

Pricing the Priceless

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- Are health and life priceless, really?
- Quality Adjusted Life Years (QALYs)

The Sorrows of Young Werther

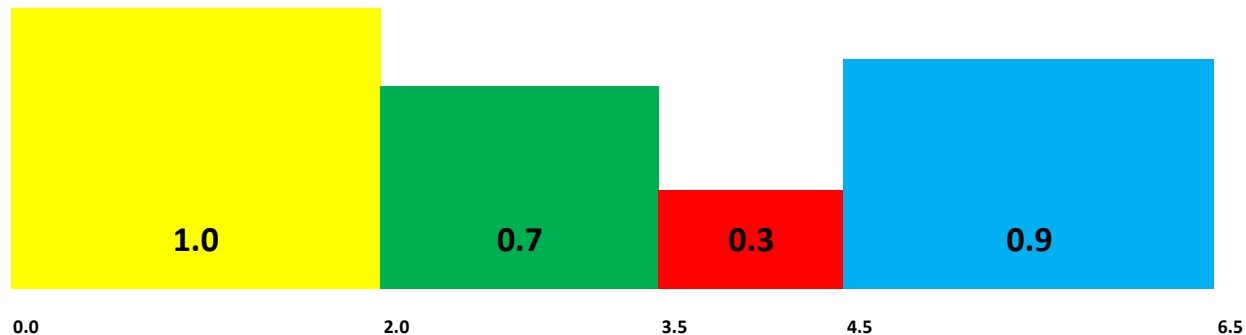
- Perfect from January 1 2001 to December 31 2002 (two years)
- Diminished to 70% from January 1 2003 to June 30 2004 (one-and-a-half years) as the result of injuries sustained in a car accident that have constrained Werther's mobility
- Further deteriorated to 30% from July 1 2005 to June 30 2006 (one year) as Werther experienced episodes of severe pain
- Increased to 90% from July 1 2006 to June 30 2008 (two years) after undergoing a surgical procedure that restored most mobility and significantly reduced pain

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The Sorrows of Young Werther (cont'd)

Figure 1—Example of QALY Calculation



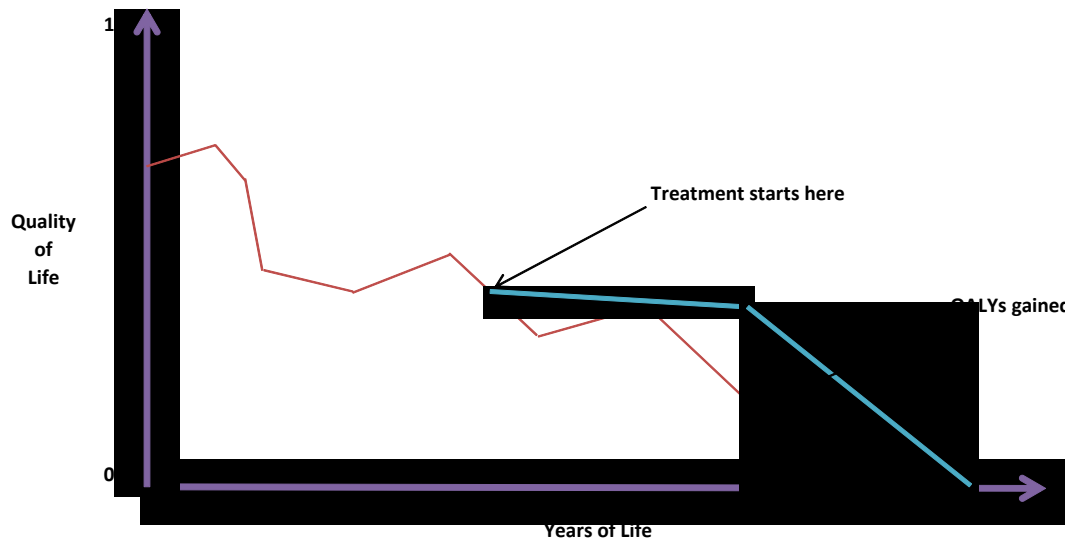
$$QALYs = (2.00 - 0.00) \times 1.00 + (3.50 - 2.00) \times 0.70 + (4.50 - 3.50) \times 0.30 + (6.50 - 4.50) \times 0.90 = 5.15$$

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QALYs of Treatments

Figure 2—Increased life expectancy and no periods of diminished quality of life

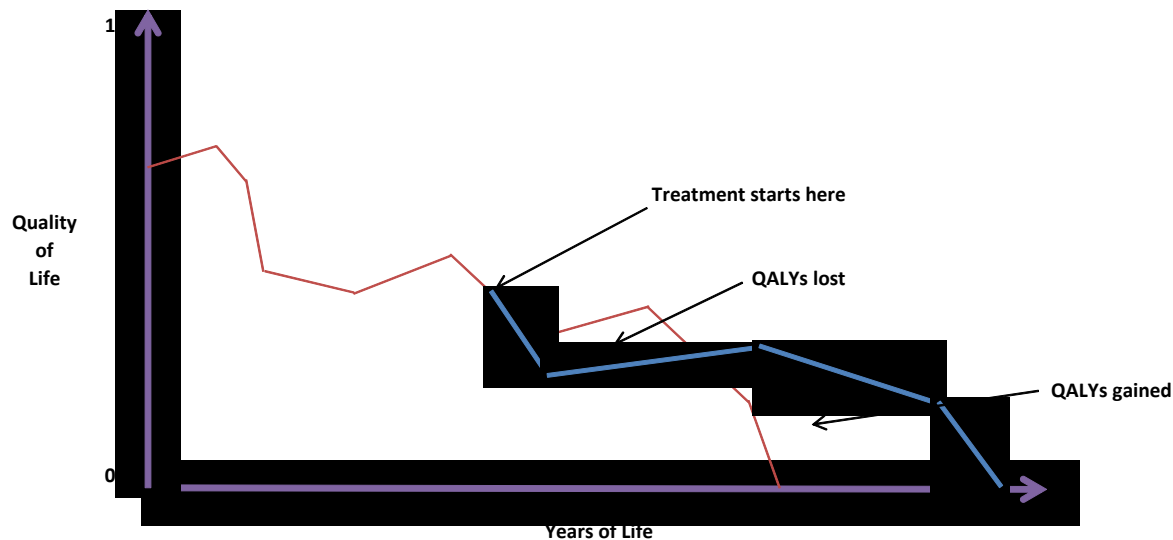


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QALYs of Treatments (cont'd)

Figure 3—Increased life expectancy but with periods of diminished quality of life



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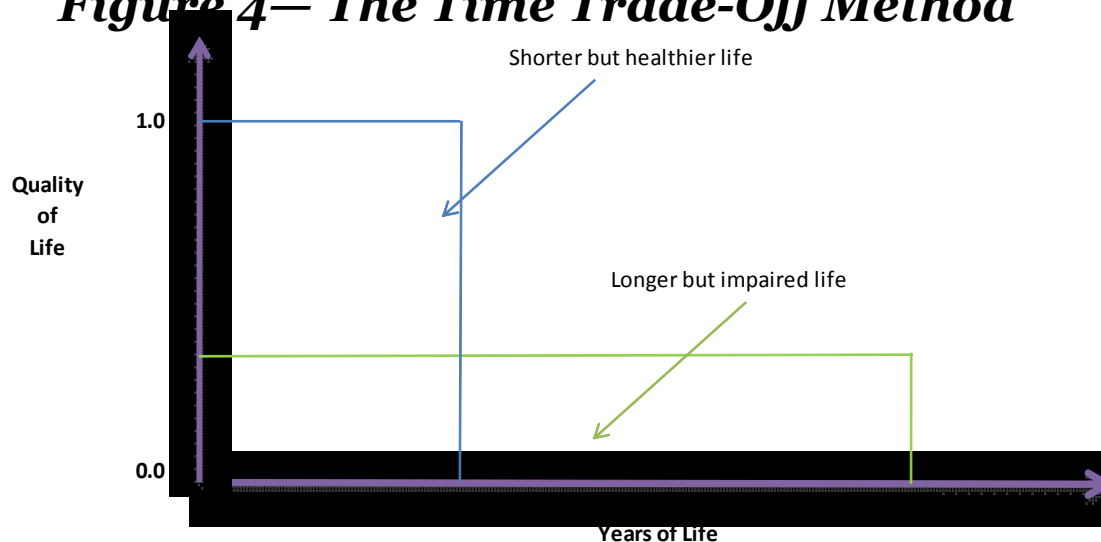
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QALY Weights

- Time trade-off
- Rating scale
- Standard gamble

The Time Trade-Off Method

Figure 4— The Time Trade-Off Method



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The Time Trade-Off Method (cont'd)

- Calculate an average

Table 1--Example of The Trade-off Method

Person	Life Expectancy	Time Trade-Off	Preference
1	35.2	4.4	87.4%
2	26.6	2.9	89.0%
3	49.1	11.2	77.3%
4	25.4	1.3	94.9%
...	
97	32.3	4.4	86.4%
98	23.1	3.3	85.7%
99	37.2	0.1	99.8%
100	33.3	1.2	96.3%
Total/Average	2,500.5	309.8	87.6%

- Rank preferences

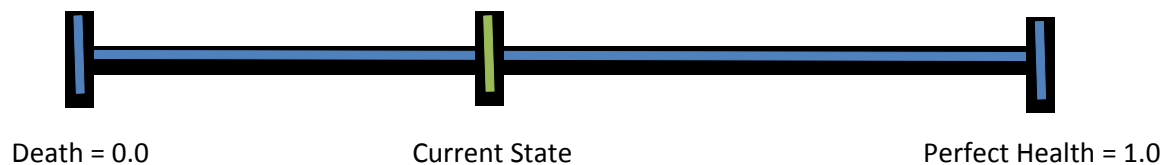
$$0.00 < \textit{preference}(\textit{condition}_1) < \dots < \textit{preference}(\textit{condition}_n) < 1.00$$

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Rating Scale Method

Figure 5— The Rating Scale Method



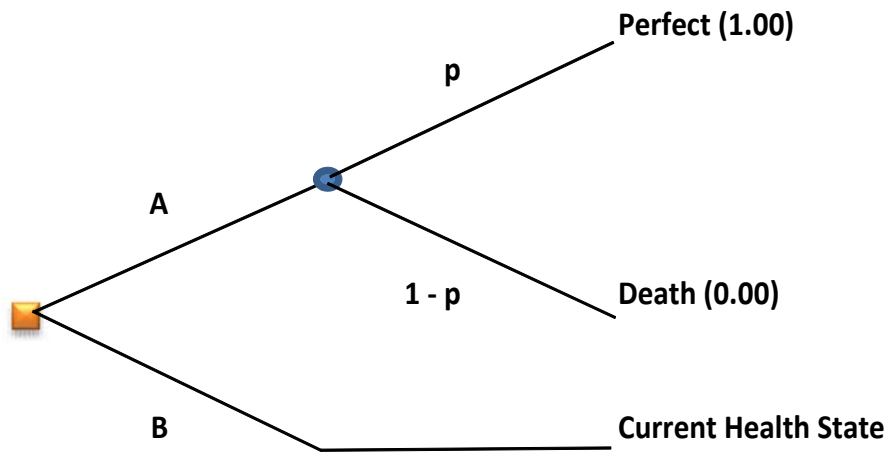
$$0.00 < \textit{preference}(\textit{condition}_1) < \dots < \textit{preference}(\textit{condition}_n) < 1.00$$

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The Standard Gamble Method

Figure 6—The Standard Gamble Method



condition ₁	----->	p ₁
condition ₂	----->	p ₂
...
condition _{n-1}	----->	p _{n-1}
condition _n	----->	p _n

$$E[A] = E[B]$$

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What Type of QALY Weight to Use

- Similarities among the three methods
- Decisions made in conditions of certainty or uncertainty
- Ranks are meaningful in cardinal utility (e.g., dinner dishes)
- Intervals are meaningful in ordinal utility (e.g., temperature)
- Cardinal utilities are part of an impressive theory pioneered by Professors John von Neumann and Oskar Morgenstern that allows us to make inferences about the choices rational people make

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The Fundamental Axioms of Utility Theory

Let $B \ll A$ denote "A is preferred to B" and $B = A$ denote "A is equally preferable to B."

The fundamental axioms of utility theory are:

Completeness--For any two simple lotteries L and M, either $L \ll M$, $L = M$, or $M \ll L$

Transitivity--If $L \ll M$ and $M \ll N$, then $L \ll N$

Convexity/Continuity--If $L \ll M \ll N$ then there is p between 0 and 1 such that the lottery $pL + (1 - p)N$ is equally preferable to M

Independence--If $L = M$ then $pL + (1 - p)N = pM + (1 - p)N$

These axioms appear to capture the basic properties of rational decision making under uncertainty and are the basis for Utility Theory, which allows us to make inferences about the choices rational people make under uncertainty.

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Empirical Studies

Table 2—QALYs for Intermittent Claudication

Method	Mean/Median
Standard Gamble	0.85
Time Trade-Off	0.74
Rating Scale	0.70

Source: JL Bosch, Qual Life Res 2000; 9(6):591-601

Intermittent claudication is a clinical diagnosis given for muscle pain (ache, cramp, numbness or a sense of fatigue) due to inadequate blood flow to the muscle. Surgery is indicated in severe cases with limb-threatening ischemia or lifestyle limiting claudication

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Empirical Studies (cont'd)

Table 3—Depression Health State Utility Scores (Standard Gamble)

Health State	Utility Score	
	Mean	95% Confidence Interval
Temporary states--Six-month duration		
Mild depression	0.59	0.55 - 0.62
Moderate depression	0.32	0.29 - 0.34
Severe depression	0.09	0.05 - 0.13
Chronic states--Lifetime duration		
Self-reported health state	0.79	0.74 - 0.83
Severe depression	0.04	0.01 - 0.07

Source: Bennett, Torrance, Boyle, and Guscott, *Cost-Utility Analysis in Depression*, Psychiatric Services, Sept 2000, Vol. 51, No. 9, pp. 1171-1176

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Resource Allocation

Table 4—Benefit-Cost Table of Health Initiatives

Program	QALYs Saved	Cost	Cost per QALY
A	100	1,800,000	18,000
B	100	5,000,000	50,000
C	500	1,000,000	2,000
D	100	2,200,000	22,000
E	100	1,200,000	12,000
F	500	2,000,000	4,000
G	100	10,000,000	100,000
H	200	1,200,000	6,000
I	150	4,500,000	30,000
J	50	800,000	16,000
K	250	2,000,000	8,000

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Resource Allocation (cont'd)

Table 5—Program in Increasing Order of Cost-Effectiveness Ratios

Program	QALYs Saved	Cost	Cost per QALY	Ranking	Cumulative	
					QALYs Saved	Cost
C	500	1,000,000	2,000	1	500	1,000,000
F	500	2,000,000	4,000	2	1,000	3,000,000
H	200	1,200,000	6,000	3	1,200	4,200,000
K	250	2,000,000	8,000	4	1,450	6,200,000
E	100	1,200,000	12,000	5	1,550	7,400,000
J	50	800,000	16,000	6	1,600	8,200,000
A	100	1,800,000	18,000	7	1,700	10,000,000
D	100	2,200,000	22,000	8	1,800	12,200,000
I	150	4,500,000	30,000	9	1,950	16,700,000
B	100	5,000,000	50,000	10	2,050	21,700,000
G	100	10,000,000	100,000	11	2,150	31,700,000

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Conclusions

- Pricing life and quality of life is difficult but necessary
- Quality Adjusted Life Years (QALYs) are the best tool available
- There is more than one approach for calculating QALY weights but the best is *The Standard Gamble* method, which is firmly grounded on Decision Theory
- QALYs are also an important tool for policy making in areas such as resource allocation
- QALYs could become an important tool for actuaries involved in the public health sector as expenditures are increasingly scrutinized

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Questions or Comments

Please direct questions or comments to:

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