Appendix:

QALY calculation example:

Below are two examples of QALY calculations reprinted as published in Lawrence and Miller (2020), where imp1 is the one year loss and imp6 is the lifetime loss:

Example. A 40-year-old woman with a scapula fracture is expected to experience the following impairments:

- Mobility: moderate (level 2) for six weeks.
- Cosmetic: moderate (level 2) for four weeks.
- Pain: severe (level 3) for two weeks, and moderate (level 2) for two weeks.
- Daily living: severe (level 3) for one week, moderate (level 2) for one week, and slight (level 1) for three weeks.

No impairments in the cognitive and sensory dimensions are expected, and no ongoing impairment is expected after the first year.

The first year QALY loss is computed as

$$\begin{aligned} imp1 = 1 - \{&[1 - (.2054 \times 42/365)] \\ &\times [1 - (.002 \times 28/365)] \\ &\times [1 - (.360 \times 14/365 + .150 \times 14/365)] \\ &\times [1 - (.365 \times 7/365 + .1705 \times 7/365 + .078 \times 21/365)]\} \end{aligned}$$

In the first term, for example, .2054 is the utility weight from Table 1 for level-2 mobility impairment, and 42/365 is the fraction of the first year spent by the victim with level-2 mobility impairment, as described previously. Thus, the total quality-of-life reduction due to reduced mobility is equivalent to the loss of.0236 years, or 8.63 days. Subtracting this from 1, the remaining utility from mobility that is not lost to impairment in the first-year post-injury is .9764 years.

All dimensions are multiplied together, and the result is subtracted from 1. The total QALY loss expected from this scapula fracture is .0570 years—roughly 21 days.

`The NEISS injury diagnosis/body part code for this injury is 57/30. It is mapped from the ICD-9-CM diagnosis codes 810 (clavicle fracture), 811 (scapula fracture), and 818 (ill-defined fractures of upper limb). These, in turn, are mapped from five AIS-80 diagnoses rated by Hirsch et al. (1983). AIS-80 includes three kinds of shoulder fractures—acromion, clavicle, and scapula—all of which are associated with the Occupant Injury Code (OIC) S_FS2 (shoulder, fracture, skeletal system, AIS-2). These three AIS-80 diagnoses map to the ICD-9-CM diagnoses 810 and 811. Meanwhile, diagnosis 818 is mapped from three AIS-80 diagnoses—humerus fracture, open/displaced (A_FS3); radius/ulna fracture, open/displaced (R_FS3); and scapula fracture (S_FS2). (In OIC, A stands for upper arm and R stands for forearm. The first two are rated as AIS-3, the last as AIS-2.)

Just as we computed imp1 for scapula fracture above, we likewise compute the impairment fractions for all five AIS-80 diagnoses that map to shoulder fracture in NEISS:

- acromion fracture: imp1=0.03584, imp2=0, imp6=0
- clavicle fracture: imp1=0.03883, imp2=0, imp6=0
- scapula fracture: imp1=0.05701, imp2=0, imp6=0
- humerus fracture, open/displaced: imp1= 0.08435, imp2=0.078, imp6=0.078
- radius/ulna fracture, open/displaced: imp1=0.16012, imp2=0.07127, imp6=0.07127

ICD-9-CM diagnoses 810 and 811 are mapped from the first three AIS-80 diagnoses in a straightforward way:

- acromion fracture maps to 811.x1

- clavicle fracture maps to 810.xx
- scapula fracture maps to 811.xy for y=0,2,3,9

However, diagnosis 818 is more complicated. As an "ill-defined" diagnosis, it has no corresponding diagnosis in AIS-80. Therefore, it was mapped from three diagnoses chosen to be representative of upper limb fracture—the last three of the five listed AIS-80 diagnoses. (Scapula fracture maps to both 811 and 818.) Since scapula fracture is severity 2, while the other two diagnoses are severity 3, they must be weighted according to their treatment level (hospital-admitted), AIS body region (7=upper extremity) and AIS severity (2 or 3). (Table 3 provides these weights.) For hospital-admitted injuries of the upper extremity, 72.58% were AIS-2 and 11.9843% were AIS-3. These two weights sum to 0.845643. First, we compute the mean impairment fractions for the two AIS-3 diagnoses, which come to imp1=0.122240, imp2=0.074635, imp6=0.074635. Then we compute the weighted mean of the AIS-2 and AIS-3 impairment fractions:

imp1 = (0.7258×0.057006 + 0.119843×0.122240) / 0.845643 = 0.066251
imp2 = (0.7258×0 + 0.119843×0.074635) / 0.845643 = 0.010577
imp6 = (0.7258×0 + 0.119843×0.074635) / 0.845643 = 0.010577

These computed impairment fractions are assigned to ICD-9-CM diagnosis 818 when the Hirsch-based impairment fractions are merged onto the injury subsets of the 2010 NIS.

Work loss calculation example:

Work-related disability is represented by the variables **perm** and **temp**, which are intermediate values in the work-loss computations. Their formulas are

perm = prob(total) + prob(partial)×avgloss
temp = [1−prob(total)] × dayslost/365

where

prob(total) = probability of being permanently totally disabled
prob(partial) = probability of being permanently partially disabled
avgloss = average loss of earning power if permanently partially disabled
dayslost = work days lost to temporary disability

Greater detail on the work-loss variables can be found in Lawrence and Miller (2014).

Example. The inputs for work-related disability are given by three-digit ICD-9-CM diagnosis. For our hospital-admitted shoulder fracture example, these inputs are

Diag	Prob(Total)	Prob(Partial)	AvgLoss	DaysLost
810	0.0125348	0.238162	0.135	312.446
811	0.0088785	0.115888	0.135	166.730
818	0.0090909	0.269920	0.180676	291.355

From these values we can calculate perm and temp, as per the formulas above. For diagnosis 810, these calculations are

perm = 0.0125348 + (0.238162×0.135) = 0.044687
temp = [1−0.0125348] × 312.446/365 = 0.845286

In the same manner, we compute perm and temp for the other diagnoses:

Diag	perm	temp
810	0.044687	0.845286
811	0.024523	0.452739
818	0.057859	0.790976

Utility Weight for Work Loss

The utility weight for the work-related role function dimension is computed as:
weight7 = [VSL×0.3266 – (lifetime earnings + lifetime household production)] / VSL

The factor 0.3266 is derived from the Health Utilities Index (HUI), found in Drummond, Stoddart, and Torrance (1987), pp. 119–124. It comes from level 3 of the second dimension of the four-dimensional HUI. This dimension is described as *role function: self-care and role activity*, and the description of level 3 (R3) is "Being able to eat, dress, bathe and go to the toilet WITHOUT HELP; AND NOT being able to play, go to school or work." Therefore, this type of impairment which disallows work but does not hinder other aspects of daily life, appeared to best represent work disability, of the available options. (Higher severity levels in this dimension require help with daily activities, while lower levels permit some work.) The utility weight on impairment R3 is 0.77. Because of the way the HUI works, this must be fed into the formula, $U=1.42\times(m1\times m2\times m3\times m4)-0.42$, where m1–m4 are the utility weights from the HUI's four dimensions. If the victim suffers no disability in the other three dimensions, then this works out to $U=1.42\times(1\times0.77\times1\times1)-0.42=0.6734$. This number represents the share of quality of life that is retained. Thus, its inverse, 0.3266, is the utility loss associated with inability to work.

The tangible benefits of working—income and household production—are included in this figure. Since the WISQARS cost model accounts for these separately under work loss, they must be subtracted out of the QALY loss. With the VSL of $9.6 million (in 2014 dollars) prescribed by DHHS regulatory guidance and the 1.4% annual rate of earnings/productivity growth prescribed in the guidance, the computation (in 2014 dollars) is:
weight7 = ($9.6 million × 0.3266 − $1,501,846) / $9.6 million = 0.170
where $1,501,846 is the expected combined lifetime loss of earnings and household production, discounted at 3%.

References

Lawrence BA, Miller T. Quality of Life Loss Estimation Methods for the WISQARS Cost of Injury Module. Pacific Institute of Research and Evaluation; 2020.

Lawrence BA, Miller TR. Medical and work loss cost estimation methods for the WISQARS cost of injury module. Final Report to the Centers for Disease Control and Prevention. Calverton, MD: Pacific Institute for Research and Evaluation; 2014.