasks. ILq5, D: I need daily help with most or all household tasks.	4. I can only manage a small proportion of my previously usual activities.
4. Totally dependent on assistance for most activities and functions		5. I am unable to manage any of my previously usual activities.
Sensory	**Physical Senses, question 10 (PSq10): Thinking about my vision, including when using my glasses or contact lenses if needed:** **Physical Senses, question 11 (PSq11): Thinking about**	**Vision (V), Hearing (H)**

The III (Injury Impairment Index) **Def by Physicians in Hirsch et al. 1983**	**AQoL**	**15D**
	my hearing, including using my hearing aid if needed:	
1. Ten percent to 25 percent loss to special senses or limbs	PSq10, B: I have some difficulty focusing on things, or I do not see them sharply. For example: small print, a newspaper, or seeing objects in the distance. PSq11, B: I have some difficulty hearing or I do not hear clearly. For example: I ask people to speak up, or turn up the TV or radio volume.	V, 2: I can read papers and/or TV text with slight difficulty (with or without glasses) H, 2: I hear normal speech with a little difficulty.
2. Twenty-six percent to 50 percent loss to special senses or limbs	PSq10, C: I have a lot of difficulty seeing things. My vision is blurred. For example: I can see just enough to get by with. PSq11, C: I have difficulty hearing things clearly. For example: Often I do not understand what is said. I usually do not take part in conversations because I cannot hear what is said.	V, 3: I can read papers and/or TV text with considerable difficulty (with or without glasses) H, 3: I hear normal speech with considerable difficulty; in conversation I need voices to be louder than normal.
3. >50% loss to special senses or limbs	PSq10, D: I only see general shapes, or am blind. For example: I need a guide to move around PSq11, D: I hear very little indeed. For example: I cannot fully understand loud voices speaking directly to me.	V, 4: I cannot read papers or TV text either with glasses or without, but I can see enough to walk about without guidance. H, 4: I hear even loud voices poorly; I am almost deaf
4. Total loss to special senses or limbs.		V, 5: I cannot see enough to walk about without a guide, i.e. I am almost or completely blind. H, 5: I am completely deaf.
Pain	**Psychological Well-being, question 15 (PWBq15): How much pain or discomfort do I experience**	**Pain**
1. Normal function with no or occasional non-narcotic drugs and/or	PWBq15, A: None at all	

The III (Injury Impairment Index) **Def by Physicians in Hirsch et al. 1983**	**AQoL**	**15D**
other noninvasive therapy		
2. Normal function only with use of non-narcotic drugs and/or other noninvasive therapy	PWBq15, B: I have moderate pain	2: I have mild physical discomfort or symptoms, e.g. pain ache nausea itching etc.
3. Can function normally only with narcotic drugs and/or invasive therapy	PWBq15, C: I suffer from severe pain	3: I have marked physical discomfort or symptoms, e.g. pain, ache, nausea, itching, etc.
4. Cannot function normally even with narcotic drugs and/or invasive therapy	PWBq15, D: I suffer unbearable pain	4: I have severe physical discomfort or symptoms, e.g. pain, ache, nausea, itching, etc. 5: I have unbearable physical discomfort or symptoms, e.g. pain, ache, nausea, itching, etc.
Disfigurement/Cosmetic		
1. Normally covered, amenable to cosmetic cover-up. Readily covered orthosis		
2. Can be effectively covered by cosmetics and/or forces a change in dress habits. May require orthosis, but does not require prosthesis.		
3. Prosthesis or cover-up required.		
4. Readily observable; not amenable to cosmetic prosthetic, or clothing cover-up		

Table 3: Summary of studies from which utility weights of instruments that measure health states were retrieved

Study	**Instrument**	**Valuation Method for preference weights**	**Population**	**Sample size**	**Notes**	**Functional Form**
Brazier et al., 2002	SF-6D	Standard Gamble	Sample of UK population	611	Utility weights calculated using coefficients presented in Table 6 (page288) using the model where the constant was forced to unity. (utility weight = 1- coefficient)	*Ad hoc* modified linear additive
Carsten, 1986	Hirsch et al. (1983) ratings	Based on AMA Guides (1971)	n/a	n/a	These data used in the original III literature review (Miller et al, 1995). The study expands the original Hirsch et al. (1993) study and used the AMA Guides (1971) to convert the Hirsch et al. scores to a whole-body percentage of impairment based on the level of impairment of an injury that had equal consequences in terms of level and type of impairment.	n/a
Devlin et al., 2003	EQ-5D New Zealand Valuation	Time Trade Off	Adult New Zealanders	3000	Utility weights in Table 7, Full Sample (page 542). Values for EQ-5D mobility level 3 and Self Care level 3 computed using equation 1 (page541). Value for "unconscious" (III cognitive 4) received via personal communication with Dr. Nancy Devlin (Dec. 14, 2004)	*Ad hoc* modified linear additive
Dolan et al.,	EQ-5D United	Time Trade Off	Representative	3395	Utility weights calculated as 1 minus the	*Ad hoc* modified

Study	Instrument	Valuation Method for preference weights	Population	Sample size	Notes	Functional Form
1997	Kingdom Valuation		sample of the UK population		value calculated using the parameter estimate for whole sample (Table 1) and the equation in Table 2.	linear additive
Feeny et al., 2002	HUI-3	Rating Scale and Standard Gamble for 4 marker states	Representative sample of Canadian population >=16 years old	256	Utility weights in Table 3, page 124, Multi-Attribute Utility Function	Multiplicative
Fryback et al., 1997	SF-36 modeled on the QWB	Models preference weights based on the QWB which uses a Rating Scale	Sample adults (>45 years) in Beaver Dam, WI	1356	Using coefficients from the regression model, preference weights were computed for the maximum pain level (pain 3 on the III) and maximum physical functioning losses (daily living 3 on the III)	QWB: linear additive
Hakim and Pathak, 1999	EQ-5D	Visual Analog Scale and Standard Gamble	U.S. veterans treated as outpatients for hypertension	139	Utility weights in Table 1, page 107. These scores were anchored at 1 (best state) and 0 (worst state). For our purposes they were transformed so that the worst state was equal to the corner state and level 2 (middle level) was rescaled accordingly.	*Ad hoc* modified linear additive
Hawthorne et al., 2001	AQoL	Time Trade Off	Random sample of 350 people in Victoria,	Approx. 350	Utility weights calculated as 1 minus the dis-utility values presented in Figure 8	Multiplicative

Study	Instrument	Valuation Method for preference weights	Population	Sample size	Notes	Functional Form
			Australia			
Kaplan, 1982	QWB	Rating Scale	Sample of adult San Diego residents		These data were used in the original III literature review (Miller et al, 1995). No allowance for states worse than death	Linear additive
Lundberg et al., 1999	SF-12	Visual Analog Scale and Time Trade Off	Sample of Swedish population	8000	Utility weights based on values in Tables 3 and 4.	
MacKenzie et al., 1996	FCI	Rating Scale	Clinical experts and lay people	114	Utility weights calculated as 1 minus the whole body FCI score (Table 3)	Multiplicative
Murray and Lopez, 1994	DALY	Visual Analog Scale	Health professionals, primarily mental health	Less than 15	Authors did not provide information on raters.	Linear additive
Nichol et al., 2001	SF-36 modeled on HUI-2	Standard Gamble (HUI-3)	Southern California Kaiser Permanente members	6921	Utility weights calculated using the model coefficients in Table 4 multiplied by the SF-36 score for that dimension and level.	HUI-2: multiplicative
Sengupta et al., 2004	SF-12 modeled on the HUI-3 SF-12 modeled on a	Models preference weights based on the HUI-3, which uses Standard Gamble and on a Visual Analog	Southern California Kaiser Permanente members	6921	Utility weights calculated based parameter estimates (categorical model) in Tables 2 (VAS) and Tables 3 (HUI3).	The HUI-3: multiplicative

Study	Instrument	Valuation Method for preference weights	Population	Sample size	Notes	Functional Form
	VAS	Scale				
Shaw et al., 2005	EQ-5D, US Valuation	Time Trade Off	US adult civilian non-institutionalized population	3773	Linear transformation was applied to values for states worse than death. Most previous studies use a nonlinear transformation. Therefore the Shaw et al results are not strictly comparable with previous studies.	*Ad hoc* modified linear additive
Sintonen et al, 1994	15D	Rating Scale	Health care patients in Finland	Approx. 500	The instrument and validity is discussed in this working paper. Utility weights were provided through personal communications with the author.	*Ad hoc* modified linear additive
Torrance et al., 1982	HUI-1	Time Trade Off	Canadian parents of school age children	112	These data presented used in the original III literature review (Miller et al, 1995).	Multiplicative
Torrance et al., 1996	HUI-2	Standard Gamble	Sample of Canadian population parents	194	Used the multiattribute utility function (Table 8). Did not include estimates using a visual analog scale because these performed poorly with the HUI2 (personal correspondence with Dr. David Feeny, May 12, 2005)	Multiplicative

Table 4: Literature review of utility weights mapped to the Injury Impairment Index (III) - from other preference-based instruments, by dimension and level (utility weights refer to - percentage of functioning remaining where 1=perfect health and 0=dead)

DIMENSION	STUDY	LEVEL			
MOBILITY					
		1	**2**	**3**	**4**
HUI3-SG	Feeny et al., 2002	0.93	0.86	0.69	0.58
HUI2-SG	Torrance et al., 1996	0.97	0.84	0.73	0.58
EQ-5D New Zealand	Devlin et al., 2003		0.67		
EQ-5D US VAS	Hakim and Pathak		0.75		0.40
EQ-5D US SG	Hakim and Pathak		0.94		0.66
SF-12 modeled on HUI3	Sengupta et al., 2004	0.95			
SF-12 modeled on VAS	Sengupta et al., 2004	0.99			
SF-36 modeled on HUI2	Nichol et al., 2001	0.91	0.84		
EuroQol UK weights	Dolan et al, 1997		0.88		
SF-6D	Brazier et al, 2002	0.95	0.99		
SF-12 VAS	Lundberg et al., 1999	0.90			
SF-12 TTO	Lundberg et al., 1999	0.94			
FCI	MacKenzie et al, 1996	0.85	0.54	0.50	0.33
	Carsten, 1986	0.95	0.78	0.35	0.15
HUI1	Torrance, 1982	0.87	0.72	0.45	0.32
QWB	Kaplan, 1982	0.93	0.73	0.54	0.42
EQ-5D US	Shaw et al.2005		0.85		0.44
15D	Sintonen, 1994	0.71	0.47	0.25	0.08
AQoL	Hawthorne et al., 2001		0.79	0.74	0.37
LT nursing home after hip fracture	Tosteson et al., 2001			0.40	
paraplegia, QWB	Andresen et al., 1999			0.56	
quadriplegia, QWB	Andresen et al., 1999				0.53
partial paraplegia	Tolley et al., 1994			0.49	
complete paraplegia	Tolley et al., 1994			0.30	
quadriplegia	Tolley et al., 1994				0.11
	MEDIAN	**0.93**	**0.79**	**0.50**	**0.40**
	MEDIAN ("Best" studies only)	0.93	0.78	0.50	0.37
COGNITIVE/PSYCHOLOGICAL					
		1	**2**	**3**	**4**
HUI3-SG	Feeny et al., 2002	0.94	0.72	0.42	
HUI2-SG	Torrance et al., 1996	0.95	0.88	0.65	
EQ-5D New Zealand	Devlin et al., 2003				0.00
EuroQol UK weights	Dolan et al, 1997	0.83			
FCI	MacKenzie et al, 1996	0.74	0.51	0.16	0.02
	Carsten, 1986	0.95	0.75	0.10	0.05
HUI-1	Torrance, 1982		0.80	-0.10	-0.16
15-D	Sintonen, 1994				0.02
	Kind et al., 1982				-0.08
	Green and Brown				-0.28
	MEDIAN	**0.94**	**0.75**	**0.16**	**-0.004**
	MEDIAN ("Best" studies only)	0.94	0.75	0.16	0.00

Table 4 (cont.) Literature review of utility weights mapped to the Injury Impairment Index (III) from other preference-based instruments (utility weights refer to percentage of functioning remaining where 1=perfect health and 0=dead)

DIMENSION	**STUDY**	**LEVEL**			
SENSORY					
	Score:	**1**	**2**	**3**	**4**
HUI3-SG	Feeny et al., 2002	0.89	0.84	0.75	0.61
HUI3-SG	Feeny et al., 2002	0.89	0.80	0.74	0.61
HUI2-SG	Torrance et al., 1996		0.95	0.86	0.61
FCI	MacKenzie et al, 1996		0.93	0.98	0.65
FCI	MacKenzie et al, 1996		0.91	0.86	
	Carsten, 1986	0.95	0.85	0.76	0.15
HUI-1	Torrance, 1982				0.63
QWB	Kaplan, 1982		0.83	0.77	0.61
15D	Sintonen, 1994	0.77	0.48	0.27	0.10
AQoL	Hawthorne et al., 2001	0.86	0.73	0.51	0.00
	Green and Brown				0.66
cataracts (QWB)	Fryback et al, 1993			0.71	
cataracts (TTO)	Fryback et al, 1993			0.82	
cataracts (Age adj SF-36)	Fryback et al, 1993			0.71	
cataracts (Age adj EVGFP)	Fryback et al, 1993			0.68	
cataracts	Gold et al., 1996			0.64	
macular degeneration (QWB)	Fryback et al, 1993			0.67	
macular degeneration (TTO)	Fryback et al, 1993			0.75	
macular degeneration (Age-adj SF	Fryback et al, 1993			0.68	
Macular degeneration (Age-adj EV	Fryback et al, 1993			0.62	
glaucoma (QWB)	Fryback et al, 1993			0.70	
glaucoma (TTO)	Fryback et al, 1993			0.82	
glaucoma (Age-Adj SF-36)	Fryback et al, 1993			0.71	
glaucoma (Age-Adj EVGFP)	Fryback et al, 1993			0.68	
glaucoma	Gold et al., 1996			0.64	
profound deaf w/ implant	Wyatt et al., 1996			0.79	
well-adjusted blind person	Javitt and Aiello, 1996				0.48
poorly adjusted blind person	Javitt and Aiello, 1996				0.36
profound deafness	Wyatt et al., 1996				0.59
deafness	Salomon and Murray, 2004				0.71
deafness	Gold et al., 1998				0.65
blindness	Tolley et al., 1994				0.63
blindness	Mathers et al., 1999				0.57
blindness	Salomon and Murray, 2004				0.50
blindness	Gold et al., 1998				0.47
	MEDIAN	**0.89**	**0.84**	**0.71**	**0.61**
	MEDIAN ("Best" studies only)	0.89	0.84	0.71	0.61

Table 4 (cont.) Literature review of utility weights mapped to the Injury Impairment Index (III) from other preference-based instruments (utility weights refer to percentage of functioning remaining where 1=perfect health and 0=dead)

DIMENSION	**STUDY**	**LEVEL**			
DAILY LIVING					
		1	**2**	**3**	**4**
HUI3-SG	Feeny et al., 2002	0.88	0.76	0.65	0.06
HUI2-SG	Torrance et al., 1996	0.97	0.91	0.80	
EQ-5D New Zealand	Devlin et al., 2003	0.74	0.69		
EQ-5D US VAS	Hakim and Pathak	0.87	0.85		0.44
EQ-5D US SG	Hakim and Pathak	0.97	0.97		0.71
DALY	Murray and Lopez, 1994	0.90	0.69	0.30	0.08
SF-12 modeled on HUI3	Sengupta et al., 2004	0.99	0.99		
SF-12 modeled on VAS	Sengupta et al., 2004	1.00	0.98		
SF-36 modeled on HUI2	Nichol et al., 2001	0.95	0.93	0.79	0.77
EuroQol UK weights	Dolan et al, 1997	0.87	0.83		
SF-6D	Brazier et al, 2002		0.96	0.92	
SF-36 modeled on HUI2	Fryback et al., 1997			0.81	
SF-12 VAS	Lundberg et al., 1999	0.97	0.96		
SF-12 TTO	Lundberg et al., 1999	0.94	0.92		
FCI - BSL	MacKenzie et al, 1996	0.85	0.60		
FCI - H/A	MacKenzie et al, 1996		0.59		
FCI - eat	MacKenzie et al, 1996			0.25	
FCI - excr	MacKenzie et al, 1996			0.26	
HUI-1	Torrance, 1982	0.98	0.67	0.64	0.29
EQ-5D US	Shaw et al.2005	0.86	0.83		0.58
15D	Sintonen, 1994	0.72	0.41	0.22	0.08
AQoL	Hawthorne et al., 2001	0.78	0.60	0.30	0.13
QWB	Kaplan, 1982	0.94	0.67	0.63	0.50
	MEDIAN	**0.92**	**0.83**	**0.64**	**0.37**
	MEDIAN ("Best" studies only)	0.86	0.67	0.47	0.21
PAIN					
		1	**2**	**3**	**4**
HUI3-SG	Feeny et al., 2002	0.96	0.90	0.77	0.55
HUI2-SG	Torrance et al., 1996	0.97	0.85	0.64	0.38
EQ-5D New Zealand	Devlin et al., 2003			0.57	
EQ-5D US VAS	Hakim and Pathak				0.56
EQ-5D US SG	Hakim and Pathak				0.77
SF-36 modeled on HUI2	Nichol et al., 2001	0.91	0.79	0.61	
EuroQol UK weights	Dolan et al, 1997		0.85		0.20
SF-36 modeled on HUI2	Fryback et al., 1997			0.92	
EQ-5D	Shaw et al., 2005		0.83	0.46	0.46
AQoL	Hawthorne et al., 2001	1.00	0.91	0.74	0.18
15D	Sintonen, 1994		0.70	0.40	0.14
	Carsten et al., 1986	1.00	1.00	0.90	0.40
HUI-1	Torrance, 1982			0.87	
QWB	Kaplan, 1982	0.97	0.71	0.61	
	Kind et al, 1982	0.99	0.98		
	MEDIAN	**0.97**	**0.85**	**0.64**	**0.40**
	MEDIAN ("Best" studies only)	0.98	0.85	0.64	0.38

Table 4 (cont.) Literature review of utility weights mapped to the Injury Impairment Index (III) from other preference-based instruments (utility weights refer to percentage of functioning remaining where 1=perfect health and 0=dead)

DIMENSION	STUDY	LEVEL			
DISFIGUREMENT/COSMETIC					
		1	**2**	**3**	**4**
	Carsten, 1986	1.00	1.00	1.00	0.90
HUI-1	Torrance, 1982				0.89
QWB	Kaplan, 1982			0.94	0.86
surgical scar on stomach	Bass et al., 1993		1.00		
dermatological problems	Isacson et al, 2004				0.81
surgical scar on stomach	Bass et al., 1993		0.99		
dermatological problems w Rx	Isacson et al, 2004				0.79
psoriasis	Gold et al., 1998				0.80
acne	Gold et al., 1998				0.89
	MEDIAN	**1.00**	**1.00**	**0.97**	**0.86**
	MEDIAN ("Best" studies only)	1.00	1.00	0.97	0.86

Table 5: Results of the updated literature review: Median utility weights by dimension and level of the Injury Impairment Index (III) compared to the original Injury Impairment Index utility weights (1=perfect health, 0=dead)

III Dimension and Level	Literature Review Update: Median Utility Weight	Literature Review Update: Interquartile Range of Utility Weights	Original III: Utility Weight
Mobility			
1	.93	.90 - .95	.87
2	.79	.73 - .86	.72
3	.50	.39 - .59	.45
4	.40	.32 - .53	.32
Cognitive			
1	.94	.83 - .95	.95
2	.75	.72 - .80	.80
3	.16	.10 - .42	.10
4	-.004	-.12 - 0.02	.01
Daily Living			
1	.92	.86 - .97	.92
2	.83	.67 - .94	.67
3	.64	.29 - .79	.64
4	.37	.09 - .56	.29
Pain			
1	.97	.96 - .99	.99
2	.85	.80 - .91	.97
3	.64	.59 - .82	.90
4	.40	.20 - .55	.40
Cosmetic			
1	1.00	1.0 - 1.0	.99
2	1.00	.996 - .999	.97
3	.97	.95 - .98	.94
4	.86	.80 - .88	.90
Sensory			
1	.89	.86 - .89	.95
2	.84	.80 - .91	.85
3	.71	.68 - .78	.76
4	.61	.48 - .63	.63

Table 6: Estimated quality adjusted life years (QALYs) lost per injury for median, quartile 1 (Q1), quartile 3 (Q3) utility weights; by Maximum AIS and discount rate; based on motor vehicle-related injuries, 2000-2006

	Nonhospitalized			Hospitalized			All		
Max AIS	Median	Q1	Q3	Median	Q1	Q3	Median	Q1	Q3
3% discount rate									
AIS 1	0.05	0.04	0.08	0.63	0.63	0.64	0.06	0.05	0.09
AIS 2	0.59	0.42	0.93	1.61	1.39	2.22	0.94	0.76	1.38
AIS 3	1.56	0.72	2.82	2.16	1.58	3.33	2.09	1.48	3.27
AIS 4				5.78	4.62	7.32	5.78	4.62	7.32
AIS 5				13.17	10.84	15.23	13.17	10.84	15.23
4% discount rate									
AIS 1	0.04	0.03	0.07	0.53	0.53	0.53	0.06	0.05	0.08
AIS 2	0.55	0.40	0.87	1.41	1.21	1.96	0.85	0.68	1.25
AIS 3	1.34	0.63	2.39	1.83	1.34	2.81	1.77	1.26	2.76
AIS 4				4.90	3.91	6.21	4.90	3.91	6.21
AIS 5				11.09	9.13	12.82	11.09	9.13	12.82
7% discount rate									
AIS 1	0.03	0.02	0.05	0.34	0.34	0.34	0.04	0.03	0.06
AIS 2	0.48	0.35	0.76	1.06	0.89	1.50	0.68	0.54	1.02
AIS 3	0.95	0.47	1.66	1.25	0.92	1.91	1.21	0.87	1.88
AIS 4				3.35	2.67	4.26	3.35	2.67	4.26
AIS 5				7.45	6.14	8.61	7.45	6.14	8.61
10% discount rate									
AIS 1	0.03	0.02	0.04	0.25	0.25	0.25	0.03	0.03	0.05
AIS 2	0.44	0.32	0.69	0.87	0.72	1.25	0.59	0.46	0.88
AIS 3	0.75	0.39	1.28	0.96	0.70	1.46	0.93	0.67	1.44
AIS 4				2.57	2.04	3.27	2.57	2.04	3.27
AIS 5				5.61	4.63	6.48	5.61	4.63	6.48
Years not discounted									
AIS 1	0.08	0.07	0.13	1.31	1.31	1.32	1.31	1.31	1.32
AIS 2	0.82	0.58	1.28	2.86	2.53	3.82	2.86	2.53	3.82
AIS 3	2.99	1.30	5.53	4.28	3.12	6.62	4.28	3.12	6.62
AIS 4				11.44	9.16	14.41	11.44	9.16	14.41
AIS 5				26.48	21.78	30.64	26.48	21.78	30.64

Table 7: Quality-adjusted percentage of remaining life lost for median, quartile 1 (Q1), quartile 3 (Q3) utility weights by Maximum AIS and Discount Rate; based on motor vehicle-related injuries, 2000-2006

	Nonhospitalized			Hospitalized			All		
Max AIS	Median	Q1	Q3	Median	Q1	Q3	Median	Q1	Q3
3% discount rate, remaining life=23.00 years									
AIS 1	0.2%	0.2%	0.3%	2.8%	2.7%	2.8%	0.3%	0.2%	0.4%
AIS 2	2.6%	1.8%	4.1%	7.0%	6.0%	9.6%	4.1%	3.3%	6.0%
AIS 3	6.8%	3.1%	12.3%	9.4%	6.9%	14.5%	9.1%	6.4%	14.2%
AIS 4				25.1%	20.1%	31.8%	25.1%	20.1%	31.8%
AIS 5				57.3%	47.1%	66.2%	57.3%	47.1%	66.2%
4% discount rate, remaining life=19.28 years									
AIS 1	0.2%	0.2%	0.3%	2.7%	2.7%	2.8%	0.3%	0.2%	0.4%
AIS 2	2.9%	2.1%	4.5%	7.3%	6.3%	10.2%	4.4%	3.5%	6.5%
AIS 3	6.9%	3.3%	12.4%	9.5%	7.0%	14.6%	9.2%	6.5%	14.3%
AIS 4				25.4%	20.3%	32.2%	25.4%	20.3%	32.2%
AIS 5				57.5%	47.4%	66.5%	57.5%	47.4%	66.5%
7% discount rate, remaining life=12.78 years									
AIS 1	0.2%	0.2%	0.4%	2.7%	2.7%	2.7%	0.3%	0.3%	0.5%
AIS 2	3.8%	2.7%	6.0%	8.3%	7.0%	11.7%	5.3%	4.2%	7.9%
AIS 3	7.4%	3.7%	13.0%	9.8%	7.2%	15.0%	9.5%	6.8%	14.7%
AIS 4				26.2%	20.9%	33.4%	26.2%	20.9%	33.4%
AIS 5				58.3%	48.1%	67.4%	58.3%	48.1%	67.4%
10% discount rate, remaining life=9.51 years									
AIS 1	0.3%	0.2%	0.4%	2.6%	2.6%	2.6%	0.3%	0.3%	0.5%
AIS 2	4.6%	3.3%	7.3%	9.2%	7.6%	13.2%	6.2%	4.8%	9.3%
AIS 3	7.9%	4.1%	13.5%	10.1%	7.4%	15.3%	9.8%	7.0%	15.1%
AIS 4				27.0%	21.5%	34.4%	27.0%	21.5%	34.4%
AIS 5				59.0%	48.7%	68.1%	59.0%	48.7%	68.1%
Years not discounted, remaining life=46.82 years									
AIS 1	0.2%	0.1%	0.3%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%
AIS 2	1.7%	1.2%	2.7%	6.1%	5.4%	8.2%	6.1%	5.4%	8.2%
AIS 3	6.4%	2.8%	11.8%	9.1%	6.7%	14.1%	9.1%	6.7%	14.1%
AIS 4				24.4%	19.6%	30.8%	24.4%	19.6%	30.8%
AIS 5				56.6%	46.5%	65.4%	56.6%	46.5%	65.4%

Table 8: Estimated quality adjusted life years (QALYs) lost per injury for median, quartile 1 (Q1), quartile 3 (Q3) utility rates based on "best" studies only; by Maximum AIS and discount rate; based on motor vehicle-related injuries, 2000-2006

	Nonhospitalized			Hospitalized			All		
Max AIS	Median	Q1	Q3	Median	Q1	Q3	Median	Q1	Q3
3% discount rate									
AIS 1	0.06	0.04	0.09	0.63	0.63	0.64	0.07	0.06	0.10
AIS 2	0.65	0.47	1.02	1.67	1.43	2.32	1.00	0.80	1.46
AIS 3	2.15	1.11	3.71	2.42	1.76	3.81	2.39	1.68	3.80
AIS 4				6.04	4.81	7.69	6.04	4.81	7.69
AIS 5				13.59	11.21	15.56	13.59	11.21	15.56
4% discount rate									
AIS 1	0.05	0.04	0.08	0.53	0.53	0.53	0.06	0.05	0.09
AIS 2	0.61	0.44	0.95	1.46	1.25	2.05	0.90	0.72	1.33
AIS 3	1.82	0.95	3.13	2.05	1.49	3.22	2.02	1.43	3.20
AIS 4				5.12	4.07	6.52	5.12	4.07	6.52
AIS 5				11.44	9.44	13.10	11.44	9.44	13.10
7% discount rate									
AIS 1	0.04	0.03	0.06	0.34	0.34	0.35	0.05	0.04	0.07
AIS 2	0.52	0.38	0.83	1.09	0.92	1.57	0.72	0.57	1.08
AIS 3	1.26	0.68	2.12	1.39	1.02	2.17	1.38	0.98	2.17
AIS 4				3.51	2.79	4.48	3.51	2.79	4.48
AIS 5				7.69	6.35	8.79	7.69	6.35	8.79
10% discount rate									
AIS 1	0.03	0.02	0.05	0.25	0.25	0.25	0.04	0.03	0.05
AIS 2	0.47	0.35	0.75	0.90	0.75	1.31	0.62	0.48	0.94
AIS 3	0.98	0.54	1.61	1.06	0.78	1.65	1.05	0.75	1.64
AIS 4				2.70	2.14	3.44	2.70	2.14	3.44
AIS 5				5.79	4.79	6.61	5.79	4.79	6.61
Years of life not discounted									
AIS 1	0.10	0.07	0.15	1.31	1.31	1.32	0.14	0.11	0.18
AIS 2	0.93	0.67	1.39	2.98	2.60	3.99	1.63	1.33	2.29
AIS 3	4.22	2.11	7.42	4.81	3.49	7.64	4.74	3.32	7.61
AIS 4				11.93	9.51	15.11	11.93	9.51	15.11
AIS 5				27.31	22.51	31.31	27.31	22.51	31.31

Table 9: Quality-adjusted percentage of remaining life lost for median, quartile 1 (Q1), quartile 3 (Q3) utility weights based on "best" studies only; by Maximum AIS and discount rate; based on motor vehicle-related injuries, 2000-2006

	Nonhospitalized			Hospitalized			All		
Max AIS	Median	Q1	Q3	Median	Q1	Q3	Median	Q1	Q3
3% discount rate, remaining life=23.00 years									
AIS 1	0.2%	0.2%	0.4%	2.8%	2.7%	2.8%	0.3%	0.3%	0.4%
AIS 2	2.8%	2.1%	4.4%	7.3%	6.2%	10.1%	4.4%	3.5%	6.4%
AIS 3	9.3%	4.8%	16.1%	10.5%	7.7%	16.6%	10.4%	7.3%	16.5%
AIS 4				26.3%	20.9%	33.4%	26.3%	20.9%	33.4%
AIS 5				59.1%	48.8%	67.7%	59.1%	48.8%	67.7%
4% discount rate, remaining life=19.28 years									
AIS 1	0.3%	0.2%	0.4%	2.7%	2.7%	2.8%	0.3%	0.3%	0.5%
AIS 2	3.1%	2.3%	4.9%	7.6%	6.5%	10.6%	4.7%	3.7%	6.9%
AIS 3	9.5%	4.9%	16.2%	10.6%	7.7%	16.7%	10.5%	7.4%	16.6%
AIS 4				26.6%	21.1%	33.8%	26.6%	21.1%	33.8%
AIS 5				59.3%	49.0%	67.9%	59.3%	49.0%	67.9%
7% discount rate, remaining life=12.78 years									
AIS 1	0.3%	0.2%	0.5%	2.7%	2.7%	2.7%	0.4%	0.3%	0.5%
AIS 2	4.1%	3.0%	6.5%	8.6%	7.2%	12.3%	5.6%	4.4%	8.5%
AIS 3	9.9%	5.3%	16.6%	10.9%	8.0%	17.0%	10.8%	7.6%	16.9%
AIS 4				27.5%	21.8%	35.1%	27.5%	21.8%	35.1%
AIS 5				60.1%	49.7%	68.8%	60.1%	49.7%	68.8%
10% discount rate, remaining life=9.51 years									
AIS 1	0.3%	0.2%	0.5%	2.6%	2.6%	2.7%	0.4%	0.3%	0.6%
AIS 2	5.0%	3.6%	7.9%	9.5%	7.9%	13.8%	6.5%	5.1%	9.9%
AIS 3	10.3%	5.7%	17.0%	11.2%	8.2%	17.3%	11.1%	7.9%	17.3%
AIS 4				28.4%	22.5%	36.2%	28.4%	22.5%	36.2%
AIS 5				60.9%	50.4%	69.5%	60.9%	50.4%	69.5%
Years not discounted, remaining life=46.82 years									
AIS 1	0.2%	0.2%	0.3%	2.8%	2.8%	2.8%	0.3%	0.2%	0.4%
AIS 2	2.0%	1.4%	3.0%	6.4%	5.6%	8.5%	3.5%	2.8%	4.9%
AIS 3	9.0%	4.5%	15.8%	10.3%	7.4%	16.3%	10.1%	7.1%	16.3%
AIS 4				25.5%	20.3%	32.3%	25.5%	20.3%	32.3%
AIS 5				58.3%	48.1%	66.9%	58.3%	48.1%	66.9%

Table 10: Comparison of estimated QALY lost used in this report versus Blincoe et al. (2002)

Maximum AIS	QALY08: Estimated Average QALY Lost (current report)	QALY02: Estimated Average QALY Lost (Blincoe et al., 2002)
MAIS 1	0.06	0.04
MAIS 2	0.85	0.79
MAIS 3	1.77	1.08
MAIS 4	4.90	3.73
MAIS 5	11.09	11.77

Table 11a to 11d: Analyzing the changes in QALY estimates resulting from new utility weights, compared to the original utility weights used in Blincoe et al. (2002)

Table 11a: ***A comparison of average QALYs lost per injury by Maximum Abbreviate Injury Scale (MAIS) score using a variety of combinations of case mix and utility weights (4% discount rate)***

MAIS	QALY08/ wt08	QALY02/ wt08	QALY08/ wt02	QALY02/ wt02	QALYiii/ wt08
1	0.056	0.036	0.047	0.039	0.063
2	0.848	0.840	0.534	0.793	0.916
3	1.771	1.142	1.777	1.076	2.001
4	4.896	4.340	4.216	3.733	5.134
5	11.093	12.614	10.870	11.772	11.706

Where, -
QALY08 = average QALY loss per injury based on the new generation of utility weights used in this report -
QALY02 = average QALY loss per injury used in Blincoe et al. (2002), where $114,791 (year 2000 dollars) in Quality of Life losses is equal to one QALY. -
QALYiii = average QALY loss per injury based on the original utility weights in Miller et al. (1995) -
wt08 = weighted by the 2000-2006 case mix used in this report -
wt02 = weighted by the 2000 case mix used in Blincoe et al. (2002) -

Table 11b: ***Proportion of the difference between QALY02 and QALY08 due to a change in case mix***

	Absolute Difference				
MAIS	QALY08/ wt08- QALY02/ wt08	QALY02/ wt08- QALY02/ wt02	Total	Proportion of difference due to Case Mix	Proportion of difference due to Other factors
1	0.020	0.002	0.022	10.41%	89.59%
2	0.007	0.048	0.055	86.52%	13.48%
3	0.629	0.065	0.694	9.39%	90.61%
4	0.556	0.607	1.163	52.18%	47.82%
5	1.522	0.842	2.364	35.63%	64.37%

Table 11c: ***Impact of a change in utility weights on the estimation of average QALYs lost***

MAIS	QALY08/wt08 - QALYiii/wt08	% change
1	-0.007	-11.4%
2	-0.069	-7.5%
3	-0.230	-11.5%
4	-0.239	-4.6%
5	-0.614	-5.2%

Table 11d: ***Comparison of estimated QALY lost used in this report versus Blincoe et al. (2002)***

Maximum AIS	Estimated Median Average QALY Lost per injury: using the new generation of utility weights with 2000-2006 crash data	Quartile 1	Quartile 3	Estimated Average QALY lost per injury: using the original utility weights (Miller et al., 1995) with 2000-2006 crash data
MAIS 1	0.06	0.05	0.08	0.06
MAIS 2	0.85	0.68	1.25	0.92
MAIS 3	1.77	1.26	2.76	2.00
MAIS 4	4.90	3.91	6.21	5.13
MAIS 5	11.09	9.13	12.82	11.71

Appendix A: Background on coding systems

Occupant Injury Code (OIC)

The Occupant Injury Code system is used in National Highway Traffic Safety Administration surveillance systems to motor vehicle/traffic-related injuries. The OIC code is comprised of one code from each of the following categories that describe the injury: lesion/injury, body region injured, body system/organ injured, and the Abbreviated Injury Scale (AIS) score (see AIS below).

Body Region:	Lesion:	System/Organ:
Arm	Abrasion	Arteries, veins
Back – thoracolumbar spine	Burn	Brain
Chest	Contusion	Spinal cord
Elbow	Dislocation	Digestive
Face	Total severance, transaction	Ears
Head – skull	Fracture	Urogenital
Knee	Detachment, separation	Heart
Lower Leg	Concussion	Integumentary
Abdomen	Laceration	Joints
Neck – cervical spine	Amputation	Kidneys
Whole body	Crush	Liver
Pelvis – hip	Perforation, puncture	Muscles
Ankle – foot	Rupture	Nervous system
Forearm	Sprain	Eye
Shoulder	Strain	Pulmonary, lungs
Thigh	Avulsion	Spleen
Wrist	Fracture, dislocation	Respiratory
Upper Limb		Skeletal
Lower Limb		Thyroid, other endocrine system
		Vertebrae
		All systems

The Abbreviated Injury Scale (AIS)

The Abbreviated Injury Scale (AIS) is an anatomical scoring system first introduced in 1969. Since this time it has been revised and updated against survival so that it now provides a reasonably accurate way of ranking the severity of injury. The latest incarnation of the AIS score is the 2006 revision. The AIS is monitored by a scaling committee of the Association for the Advancement of Automotive Medicine.

Injuries are ranked on a scale of 1 to 6:
AIS 1 = Minor
AIS 2 = Moderate
AIS 3 = Serious
AIS 4 = Severe
AIS 5 = Critical

AIS 6 = Unsurvivable

The score represents the 'threat to life' associated with an injury and is not meant to represent a comprehensive measure of severity. The AIS is not an injury scale, in that the difference between AIS1 and AIS2 is not the same as that between AIS4 and AIS5.

The International Classification of Diseases, Clinical Modification (ICD-9-CM)

The International Classification of Diseases, Clinical Modification is used to code and classify morbidity data from the inpatient and outpatient records, physician offices, and most National Center for Health Statistics (NCHS) surveys.

ICD-9-CM is made up of diagnosis codes and E codes (external cause of injury codes). An injury can be coded with one of both of these types of codes. Traditional injury diagnosis codes: (a) 800–994 Injury and poisoning (Except late effect of complications of surgical and medical care [909.3], late effect of adverse effect of drug, medicinal or biological substance [909.5]). E codes range from E800 to E999. Motor vehicle traffic-related injuries are coded E810-E819.

NEISS Coding System

The Consumer Product Safety Commission's National Electronic Injury Surveillance System (NEISS) is a national probability sample of hospitals in the U.S. and its territories. Patient information is collected from each NEISS hospital for every emergency visit involving an injury associated with consumer products. Injury descriptions are coded with a diagnosis code (type of injury) and a body part code.

<u>Diagnosis/injury codes:</u>
Amputation
Anoxia
Aspirated foreign object
Avulsion
Burns, scald (from hot liquids or steam)
Burns, thermal (from flames or hot surface)
Burns, chemical (caustics, etc.)
Burns, radiation (includes all cell damage by ultraviolet, x-rays, microwaves, laser beam, radioactive materials, etc.)
Burns, electrical
Burns, not specified
Concussions
Contusions, Abrasions
Crushing
Dental injury
Dermatitis, Conjunctivitis
Dislocation
Electric shock
Foreign body
Fracture
Hematoma
Hemorrhage
Ingested foreign object
Internal organ injury
Laceration
Nerve damage
Poisoning
Puncture
Strain or Sprain
Submersion (including Drowning)

Body part codes:
Arm, lower (not including elbow or wrist)
Arm, upper
Ankle
Ear
Elbow
Eyeball
Face (including eyelid, eye area and nose)
Finger
Foot
Hand
Head
Internal (use with aspiration and ingestion)
Knee
Leg, lower (not including knee or ankle)
Leg, upper
Mouth (including lips, tongue and teeth)
Neck
Pubic region
Shoulder (including clavicle, collarbone)
Toe
Trunk, lower
Trunk, upper (not including shoulders)
Wrist
25-50% of body
All parts of body (more than 50% of body)

KABCO

KABCO is often used in U.S. State and National highway traffic injury surveillance systems. The KABCO severity scale is used by the investigating police officer on the scene to classify injury severity for occupants with five categories:
K = killed
A = disabling injury
B = evident injury
C = possible injury
O = no apparent injury

Appendix B: Detailed Tables of Estimated Quality Adjusted Life Years (QALYs) lost per injury: Median, Quartile 1 (Q1), Quartile 3 (Q3); by Discount Rate, Maximum AIS, Fracture/Dislocation, and Body Region

Tables B 1 – B 4 are based on the main analysis that includes utility weights from all literature reviewed.

Tables B 5 – B 8 are based on the "best studies" analysis that includes utility weights only from those studies that met at least 2 of 3 criteria on study quality.

Table B1: Estimated Quality Adjusted Life Years (QALYs) lost per injury: Median, Quartile 1 (Q1), Quartile 3 (Q3); by Maximum AIS, Fracture/Dislocation, and Body Region; 3% Discount Rate; based on motor vehicle-related injuries, 2000-2006

			Nonhospitalized			Hospitalized			All		
Max AIS	Fracture or Dislocation	Body Region	Median	Q1	Q3	Median	Q1	Q3	Median	Q1	Q3
AIS 1	No	Head	0.16	0.13	0.20	1.30	1.30	1.30	0.25	0.23	0.28
AIS 2	No	Head	1.13	0.86	1.76	1.99	1.74	2.70	1.44	1.18	2.11
AIS 3	No	Head	1.16	0.75	1.79	4.13	3.17	5.48	3.36	2.55	4.53
AIS 4	No	Head				8.87	7.08	10.84	8.87	7.08	10.84
AIS 5	No	Head				13.88	11.18	16.22	13.88	11.18	16.22
AIS 1	No	Face	0.03	0.02	0.03	1.07	1.07	1.07	0.05	0.04	0.05
AIS 2	No	Face				2.50	1.72	5.16	2.50	1.72	5.16
AIS 3	No	Face				2.29	1.57	5.09	2.29	1.57	5.09
AIS 1	No	Neck				1.22	1.10	1.50	1.22	1.10	1.50
AIS 2	No	Neck				3.13	2.68	4.11	3.13	2.68	4.11
AIS 1	No	Thorax	0.01	0.01	0.02	0.33	0.33	0.33	0.03	0.03	0.03
AIS 2	No	Thorax	0.08	0.07	0.09	1.16	1.06	1.38	0.32	0.29	0.37
AIS 3	No	Thorax	0.07	0.06	0.08	0.52	0.42	0.72	0.46	0.37	0.63
AIS 4	No	Thorax				0.93	0.62	1.33	0.93	0.62	1.33
AIS 5	No	Thorax				1.51	1.05	2.38	1.51	1.05	2.38
AIS 1	No	Abdomen/Pelvic Contents				0.20	0.19	0.22	0.48	0.32	0.93
AIS 2	No	Abdomen/Pelvic Contents	0.07	0.06	0.07	0.51	0.37	0.78	0.36	0.27	0.54
AIS 3	No	Abdomen/Pelvic Contents				0.84	0.57	1.43	0.84	0.57	1.43
AIS 4	No	Abdomen/Pelvic Contents				1.21	0.80	2.07	1.21	0.80	2.07
AIS 5	No	Abdomen/Pelvic Contents				0.70	0.40	1.25	0.70	0.40	1.25
AIS 3	No	Spinal Cord				5.54	5.05	6.36	5.45	4.97	6.27
AIS 4	No	Spinal Cord				15.53	15.50	15.64	15.53	15.50	15.64
AIS 5	No	Spinal Cord				18.09	17.70	18.43	18.09	17.70	18.43
AIS 1	No	Upper Extremity	0.03	0.02	0.04	0.38	0.38	0.38	0.04	0.03	0.05
AIS 2	No	Upper Extremity	0.12	0.10	0.15	1.24	1.18	1.38	0.47	0.44	0.53
AIS 3	No	Upper Extremity				1.91	1.63	2.40	2.31	1.65	3.38

Table B1 (cont.): Estimated Quality Adjusted Life Years (QALYs) lost per injury: Median, Quartile 1 (Q1), Quartile 3 (Q3); by Maximum AIS, Fracture/Dislocation, and Body Region; 3% Discount Rate; based on motor vehicle-related injuries, 2000-2006

	Fracture or		Nonhospitalized			Hospitalized			All		
Max AIS	Dislocation	Body Region	Median	Q1	Q3	Median	Q1	Q3	Median	Q1	Q3
AIS 1	No	Lower Extremity	0.03	0.02	0.03	0.45	0.45	0.45	0.04	0.04	0.05
AIS 2	No	Lower Extremity	0.18	0.09	0.33	1.32	1.17	1.59	0.22	0.13	0.38
AIS 3	No	Lower Extremity				1.96	1.40	2.88	1.58	1.12	2.32
AIS 4	No	Lower Extremity				3.25	2.34	4.56	3.25	2.34	4.56
AIS 1	No	Burns/Other	0.06	0.06	0.06	0.61	0.61	0.61	0.06	0.06	0.06
AIS 2	No	Burns/Other				2.00	1.34	3.02	2.00	1.34	3.02
AIS 2	Yes	Head	2.92	1.73	7.10	4.42	3.17	9.25	3.94	2.71	8.56
AIS 3	Yes	Head				4.75	3.44	9.55	4.75	3.44	9.55
AIS 4	Yes	Head				4.72	3.40	9.52	4.72	3.40	9.52
AIS 1	Yes	Face	1.65	0.92	3.89	0.54	0.54	0.54	1.55	0.89	3.60
AIS 2	Yes	Face	0.05	0.04	0.06	2.43	1.59	5.30	0.76	0.50	1.63
AIS 3	Yes	Face				2.38	1.62	5.31	2.38	1.62	5.31
AIS 1	Yes	Thorax				0.44	0.44	0.44	0.44	0.44	0.44
AIS 2	Yes	Thorax				0.82	0.77	0.92	0.82	0.77	0.92
AIS 3	Yes	Thorax				1.05	0.94	1.36	1.05	0.94	1.36
AIS 4	Yes	Thorax				1.54	1.01	2.73	1.54	1.01	2.73
AIS 1	Yes	Upper Extremity	0.07	0.07	0.07	0.79	0.78	0.80	0.07	0.07	0.07
AIS 2	Yes	Upper Extremity	0.14	0.12	0.17	1.20	1.16	1.29	0.36	0.34	0.41
AIS 3	Yes	Upper Extremity				2.41	1.76	3.89	2.41	1.76	3.89
AIS 1	Yes	Lower Extremity	0.03	0.03	0.03				0.03	0.03	0.03
AIS 2	Yes	Lower Extremity	0.53	0.29	0.87	1.42	1.27	1.65	0.84	0.64	1.15
AIS 3	Yes	Lower Extremity	2.19	0.88	4.15	1.94	1.34	2.88	1.98	1.27	3.08
AIS 4	Yes	Lower Extremity				3.99	2.64	8.04	3.99	2.64	8.04

Table B2: Estimated Quality Adjusted Life Years (QALYs) lost per injury: Median, Quartile 1 (Q1), Quartile 3 (Q3); by Maximum AIS, Fracture/Dislocation, and Body Region; 4% Discount Rate; based on motor vehicle-related injuries, 2000-2006

	Fracture or		Nonhospitalized			Hospitalized			All		
Max AIS	Dislocation	Body Region	Median	Q1	Q3	Median	Q1	Q3	Median	Q1	Q3
AIS 1	No	Head	0.14	0.11	0.18	1.08	1.08	1.08	0.21	0.19	0.25
AIS 2	No	Head	1.09	0.83	1.71	1.80	1.56	2.48	1.35	1.10	2.00
AIS 3	No	Head	1.14	0.73	1.75	3.59	2.76	4.78	2.96	2.24	4.00
AIS 4	No	Head				7.51	5.99	9.21	7.51	5.99	9.21
AIS 5	No	Head				11.69	9.43	13.66	11.69	9.43	13.66
AIS 1	No	Face	0.02	0.02	0.03	0.89	0.89	0.89	0.04	0.04	0.05
AIS 2	No	Face				2.12	1.46	4.36	2.12	1.46	4.36
AIS 3	No	Face				1.95	1.33	4.31	1.95	1.33	4.31
AIS 1	No	Neck				1.03	0.92	1.26	1.03	0.92	1.26
AIS 2	No	Neck				2.63	2.25	3.45	2.63	2.25	3.45
AIS 1	No	Thorax	0.01	0.01	0.01	0.28	0.28	0.28	0.02	0.02	0.03
AIS 2	No	Thorax	0.07	0.06	0.08	0.99	0.89	1.19	0.27	0.24	0.32
AIS 3	No	Thorax	0.06	0.05	0.07	0.45	0.36	0.62	0.40	0.32	0.55
AIS 4	No	Thorax				0.79	0.53	1.13	0.79	0.53	1.13
AIS 5	No	Thorax				1.29	0.89	2.02	1.29	0.89	2.02
AIS 1	No	Abdomen/Pelvic Contents				0.17	0.16	0.18	0.40	0.27	0.78
AIS 2	No	Abdomen/Pelvic Contents	0.06	0.05	0.07	0.46	0.33	0.70	0.32	0.24	0.49
AIS 3	No	Abdomen/Pelvic Contents				0.74	0.51	1.25	0.74	0.51	1.25
AIS 4	No	Abdomen/Pelvic Contents				1.03	0.68	1.76	1.03	0.68	1.76
AIS 5	No	Abdomen/Pelvic Contents				0.60	0.35	1.07	0.60	0.35	1.07
AIS 3	No	Spinal Cord				4.67	4.23	5.40	4.60	4.16	5.34
AIS 4	No	Spinal Cord				13.02	12.99	13.11	13.02	12.99	13.11
AIS 5	No	Spinal Cord				15.17	14.84	15.45	15.17	14.84	15.45
AIS 1	No	Upper Extremity	0.02	0.02	0.04	0.32	0.32	0.32	0.03	0.02	0.05
AIS 2	No	Upper Extremity	0.10	0.08	0.13	1.05	1.00	1.18	0.40	0.37	0.46
AIS 3	No	Upper Extremity				1.60	1.36	2.02	1.93	1.38	2.83

Table B2 (cont.): Estimated Quality Adjusted Life Years (QALYs) lost per injury: Median, Quartile 1 (Q1), Quartile 3 (Q3); by Maximum AIS, Fracture/Dislocation, and Body Region; 4% Discount Rate; based on motor vehicle-related injuries, 2000-2006

	Fracture or		Nonhospitalized			Hospitalized			All		
Max AIS	Dislocation	Body Region	Median	Q1	Q3	Median	Q1	Q3	Median	Q1	Q3
AIS 1	No	Lower Extremity	0.02	0.02	0.03	0.37	0.37	0.37	0.03	0.03	0.04
AIS 2	No	Lower Extremity	0.16	0.08	0.29	1.12	0.98	1.36	0.19	0.11	0.33
AIS 3	No	Lower Extremity	0.05	0.04	0.08	1.63	1.17	2.39	1.32	0.94	1.93
AIS 4	No	Lower Extremity				2.74	1.98	3.84	2.74	1.98	3.84
AIS 1	No	Burns/Other	0.05	0.05	0.05	0.51	0.51	0.51	0.05	0.05	0.05
AIS 2	No	Burns/Other				1.67	1.12	2.52	1.67	1.12	2.52
AIS 2	Yes	Head	2.48	1.47	5.99	3.73	2.67	7.78	3.33	2.29	7.20
AIS 3	Yes	Head				4.03	2.92	8.05	4.03	2.92	8.05
AIS 4	Yes	Head				4.01	2.89	8.04	4.01	2.89	8.04
AIS 1	Yes	Face	1.41	0.79	3.29	0.45	0.45	0.45	1.33	0.76	3.05
AIS 2	Yes	Face	0.04	0.03	0.06	2.07	1.35	4.48	0.65	0.43	1.38
AIS 3	Yes	Face				2.02	1.38	4.49	2.02	1.38	4.49
AIS 1	Yes	Thorax				0.37	0.37	0.37	0.37	0.37	0.37
AIS 2	Yes	Thorax				0.70	0.64	0.79	0.70	0.64	0.79
AIS 3	Yes	Thorax				0.89	0.79	1.16	0.89	0.79	1.16
AIS 4	Yes	Thorax				1.32	0.86	2.32	1.32	0.86	2.32
AIS 1	Yes	Upper Extremity	0.06	0.06	0.06	0.66	0.65	0.67	0.06	0.06	0.06
AIS 2	Yes	Upper Extremity	0.12	0.11	0.15	1.01	0.97	1.09	0.31	0.29	0.35
AIS 3	Yes	Upper Extremity				2.03	1.47	3.27	2.03	1.47	3.27
AIS 1	Yes	Lower Extremity	0.02	0.02	0.02				0.02	0.02	0.02
AIS 2	Yes	Lower Extremity	0.44	0.24	0.74	1.19	1.06	1.39	0.71	0.53	0.97
AIS 3	Yes	Lower Extremity	1.79	0.72	3.39	1.61	1.12	2.38	1.64	1.06	2.54
AIS 4	Yes	Lower Extremity				3.38	2.24	6.77	3.38	2.24	6.77

Table B3: Estimated Quality Adjusted Life Years (QALYs) lost per injury: Median, Quartile 1 (Q1), Quartile 3 (Q3); by Maximum AIS, Fracture/Dislocation, and Body Region; 7% Discount Rate; based on motor vehicle crash-related injury case data, 2000-2006

			Nonhospitalized			Hospitalized			All		
Max AIS	Fracture or Dislocation	Body Region	Median	Q1	Q3	Median	Q1	Q3	Median	Q1	Q3
AIS 1	No	Head	0.11	0.08	0.15	0.70	0.70	0.70	0.16	0.13	0.19
AIS 2	No	Head	1.02	0.77	1.60	1.47	1.24	2.09	1.19	0.95	1.78
AIS 3	No	Head	1.09	0.70	1.66	2.65	2.04	3.53	2.25	1.69	3.05
AIS 4	No	Head				5.15	4.10	6.35	5.15	4.10	6.35
AIS 5	No	Head				7.86	6.35	9.18	7.86	6.35	9.18
AIS 1	No	Face	0.02	0.01	0.02	0.58	0.58	0.58	0.03	0.03	0.04
AIS 2	No	Face				1.46	1.00	2.97	1.46	1.00	2.97
AIS 3	No	Face				1.35	0.92	2.93	1.35	0.92	2.93
AIS 1	No	Neck				0.68	0.61	0.85	0.68	0.61	0.85
AIS 2	No	Neck				1.74	1.49	2.30	1.74	1.49	2.30
AIS 1	No	Thorax	0.01	0.01	0.01	0.18	0.18	0.18	0.02	0.02	0.02
AIS 2	No	Thorax	0.05	0.04	0.06	0.70	0.61	0.86	0.19	0.17	0.24
AIS 3	No	Thorax	0.04	0.04	0.06	0.32	0.26	0.45	0.29	0.23	0.40
AIS 4	No	Thorax				0.53	0.36	0.76	0.53	0.36	0.76
AIS 5	No	Thorax				0.89	0.62	1.38	0.89	0.62	1.38
AIS 1	No	Abdomen/Pelvic Contents				0.11	0.11	0.12	0.27	0.18	0.52
AIS 2	No	Abdomen/Pelvic Contents	0.04	0.04	0.05	0.36	0.26	0.55	0.25	0.19	0.38
AIS 3	No	Abdomen/Pelvic Contents				0.56	0.39	0.94	0.56	0.39	0.94
AIS 4	No	Abdomen/Pelvic Contents				0.71	0.48	1.21	0.71	0.48	1.21
AIS 5	No	Abdomen/Pelvic Contents				0.42	0.25	0.74	0.42	0.25	0.74
AIS 3	No	Spinal Cord				3.14	2.79	3.73	3.10	2.75	3.68
AIS 4	No	Spinal Cord				8.63	8.61	8.69	8.63	8.61	8.69
AIS 5	No	Spinal Cord				10.05	9.84	10.24	10.05	9.84	10.24
AIS 1	No	Upper Extremity	0.02	0.01	0.04	0.21	0.21	0.21	0.03	0.02	0.04
AIS 2	No	Upper Extremity	0.08	0.06	0.11	0.72	0.67	0.84	0.28	0.25	0.34
AIS 3	No	Upper Extremity				1.06	0.90	1.35	1.27	0.90	1.86

Table B3 (cont.): Estimated Quality Adjusted Life Years (QALYs) lost per injury: Median, Quartile 1 (Q1), Quartile 3 (Q3); by Maximum AIS, Fracture/Dislocation, and Body Region; 7% Discount Rate; based on motor vehicle crash-related injury case data, 2000-2006

	Fracture or		Nonhospitalized			Hospitalized			All		
Max AIS	Dislocation	Body Region	Median	Q1	Q3	Median	Q1	Q3	Median	Q1	Q3
AIS 1	No	Lower Extremity	0.02	0.01	0.02	0.24	0.24	0.24	0.03	0.02	0.03
AIS 2	No	Lower Extremity	0.12	0.06	0.23	0.76	0.66	0.94	0.15	0.09	0.26
AIS 3	No	Lower Extremity	0.05	0.03	0.07	1.06	0.76	1.55	0.86	0.61	1.25
AIS 4	No	Lower Extremity				1.85	1.34	2.59	1.85	1.34	2.59
AIS 1	No	Burns/Other	0.03	0.03	0.03	0.33	0.33	0.33	0.03	0.03	0.03
AIS 2	No	Burns/Other				1.09	0.73	1.65	1.09	0.73	1.65
AIS 2	Yes	Head	1.72	1.02	4.05	2.53	1.80	5.22	2.27	1.55	4.84
AIS 3	Yes	Head				2.77	2.00	5.44	2.77	2.00	5.44
AIS 4	Yes	Head				2.77	1.99	5.44	2.77	1.99	5.44
AIS 1	Yes	Face	0.99	0.56	2.26	0.29	0.29	0.29	0.93	0.54	2.09
AIS 2	Yes	Face	0.03	0.03	0.05	1.43	0.93	3.05	0.45	0.29	0.94
AIS 3	Yes	Face				1.40	0.95	3.05	1.40	0.95	3.05
AIS 1	Yes	Thorax				0.24	0.24	0.24	0.24	0.24	0.24
AIS 2	Yes	Thorax				0.48	0.43	0.56	0.48	0.43	0.56
AIS 3	Yes	Thorax				0.62	0.54	0.82	0.62	0.54	0.82
AIS 4	Yes	Thorax				0.92	0.61	1.60	0.92	0.61	1.60
AIS 1	Yes	Upper Extremity	0.04	0.04	0.04	0.43	0.43	0.44	0.04	0.04	0.04
AIS 2	Yes	Upper Extremity	0.09	0.08	0.12	0.68	0.64	0.75	0.21	0.19	0.25
AIS 3	Yes	Upper Extremity				1.35	0.98	2.18	1.35	0.98	2.18
AIS 1	Yes	Lower Extremity	0.02	0.02	0.02	0.00	0.00	0.00	0.02	0.02	0.02
AIS 2	Yes	Lower Extremity	0.30	0.16	0.50	0.79	0.70	0.94	0.47	0.35	0.65
AIS 3	Yes	Lower Extremity	1.10	0.45	2.07	1.04	0.73	1.53	1.05	0.68	1.61
AIS 4	Yes	Lower Extremity				2.31	1.55	4.55	2.31	1.55	4.55

Table B4: Estimated Quality Adjusted Life Years (QALYs) lost per injury: Median, Quartile 1 (Q1), Quartile 3 (Q3); by Maximum AIS, Fracture/Dislocation, and Body Region; 10% Discount Rate; based on motor vehicle crash-related injury case data, 2000-2006

			Nonhospitalized			Hospitalized			All		
Max AIS	Fracture or Dislocation	Body Region	Median	Q1	Q3	Median	Q1	Q3	Median	Q1	Q3
AIS 1	No	Head	0.09	0.07	0.13	0.51	0.51	0.51	0.13	0.10	0.16
AIS 2	No	Head	0.97	0.73	1.51	1.29	1.07	1.85	1.09	0.86	1.63
AIS 3	No	Head	1.04	0.67	1.58	2.15	1.66	2.87	1.87	1.40	2.54
AIS 4	No	Head				3.95	3.14	4.89	3.95	3.14	4.89
AIS 5	No	Head				5.93	4.80	6.91	5.93	4.80	6.91
AIS 1	No	Face	0.01	0.01	0.02	0.42	0.42	0.42	0.02	0.02	0.03
AIS 2	No	Face				1.13	0.76	2.26	1.13	0.76	2.26
AIS 3	No	Face				1.04	0.70	2.23	1.04	0.70	2.23
AIS 1	No	Neck				0.51	0.45	0.64	0.51	0.45	0.64
AIS 2	No	Neck				1.30	1.10	1.71	1.30	1.10	1.71
AIS 1	No	Thorax	0.01	0.01	0.01	0.13	0.13	0.13	0.01	0.01	0.02
AIS 2	No	Thorax	0.04	0.03	0.05	0.54	0.47	0.69	0.15	0.13	0.19
AIS 3	No	Thorax	0.04	0.03	0.05	0.26	0.20	0.37	0.23	0.18	0.33
AIS 4	No	Thorax				0.40	0.27	0.58	0.40	0.27	0.58
AIS 5	No	Thorax				0.68	0.48	1.05	0.68	0.48	1.05
AIS 1	No	Abdomen/Pelvic Contents				0.09	0.08	0.09	0.20	0.14	0.38
AIS 2	No	Abdomen/Pelvic Contents	0.03	0.03	0.04	0.30	0.22	0.47	0.21	0.16	0.33
AIS 3	No	Abdomen/Pelvic Contents				0.47	0.33	0.78	0.47	0.33	0.78
AIS 4	No	Abdomen/Pelvic Contents				0.55	0.37	0.93	0.55	0.37	0.93
AIS 5	No	Abdomen/Pelvic Contents				0.33	0.20	0.58	0.33	0.20	0.58
AIS 3	No	Spine				2.37	2.07	2.87	2.34	2.04	2.84
AIS 4	No	Spine				6.42	6.41	6.47	6.42	6.41	6.47
AIS 5	No	Spine				7.48	7.32	7.62	7.48	7.32	7.62
AIS 1	No	Upper Extremity	0.02	0.01	0.04	0.15	0.15	0.15	0.02	0.02	0.04
AIS 2	No	Upper Extremity	0.07	0.05	0.10	0.56	0.51	0.66	0.22	0.19	0.27
AIS 3	No	Upper Extremity				0.79	0.66	1.02	0.94	0.66	1.38

Table B4 (cont.): Estimated Quality Adjusted Life Years (QALYs) lost per injury: Median, Quartile 1 (Q1), Quartile 3 (Q3); by Maximum AIS, Fracture/Dislocation, and Body Region; 10% Discount Rate; based on motor vehicle crash-related injury case data, 2000-2006

	Fracture or		Nonhospitalized			Hospitalized			All		
Max AIS	Dislocation	Body Region	Median	Q1	Q3	Median	Q1	Q3	Median	Q1	Q3
AIS 1	No	Lower Extremity	0.02	0.01	0.02	0.18	0.18	0.18	0.02	0.02	0.03
AIS 2	No	Lower Extremity	0.11	0.05	0.20	0.58	0.50	0.73	0.12	0.07	0.22
AIS 3	No	Lower Extremity	0.04	0.03	0.07	0.78	0.56	1.13	0.63	0.45	0.92
AIS 4	No	Lower Extremity				1.41	1.02	1.96	1.41	1.02	1.96
AIS 1	No	Burns/Other	0.02	0.02	0.02	0.24	0.24	0.24	0.03	0.03	0.03
AIS 2	No	Burns/Other				0.80	0.54	1.21	0.80	0.54	1.21
AIS 2	Yes	Head	1.33	0.79	3.07	1.92	1.36	3.92	1.73	1.18	3.65
AIS 3	Yes	Head				2.13	1.53	4.12	2.13	1.53	4.12
AIS 4	Yes	Head				2.14	1.53	4.13	2.14	1.53	4.13
AIS 1	Yes	Face	0.78	0.44	1.73	0.21	0.21	0.21	0.73	0.42	1.60
AIS 2	Yes	Face	0.03	0.02	0.04	1.10	0.71	2.32	0.35	0.23	0.72
AIS 3	Yes	Face				1.08	0.73	2.32	1.08	0.73	2.32
AIS 1	Yes	Thorax				0.18	0.18	0.18	0.18	0.18	0.18
AIS 2	Yes	Thorax				0.37	0.32	0.44	0.37	0.32	0.44
AIS 3	Yes	Thorax				0.48	0.41	0.64	0.48	0.41	0.64
AIS 4	Yes	Thorax				0.72	0.47	1.23	0.72	0.47	1.23
AIS 1	Yes	Upper Extremity	0.03	0.03	0.03	0.32	0.31	0.33	0.03	0.03	0.03
AIS 2	Yes	Upper Extremity	0.08	0.06	0.11	0.51	0.48	0.57	0.17	0.15	0.20
AIS 3	Yes	Upper Extremity				1.01	0.73	1.64	1.01	0.73	1.64
AIS 1	Yes	Lower Extremity	0.01	0.01	0.01				0.01	0.01	0.01
AIS 2	Yes	Lower Extremity	0.22	0.12	0.38	0.59	0.51	0.71	0.35	0.26	0.49
AIS 3	Yes	Lower Extremity	0.77	0.31	1.43	0.76	0.54	1.11	0.76	0.50	1.16
AIS 4	Yes	Lower Extremity				1.77	1.19	3.44	1.77	1.19	3.44

Table B5: Estimated Quality Adjusted Life Years (QALYs) lost per injury – using "Best" studies only: Median, Quartile 1 (Q1), Quartile 3 (Q3); by Maximum AIS, Fracture/Dislocation, and Body Region; 3% Discount Rate; based on motor vehicle-related injuries, 2000-2006

	Fracture or		Nonhospitalized			Hospitalized			All		
Max AIS	Dislocation	Body Region	Median	Q1	Q3	Median	Q1	Q3	Median	Q1	Q3
AIS 1	No	Head	0.17	0.14	0.21	1.30	1.30	1.30	0.26	0.23	0.30
AIS 2	No	Head	1.14	0.89	1.88	2.00	1.76	2.77	1.46	1.21	2.21
AIS 3	No	Head	1.40	0.90	2.09	4.40	3.36	5.87	3.63	2.73	4.90
AIS 4	No	Head				9.22	7.34	11.32	9.22	7.34	11.32
AIS 5	No	Head				14.24	11.50	16.49	14.24	11.50	16.49
AIS 1	No	Face	0.03	0.02	0.03	1.07	1.07	1.07	0.05	0.05	0.05
AIS 2	No	Face				2.84	1.93	5.68	2.84	1.93	5.68
AIS 3	No	Face				2.69	1.80	5.67	2.69	1.80	5.67
AIS 1	No	Neck				1.25	1.11	1.50	1.25	1.11	1.50
AIS 2	No	Neck				3.25	2.76	4.16	3.25	2.76	4.16
AIS 1	No	Thorax	0.01	0.01	0.02	0.33	0.33	0.33	0.03	0.03	0.03
AIS 2	No	Thorax	0.08	0.07	0.09	1.21	1.09	1.46	0.33	0.30	0.39
AIS 3	No	Thorax	0.07	0.06	0.08	0.55	0.45	0.77	0.49	0.40	0.68
AIS 4	No	Thorax				1.03	0.70	1.52	1.03	0.70	1.52
AIS 5	No	Thorax				1.67	1.16	2.58	1.67	1.16	2.58
AIS 1	No	Abdomen/Pelvic Contents	0.58	0.37	1.03	0.21	0.19	0.22	0.56	0.36	0.98
AIS 2	No	Abdomen/Pelvic Contents	0.07	0.06	0.08	0.54	0.40	0.80	0.38	0.28	0.56
AIS 3	No	Abdomen/Pelvic Contents				0.92	0.63	1.55	0.92	0.63	1.55
AIS 4	No	Abdomen/Pelvic Contents				1.36	0.89	2.23	1.36	0.89	2.23
AIS 5	No	Abdomen/Pelvic Contents				0.79	0.47	1.31	0.79	0.47	1.31
AIS 3	No	Spinal Cord	1.53	1.02	2.36	5.77	5.22	6.85	5.69	5.14	6.77
AIS 4	No	Spinal Cord				15.55	15.51	15.66	15.55	15.51	15.66
AIS 5	No	Spinal Cord				19.35	18.96	19.69	19.35	18.96	19.69
AIS 1	No	Upper Extremity	0.03	0.02	0.05	0.38	0.38	0.38	0.04	0.03	0.06
AIS 2	No	Upper Extremity	0.12	0.10	0.15	1.26	1.19	1.42	0.48	0.45	0.55
AIS 3	No	Upper Extremity	5.09	2.66	8.30	2.08	1.74	2.67	2.72	1.93	3.87

Table B5 (cont.): Estimated Quality Adjusted Life Years (QALYs) lost per injury – using "Best" studies: Median, Quartile 1 (Q1), Quartile 3 (Q3); by Maximum AIS, Fracture/Dislocation, and Body Region; 3% Discount Rate; based on motor vehicle-related injuries, 2000-2006

	Fracture or		Nonhospitalized			Hospitalized			All		
Max AIS	Dislocation	Body Region	Median	Q1	Q3	Median	Q1	Q3	Median	Q1	Q3
AIS 1	No	Lower Extremity	0.03	0.03	0.04	0.45	0.45	0.45	0.04	0.04	0.05
AIS 2	No	Lower Extremity	0.25	0.14	0.40	1.38	1.21	1.68	0.29	0.18	0.45
AIS 3	No	Lower Extremity	0.07	0.05	0.10	2.20	1.58	3.42	1.77	1.27	2.75
AIS 4	No	Lower Extremity				3.54	2.54	5.15	3.54	2.54	5.15
AIS 1	No	Burns/Other	0.06	0.06	0.06	0.61	0.61	0.61	0.06	0.06	0.06
AIS 2	No	Burns/Other				2.35	1.59	3.35	2.35	1.59	3.35
AIS 2	Yes	Head	4.17	2.35	8.12	5.15	3.57	10.13	4.84	3.18	9.48
AIS 3	Yes	Head				5.48	3.86	10.43	5.48	3.86	10.43
AIS 4	Yes	Head				5.46	3.82	10.39	5.46	3.82	10.39
AIS 1	Yes	Face	2.27	1.26	4.50	0.54	0.54	0.54	2.12	1.20	4.16
AIS 2	Yes	Face	0.05	0.04	0.07	2.79	1.81	5.85	0.87	0.57	1.80
AIS 3	Yes	Face				2.80	1.86	5.90	2.80	1.86	5.90
AIS 1	Yes	Thorax				0.44	0.44	0.44	0.44	0.44	0.44
AIS 2	Yes	Thorax				0.85	0.78	0.96	0.85	0.78	0.96
AIS 3	Yes	Thorax				1.10	0.97	1.44	1.10	0.97	1.44
AIS 4	Yes	Thorax				1.67	1.11	2.96	1.67	1.11	2.96
AIS 1	Yes	Upper Extremity	0.07	0.07	0.07	0.79	0.79	0.80	0.07	0.07	0.07
AIS 2	Yes	Upper Extremity	0.16	0.13	0.19	1.21	1.17	1.31	0.38	0.35	0.42
AIS 3	Yes	Upper Extremity				2.82	2.02	4.65	2.82	2.02	4.65
AIS 1	Yes	Lower Extremity	0.03	0.03	0.03				0.03	0.03	0.03
AIS 2	Yes	Lower Extremity	0.71	0.42	0.98	1.49	1.32	1.71	0.99	0.74	1.24
AIS 3	Yes	Lower Extremity	3.14	1.50	5.64	2.19	1.53	3.45	2.34	1.53	3.79
AIS 4	Yes	Lower Extremity				4.68	3.07	9.09	4.68	3.07	9.09

Table B6: Estimated Quality Adjusted Life Years (QALYs) lost per injury – using "Best" studies only: Median, Quartile 1 (Q1), Quartile 3 (Q3); by Maximum AIS, Fracture/Dislocation, and Body Region; 4% Discount Rate; based on motor vehicle-related injuries, 2000-2006

	Fracture or		Nonhospitalized			Hospitalized			All		
Max AIS	Dislocation	Body Region	Median	Q1	Q3	Median	Q1	Q3	Median	Q1	Q3
AIS 1	No	Head	0.14	0.11	0.18	1.08	1.08	1.08	0.21	0.19	0.25
AIS 2	No	Head	1.09	0.83	1.71	1.81	1.58	2.56	1.36	1.11	2.02
AIS 3	No	Head	1.14	0.73	1.75	3.83	2.93	5.11	3.13	2.36	4.25
AIS 4	No	Head				7.82	6.22	9.62	7.82	6.22	9.62
AIS 5	No	Head				12.00	9.69	13.88	12.00	9.69	13.88
AIS 1	No	Face	0.02	0.02	0.03	0.89	0.89	0.89	0.04	0.04	0.05
AIS 2	No	Face				2.41	1.64	4.81	2.41	1.64	4.81
AIS 3	No	Face				2.29	1.53	4.80	2.29	1.53	4.80
AIS 1	No	Neck				1.25	1.11	1.50	1.25	1.11	1.50
AIS 2	No	Neck				3.25	2.76	4.16	3.25	2.76	4.16
AIS 1	No	Thorax	0.01	0.01	0.01	0.28	0.28	0.28	0.02	0.02	0.03
AIS 2	No	Thorax	0.07	0.06	0.08	1.03	0.92	1.26	0.28	0.25	0.34
AIS 3	No	Thorax	0.06	0.05	0.07	0.48	0.38	0.67	0.42	0.34	0.59
AIS 4	No	Thorax				0.87	0.59	1.28	0.87	0.59	1.28
AIS 5	No	Thorax				1.42	0.99	2.18	1.42	0.99	2.18
AIS 1	No	Abdomen/Pelvic Contents	0.41	0.27	0.81	0.17	0.16	0.19	0.40	0.27	0.78
AIS 2	No	Abdomen/Pelvic Contents	0.06	0.05	0.07	0.48	0.35	0.72	0.34	0.25	0.50
AIS 3	No	Abdomen/Pelvic Contents				0.81	0.55	1.35	0.81	0.55	1.35
AIS 4	No	Abdomen/Pelvic Contents				1.16	0.76	1.90	1.16	0.76	1.90
AIS 5	No	Abdomen/Pelvic Contents				0.68	0.41	1.12	0.68	0.41	1.12
AIS 3	No	Spinal Cord	1.08	0.73	1.79	4.88	4.38	5.85	4.81	4.31	5.77
AIS 4	No	Spinal Cord				13.03	13.00	13.13	13.03	13.00	13.13
AIS 5	No	Spinal Cord				16.22	15.90	16.51	16.22	15.90	16.51
AIS 1	No	Upper Extremity	0.02	0.02	0.04	0.32	0.32	0.32	0.03	0.02	0.05
AIS 2	No	Upper Extremity	0.10	0.08	0.13	1.07	1.01	1.21	0.41	0.37	0.47
AIS 3	No	Upper Extremity	3.18	1.45	5.81	1.74	1.45	2.25	2.05	1.45	3.00

Table B6 (cont.): Estimated Quality Adjusted Life Years (QALYs) lost per injury – using "Best" studies: Median, Quartile 1 (Q1), Quartile 3 (Q3); by Maximum AIS, Fracture/Dislocation, and Body Region; 4% Discount Rate; based on motor vehicle-related injuries, 2000-2006

	Fracture or		Nonhospitalized			Hospitalized			All		
Max AIS	Dislocation	Body Region	Median	Q1	Q3	Median	Q1	Q3	Median	Q1	Q3
AIS 1	No	Lower Extremity	0.02	0.02	0.03	0.37	0.37	0.37	0.03	0.03	0.04
AIS 2	No	Lower Extremity	0.16	0.08	0.29	1.17	1.02	1.43	0.19	0.12	0.34
AIS 3	No	Lower Extremity	0.05	0.04	0.08	1.83	1.31	2.83	1.47	1.06	2.28
AIS 4	No	Lower Extremity				2.98	2.14	4.33	2.98	2.14	4.33
AIS 1	No	Burns/Other	0.05	0.05	0.05	0.51	0.51	0.51	0.05	0.05	0.05
AIS 2	No	Burns/Other				1.96	1.32	2.80	1.96	1.32	2.80
AIS 2	Yes	Head	2.48	1.47	5.99	4.34	3.01	8.52	3.75	2.52	7.70
AIS 3	Yes	Head				4.65	3.27	8.79	4.65	3.27	8.79
AIS 4	Yes	Head				4.64	3.24	8.77	4.64	3.24	8.77
AIS 1	Yes	Face	1.41	0.79	3.29	0.45	0.45	0.45	1.33	0.76	3.05
AIS 2	Yes	Face	0.04	0.03	0.06	2.37	1.54	4.95	0.74	0.48	1.52
AIS 3	Yes	Face				2.38	1.58	4.99	2.38	1.58	4.99
AIS 1	Yes	Thorax				0.37	0.37	0.37	0.37	0.37	0.37
AIS 2	Yes	Thorax				0.72	0.66	0.83	0.72	0.66	0.83
AIS 3	Yes	Thorax				0.94	0.82	1.24	0.94	0.82	1.24
AIS 4	Yes	Thorax				1.43	0.95	2.51	1.43	0.95	2.51
AIS 1	Yes	Upper Extremity	0.06	0.06	0.06	0.66	0.66	0.67	0.06	0.06	0.06
AIS 2	Yes	Upper Extremity	0.12	0.11	0.15	1.02	0.98	1.11	0.31	0.29	0.35
AIS 3	Yes	Upper Extremity				2.37	1.70	3.90	2.37	1.70	3.90
AIS 1	Yes	Lower Extremity	0.02	0.02	0.02				0.02	0.02	0.02
AIS 2	Yes	Lower Extremity	0.44	0.24	0.74	1.25	1.11	1.44	0.73	0.55	0.99
AIS 3	Yes	Lower Extremity	1.79	0.72	3.39	1.82	1.28	2.85	1.81	1.19	2.93
AIS 4	Yes	Lower Extremity				3.95	2.60	7.65	3.95	2.60	7.65

Table B7: Estimated Quality Adjusted Life Years (QALYs) lost per injury – using "Best" studies only: Median, Quartile 1 (Q1), Quartile 3 (Q3); by Maximum AIS, Fracture/Dislocation, and Body Region; 7% Discount Rate; based on motor vehicle -related injuries, 2000-2006

			Nonhospitalized			Hospitalized			All		
Max AIS	Fracture or D	Body Region	Median	Q1	Q3	Median	Q1	Q3	Median	Q1	Q3
AIS 1	No	Head	0.11	0.08	0.15	0.70	0.70	0.70	0.16	0.13	0.19
AIS 2	No	Head	1.02	0.77	1.60	1.48	1.26	2.15	1.19	0.95	1.80
AIS 3	No	Head	1.09	0.70	1.66	2.81	2.15	3.76	2.37	1.78	3.22
AIS 4	No	Head				5.37	4.26	6.64	5.37	4.26	6.64
AIS 5	No	Head				8.07	6.53	9.32	8.07	6.53	9.32
AIS 1	No	Face	0.02	0.01	0.02	0.58	0.58	0.58	0.03	0.03	0.04
AIS 2	No	Face				1.65	1.12	3.27	1.65	1.12	3.27
AIS 3	No	Face				1.57	1.05	3.27	1.57	1.05	3.27
AIS 1	No	Neck				0.70	0.62	0.85	0.70	0.62	0.85
AIS 2	No	Neck				1.81	1.53	2.33	1.81	1.53	2.33
AIS 1	No	Thorax	0.01	0.01	0.01	0.18	0.18	0.18	0.02	0.02	0.02
AIS 2	No	Thorax	0.05	0.04	0.06	0.73	0.64	0.92	0.20	0.17	0.25
AIS 3	No	Thorax	0.04	0.04	0.06	0.35	0.27	0.49	0.31	0.24	0.43
AIS 4	No	Thorax				0.59	0.40	0.86	0.59	0.40	0.86
AIS 5	No	Thorax				0.98	0.68	1.48	0.98	0.68	1.48
AIS 1	No	Abdomen/Pelvic Contents	0.28	0.19	0.54	0.12	0.11	0.13	0.27	0.18	0.52
AIS 2	No	Abdomen/Pelvic Contents	0.04	0.04	0.05	0.38	0.28	0.57	0.26	0.20	0.40
AIS 3	No	Abdomen/Pelvic Contents				0.61	0.43	1.01	0.61	0.43	1.01
AIS 4	No	Abdomen/Pelvic Contents				0.80	0.53	1.30	0.80	0.53	1.30
AIS 5	No	Abdomen/Pelvic Contents				0.48	0.29	0.78	0.48	0.29	0.78
AIS 3	No	Spinal Cord	0.89	0.59	1.51	3.32	2.92	4.08	3.27	2.87	4.03
AIS 4	No	Spinal Cord				8.64	8.62	8.70	8.64	8.62	8.70
AIS 5	No	Spinal Cord				10.75	10.54	10.94	10.75	10.54	10.94
AIS 1	No	Upper Extremity	0.02	0.01	0.04	0.21	0.21	0.21	0.03	0.02	0.04
AIS 2	No	Upper Extremity	0.08	0.06	0.11	0.74	0.68	0.86	0.29	0.26	0.34
AIS 3	No	Upper Extremity	2.05	0.93	3.75	1.16	0.96	1.51	1.35	0.95	1.98

Table B7 (cont.): Estimated Quality Adjusted Life Years (QALYs) lost per injury – using "Best" studies only: Median, Quartile 1 (Q1), Quartile 3 (Q3); by Maximum AIS, Fracture/Dislocation, and Body Region; 7% Discount Rate; based on motor vehicle -related injuries, 2000-2006

	Fracture or		Nonhospitalized			Hospitalized			All		
Max AIS	Dislocation	Body Region	Median	Q1	Q3	Median	Q1	Q3	Median	Q1	Q3
AIS 1	No	Lower Extremity	0.02	0.01	0.02	0.24	0.24	0.24	0.03	0.02	0.03
AIS 2	No	Lower Extremity	0.12	0.06	0.23	0.80	0.69	1.00	0.15	0.09	0.26
AIS 3	No	Lower Extremity	0.05	0.03	0.07	1.18	0.85	1.82	0.95	0.69	1.47
AIS 4	No	Lower Extremity				2.01	1.45	2.90	2.01	1.45	2.90
AIS 1	No	Burns/Other	0.03	0.03	0.03	0.33	0.33	0.33	0.03	0.03	0.03
AIS 2	No	Burns/Other				1.27	0.86	1.84	1.27	0.86	1.84
AIS 2	Yes	Head	1.72	1.02	4.05	2.93	2.03	5.70	2.54	1.71	5.17
AIS 3	Yes	Head				3.19	2.24	5.93	3.19	2.24	5.93
AIS 4	Yes	Head				3.19	2.23	5.93	3.19	2.23	5.93
AIS 1	Yes	Face	0.99	0.56	2.26	0.29	0.29	0.29	0.93	0.54	2.09
AIS 2	Yes	Face	0.03	0.03	0.05	1.63	1.06	3.37	0.51	0.33	1.04
AIS 3	Yes	Face				1.64	1.08	3.40	1.64	1.08	3.40
AIS 1	Yes	Thorax				0.24	0.24	0.24	0.24	0.24	0.24
AIS 2	Yes	Thorax				0.50	0.44	0.59	0.50	0.44	0.59
AIS 3	Yes	Thorax				0.65	0.56	0.87	0.65	0.56	0.87
AIS 4	Yes	Thorax				1.00	0.67	1.73	1.00	0.67	1.73
AIS 1	Yes	Upper Extremity	0.04	0.04	0.04	0.44	0.43	0.45	0.04	0.04	0.04
AIS 2	Yes	Upper Extremity	0.09	0.08	0.12	0.69	0.65	0.77	0.22	0.20	0.26
AIS 3	Yes	Upper Extremity				1.58	1.13	2.60	1.58	1.13	2.60
AIS 1	Yes	Lower Extremity	0.02	0.02	0.02				0.02	0.02	0.02
AIS 2	Yes	Lower Extremity	0.30	0.16	0.50	0.84	0.73	0.98	0.49	0.36	0.67
AIS 3	Yes	Lower Extremity	1.10	0.45	2.07	1.17	0.83	1.81	1.16	0.77	1.85
AIS 4	Yes	Lower Extremity				2.69	1.78	5.13	2.69	1.78	5.13

Table B8: Estimated Quality Adjusted Life Years (QALYs) lost per injury – using "Best" studies only: Median, Quartile 1 (Q1), Quartile 3 (Q3); by Maximum AIS, Fracture/Dislocation, and Body Region; 10% Discount Rate; based on motor vehicle -related injuries, 2000-2006

	Fracture or		Nonhospitalized			Hospitalized			All		
Max AIS	Dislocation	Body Region	Median	Q1	Q3	Median	Q1	Q3	Median	Q1	Q3
AIS 1	No	Head	0.09	0.07	0.13	0.51	0.51	0.51	0.13	0.10	0.16
AIS 2	No	Head	0.97	0.73	1.51	1.30	1.09	1.91	1.09	0.86	1.66
AIS 3	No	Head	1.04	0.67	1.58	2.28	1.75	3.05	1.96	1.47	2.67
AIS 4	No	Head				4.13	3.28	5.12	4.13	3.28	5.12
AIS 5	No	Head				6.08	4.93	7.02	6.08	4.93	7.02
AIS 1	No	Face	0.01	0.01	0.02	0.42	0.42	0.42	0.02	0.02	0.03
AIS 2	No	Face				1.27	0.86	2.50	1.27	0.86	2.50
AIS 3	No	Face				1.21	0.80	2.49	1.21	0.80	2.49
AIS 1	No	Neck				0.52	0.46	0.64	0.52	0.46	0.64
AIS 2	No	Neck				1.35	1.14	1.74	1.35	1.14	1.74
AIS 1	No	Thorax	0.01	0.01	0.01	0.13	0.13	0.13	0.01	0.01	0.02
AIS 2	No	Thorax	0.04	0.03	0.05	0.57	0.49	0.74	0.16	0.13	0.20
AIS 3	No	Thorax	0.04	0.03	0.05	0.28	0.22	0.40	0.25	0.19	0.35
AIS 4	No	Thorax				0.45	0.31	0.66	0.45	0.31	0.66
AIS 5	No	Thorax				0.75	0.53	1.13	0.75	0.53	1.13
AIS 1	No	Abdomen/Pelvic Contents	0.21	0.14	0.40	0.09	0.08	0.10	0.20	0.14	0.38
AIS 2	No	Abdomen/Pelvic Contents	0.03	0.03	0.04	0.32	0.24	0.49	0.22	0.17	0.34
AIS 3	No	Abdomen/Pelvic Contents				0.51	0.36	0.84	0.51	0.36	0.84
AIS 4	No	Abdomen/Pelvic Contents				0.62	0.41	1.00	0.62	0.41	1.00
AIS 5	No	Abdomen/Pelvic Contents				0.38	0.23	0.61	0.38	0.23	0.61
AIS 3	No	Spinal Cord	0.78	0.50	1.34	2.52	2.18	3.16	2.49	2.15	3.13
AIS 4	No	Spinal Cord				6.43	6.41	6.48	6.43	6.41	6.48
AIS 5	No	Spinal Cord				8.00	7.84	8.14	8.00	7.84	8.14
AIS 1	No	Upper Extremity	0.02	0.01	0.04	0.15	0.15	0.15	0.02	0.02	0.04
AIS 2	No	Upper Extremity	0.07	0.05	0.10	0.57	0.52	0.68	0.22	0.20	0.28
AIS 3	No	Upper Extremity	1.49	0.67	2.73	0.87	0.71	1.13	1.00	0.70	1.47

Table B8 (cont.): Estimated Quality Adjusted Life Years (QALYs) lost per injury – using "Best" studies only: Median, Quartile 1 (Q1), Quartile 3 (Q3); by Maximum AIS, Fracture/Dislocation, and Body Region; 10% Discount Rate; based on motor vehicle -related injuries, 2000-2006

			Nonhospitalized			Hospitalized			All		
Max AIS	Fracture or Dislocation	Body Region	Median	Q1	Q3	Median	Q1	Q3	Median	Q1	Q3
AIS 1	No	Lower Extremity	0.02	0.01	0.02	0.18	0.18	0.18	0.02	0.02	0.03
AIS 2	No	Lower Extremity	0.11	0.05	0.20	0.62	0.52	0.78	0.13	0.07	0.22
AIS 3	No	Lower Extremity	0.04	0.03	0.07	0.86	0.63	1.32	0.70	0.50	1.07
AIS 4	No	Lower Extremity				1.52	1.10	2.18	1.52	1.10	2.18
AIS 1	No	Burns/Other	0.02	0.02	0.02	0.24	0.24	0.24	0.03	0.03	0.03
AIS 2	No	Burns/Other				0.93	0.63	1.36	0.93	0.63	1.36
AIS 2	Yes	Head	1.33	0.79	3.07	2.22	1.53	4.29	1.94	1.30	3.90
AIS 3	Yes	Head				2.44	1.71	4.48	2.44	1.71	4.48
AIS 4	Yes	Head				2.46	1.72	4.49	2.46	1.72	4.49
AIS 1	Yes	Face	0.78	0.44	1.73	0.21	0.21	0.21	0.73	0.42	1.60
AIS 2	Yes	Face	0.03	0.02	0.04	1.25	0.81	2.57	0.40	0.26	0.80
AIS 3	Yes	Face				1.26	0.83	2.59	1.26	0.83	2.59
AIS 1	Yes	Thorax				0.18	0.18	0.18	0.18	0.18	0.18
AIS 2	Yes	Thorax				0.38	0.34	0.47	0.38	0.34	0.47
AIS 3	Yes	Thorax				0.51	0.43	0.69	0.51	0.43	0.69
AIS 4	Yes	Thorax				0.79	0.53	1.33	0.79	0.53	1.33
AIS 1	Yes	Upper Extremity	0.03	0.03	0.03	0.32	0.31	0.33	0.03	0.03	0.03
AIS 2	Yes	Upper Extremity	0.08	0.06	0.11	0.52	0.49	0.59	0.17	0.15	0.21
AIS 3	Yes	Upper Extremity				1.18	0.84	1.95	1.18	0.84	1.95
AIS 1	Yes	Lower Extremity	0.01	0.01	0.01				0.01	0.01	0.01
AIS 2	Yes	Lower Extremity	0.22	0.12	0.38	0.63	0.54	0.74	0.37	0.27	0.51
AIS 3	Yes	Lower Extremity	0.77	0.31	1.43	0.85	0.60	1.30	0.83	0.56	1.32
AIS 4	Yes	Lower Extremity				2.06	1.37	3.86	2.06	1.37	3.86

REFERENCES

Anderson, J. P., Kaplan, R. M., Berry, C. C., Bush, J. W., & Rumbaut, R. G. (1989). Interday reliability of function assessment for a health status measure: the Quality of Well-Being scale. *Medical Care, 27*, 1076-1083.

Andresen EM, Fouts BS, Romeis JC, Brownson CA (1999). Performance of health-related quality-of-life instruments in a spinal cord injured population. Arch Phys Med Rehabil, 80:877-84.

Association for the Advancement of Automotive Medicine. (1985). The abbreviated injury scale. Des Plaines, IL: Association for the Advancement of Automotive Medicine.

Association for the Advancement of Automotive Medicine. (1990). *The abbreviated injury scale, 1990*. Des Plaines, IL: Association for the Advancement of Automotive Medicine.

Bass, E. B., Pitt, H. A., & Lillemoe, K. D. (1993). Cost-Effectiveness of laparoscopic cholecystectomy versus open cholecystectomy. *American Journal of Surgery, 165*, 466-471.

Blincoe L., Seay A., Zaloshnja E., Miller TR, Romano EO, Luchter S, Spicer RS (**2002**). The economic impact of motor vehicle crashes, 2000. Washington DC: National Highway Traffic Safety Administration.

Brazier, J., Roberts, J., & Devierill, M. (2002). The estimation of a preference-based measure of health from the SF-36. *Jounal of Health Economics, 21*(2), 271–292.

Brazier, J., Roberts, J., Tsuchiya, A., & Busschback, J. A. (2004). A comparison of the EQ-5D and SF-6D across seven patient groups. *Health Economics, 13*, 873-884.

Brooks, R. G., Jedteg, S., Lindgren, B., Persson, U., & Bjork, S. (1991). EuroQol: Health-related quality of life measurement: Results of the Swedish questionnaire exercise. *Health Policy, 18*, 37–48.

Bush, J. W., Chen, M. M., & Patrick, D. L. (1973). Health status index. In R. Berg (Ed.), *Cost-effectiveness: Analysis of PKU program* (pp. 172–209). Chicago, IL: Hospital Research and Educational Trust.

Carsten, O. (1986). *Relationship of accident type to occupant injuries* (UMTR-86-15). Ann Arbor, MI: University of Michigan Transportation Research Institute.

Devlin, N. J., Hansen, P., Kind, P., & Williams, A. (2003). Logical inconsistencies in survey respondents' health state valuations - a methodological challenge for estimating social tariffs. *Health Economics, 12*, 529-544.

Dolan, P. D. P. (1997). Modeling valuations for EuroQol health states. *Medical Care, 35*(11), 1095-1108.

Drummond, M. F., Stoddart, G. L., & Torrance, G. W. (1987). *Methods for the economic evaluation of health care programs*. New York: Oxford University Press.

EuroQol Group. (1990). EuroQol: A new facility for the measurement of health-related quality of life. *Health Policy, 16*, 199–208.

Feeny, D., Furlong, W., Torrance, G. W., Goldsmith, C. H., Zenglong, Z., De Pauw, S., Denton, M., & Boyle, M. (2002). Multiattribute and single-attribute utility functions for the Health Utilities Index Mark 3 system. *Medical Care, 40*(2), 113-128.

Fryback, D. G., Dashbach, E. J., Klein, R., Klein, B. E. K., Peterson, K., & Martin, P. A. (1993). The Beaver Dam health outcomes study: Initial catalog of health-state quality factors. *Medical Decision Making, 13*, 89–102.

Fryback, D.G., Lawrence, W.F. Dollars may not buy as many QALYs as we think: a problem with defining quality-of-life adjustments. *Medical Decision Making, 17*, 276-84.

Fryback, D. G., Lawrence, W. F., Martin, P. A., Klein, R., & Klein, B. E. (1997). Predicting quality of well-being scores from the SF-36: Results from the Beaver Dam Health Outcomes Study. *Medical Decision Making, 17*, 1–9.

Gold, M. R., Franks, P., & Erickson, P. (1996). Assessing the health of the nation: The predictive validity of a preference-based instrument and self-rated health. *Medical Care, 34*(2), 163–177.

Gold, M. R., Franks, P., McCoy, K. I., & Fryback, D. G. (1998). Toward consistency in cost-utility analyses: Using national measures to create condition-specific values. *Medical Care, 36*, 778–792.

Green, C. H., & Brown, R. (1978). *Life safety: What is it and how much is it worth?* Garston, Watford, UK: Building Research Establishment, Department of the Environment.

Hakim, Z., & Pathak, D. S. (1999). Modeling the EuroQol data: a comparison of discrete choice conjoint and conditional preference modeling. *Health Economics, 8*, 103-116.

Harvard Center for Risk Analysis. (2004). *Catalog of Preference Scores*. Accessed November 15, 2004, from the World Wide Web: www.hcra.harvard.edu/pdf/preferencescores.pdf

Hawthorne G, Richardson J, Day N. (2000). Construction and utility scaling of the Assessment of Quality of Life instrument. Melbourne: Centre for Health Program Evaluation, Working Paper 101.

Hirsch, A., Eppinger, R., Shame, T., Van Nguyen, T., Levine, R., Mackenzie, J., Marks, M., & Ommaya, A. (1983). *Impairment scaling from the abbreviated injury scale*. Washington, DC: National Highway Traffic Safety Administration.

Houle C., & Berthelot J.M. (2000). A head-to-head comparison of Health Utiilties Mark 3 and the EQ-5D for the population living in private households in Canada. *Quality of Life Newsletter*, No. 24, January-June, pp. 5-6.

Isacson, D., Bingefors, K., & Lindberg, M. (2004). Self-reported dermatological problems and preferences for health: An epidemiological survey. *Acta Dermato-Venereologica, 84*, 27-31.

Javitt, J. C., & Aiello, L. P. (1996). Cost-effectiveness of detecting and treating diabetic retinopathy. *Annales of Internal Medicine, 124*(1 pt 2), 164-169.

Johns Hopkins University, & Tri-Analytics Inc. (1997). *ICDMAP-90 Software user's guide*.

Kaplan, R. M. (1982). Human preference measurement for health decisions and the evaluation of long-term care. In R. L. Kane & R. M. Kane (Eds.), *Values and long-term care* (pp. 157–188). Lexington, MA: Lexington Books.

Kaplan, R. M., Bush, J. W., & Berry, C. C. (1976). Health status: Types of validity for an index of well-being. *Health Services Research, 11*(4), 478–507.

Kind, P., Rosser, R., & Williams, A. (1982). Valuation of quality of life: Some psychometric evidence. In M. W. Jones-Lee (Ed.), *The value of life and safety* (pp. 159–170). New York, NY: North-Holland Publishing.

Lundberg, L., Johannesson, M., Isacson, D. G. I., & Borgquist, L. (1999). The relationship between health-state utilities and the SF-12 in a general population. *Medical Decision Making, 19*, 128-140.

Luo N., Johnson J.A., Shaw J.W., Feeny D., Coons S.J. (2005). Self-reported health status of the general adult U.S. population as assessed by the EQ-5D and Health Utilities Index. Medical Care, 43(11):1078-1086.

MacKenzie, E., Damiano, A., Miller, T. R., & Luchter, S. (1994). *The development of the functional capacity index*. Washington, DC: National Highway Traffic Safety Administration.

MacKenzie, E. J., Damiano, A., Miller, T., & Luchter, S. (1996). The development of the functional capacity index. *Journal of Trauma, 41*(5), 799–807.

MacKenzie, E. J., Steinwachs, D. M., & Shanker, B. (1989). Classifying trauma severity based on hospital discharge diagnoses: Validation of an ICD-9CM to AIS '85 conversion table. *Medical Care, 17*, 412-422.

Mason B. (2005) Statistical Analysis of Expert Ratings on Health-related Quality of Life (HRQL) Metrics. Memorandum prepared for the IOM Committee to Evaluate Measures of Health Benefits for Environmental, Health, and Safety Regulation.

Mathers, C., Vos, T., & Stevenson, C. (1999 11/16). *The Burden of Disease and Injury in Australia* (1-74024-019-7). Canberra: Australian Institute of Health and Welfare.

Mccabe, C., Stevens, K., Roberts, J., & Brazier, J. (2005). Health state values for the HU12 descriptive system: Results from a UK survey. *Health Economics, 14*, 231-244.

Miller, T. R. (1993). *Costs of injuries to employers: A NETS Compendium*. Washington, DC: Department of Transportation, National Highway Traffic Safety Administration.

Miller, T. R., Calhoun, C., & Arthur, W. B. (1989). Utility-adjusted impairment years: A low-cost approach to morbidity valuation, *Estimating and Valuing Morbidity in a Policy Context. Proceedings of Association of Environmental and Resource Economists Workshop* (EPA-23-08-89-05). Washington, DC: U.S. Environmental Protection Agency.

Miller, T. R., Pindus, N. M., Douglass, J. B., & Rossman, S. B. (1995). *Databook on nonfatal injury: Incidence, costs, and consequences*. Washington, DC: The Urban Institute Press.

Murray, C., & Lopez, A. (1996). *The global burden of disease*. Cambridge, MA: Harvard University Press.

Murray, C. J. L., & Lopez, A. D. (1994). *Global comparative assessments in the health sector: Disease burden, expenditures and intervention packages*. (C. J. L. Murray & A. D. Lopez (Eds.)). Geneva: World Health Organization.

Nichol, M. B., Sengupta, N., & Globe, D. (2001). Evaluating Quality-Adjusted Life years. Estimation of the Health Utilities Index (HU12) from the SF-36. *Medical Decision Making, 21*, 105-112.

Nord, E. (1991). EuroQol: Health related quality of life measurements: Valuations of health states by the general public in Norway. *Health Policy, 18*, 25–36.

Robinson, S., & Bennett, R. (1997). Workplace deviance: Its definition, its manifestations, and its causes. *Research on Negotiations in Organizations, 6*, 3–27.

Salomon, J. A., & Murray, C. J. L. (2004). A multi-method approach to measuring health-state valuations. *Health Economics, 13*, 281-290.

Sengupta, N., Nichol, M. B., Wu, J., & Globe, D. (2004). Mapping the SF-12 to the HU13 and VAS in a managed care population. *Medical Care, 42*(9), 927-937.

Shaw JW, Johnson JA, Coons SJ (2005). US valuation of the EQ-5D health states. Development and testing of the D1 valuation model. Medical Care, 43(3):203-220.

Sintonen H. (1994). The 15D-measure of health-related quality of life. I. Reliability, validity and sensitivity of its health state descriptive system. Working Paper 41. Melbourne, Vict: National Centre for Health Program Evaluation.

Spicer R and Miller T. Uncertainty Analysis of Quality Adjusted Life Years Lost. Final Report. National Highway Traffic Safety Administration, Washington, D.C., 2006.

Tengs, T. O., & Wallace, A. (2000). One thousand health-related quality-of-life estimates. *Medical Care, 38*(6), 583–637.

Tolley, G., Kenkel, D., & Fabian, R. (Eds.). (1994). *Valuing health for policy: An economic approach*. Chicago, IL: The University of Chicago Press.

Tomlinson, G., & Beyene, J. (2004). *Imputing summary statistics for meta-analysis of continuous data.* Presented at the 12th Cochrane Colloquia, Ottowa, Canada, October 2004. Accessed July 12, 2005, from the World Wide Web: http://www.cochrane.org/colloquia/abstracts/ottowa/P-148.htm

Torrance, G. W. (1982). Multiattribute utility theory as a method of measuring social preferences for health states in long term care. In R. L. Kane & R. M. Kane (Eds.), *Values and long-term care* (pp. 127–156). Lexington: DC Heath.

Torrance, G. W., Feeny, D. H., Furlong, W. J., Barr, R. D., Zhang, Y., & Wang, Q. (1996). Multiattribute utility function for a comprehensive health status classification system: Health Utilities Index Mark 2. *Medical Care, 34*(7), 702-722.

Torrance, G. W., Zhang, Y., Feeny, D., Furlong, W. J., & Barr, R. (1992). *Multi-attribute preference functions for a comprehensive health status classification system* (Working paper No. 92-18). Hamilton, Ontario: Centre for Health Economics and Policy Analysis, McMaster University.

Tosteson, A. N. A., Gabriel, S. E., Grove, M. R., Moncur, M. M., Kneeland, T. S., & Melton, L. J. (2001). Impact of hip and vertebral fractures on quality-adjusted life years. *Osteoporosis International, 21*, 1042-1049.

U.S. Department of Health and Human Services (DHHS). (1991). *The International Classification of Diseases, 9th Revision, Clinical Modification, ICD-9-CM, 4th Edition*. Washington, DC: U.S. Department of Health and Human Services.

Ware, J. E., & Sherbourne, C. D. (1992). The MOS 36-item short form health survey (SF-36). I. Conceptual framework and item selection. *Medical Care, 30*, 473–483.

Williams, A. (1995). *The measurement and valuation of health: A chronicle*. Discussion Paper 136. York, UK: Centre for Health Economics, University of York.

Wyatt, J. R., Niparko, J. K., Rothman, M., & de Lissovoy, G. (1996). Cost utility of the multichannel cochlear implant in 258 profoundly deaf individuals. *Laryngoscope, 106*(7), 816-821.