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THE "UTILITY" OF THE TIME TRADE-OFF METHOD IN CANCER PATIENTS: FEASIBILITY AND PROPORTIONAL TRADE-OFF

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Abstract—We examined the feasibility and the proportional trade-off assumption of the Time Trade-Off method. Utilities were assessed of the actual health states of 54 testicular and 72 colorectal cancer patients, treated with the curative intent and 29 incurable colorectal cancer patients. Three periods of time were used to assess proportionality: the subject's life expectancy and two shorter periods. Results showed the method to be feasible in curatively treated patients, though the use of life expectancy posed difficulties in some very old subjects. This same difficulty was encountered in patients with symptomatic incurable disease. A two step procedure is proposed as a solution. The proportional trade-off assumption was violated. Utilities for the longer period were smaller than those for the shorter periods. Life expectancy and trade-off did not correlate, though. Remarkable was that many patients were unwilling to trade at all. The implications of the findings are discussed.

Utility assessment Time Trade-Off QALY Oncology Health state preferences Feasibility

INTRODUCTION

In medical decision-making the concept of quality-adjusted life years (QALYs) is often used. The quality-adjustment factor, which represents the subjective value that individuals assign to outcomes of decisions under uncertainty, is called the utility. A method often used to measure utilities is the Time Trade-Off (TTO), which was developed specifically for the field of health care by Torrance *et al.* [1]. In the TTO the subject is asked how much time x in a state of perfect health he or she considers equivalent to a period t in his or her current health state (usually worse than perfect health). The simplest—and most frequently used—way of transforming the perfect health equivalent x to a utility (ranging from 0 to 1) is to calculate a TTO-score x/t. A constant proportional trade-off is assumed when applying a TTO-score assessed for one period of time to other periods of time. This means that if an individual considers 16 years in perfect health equivalent to 20 years in a disabled health state, he or she should consider 12 years in perfect health equivalent to 15 years in this state. However, due to time discounting the willingness to trade off can be expected to depend on the length of period t [2]. If so, it might be useful to find a functional form of the relationship between TTO-scores and t, so as to permit adjustment to various life expectancies.

Utility assessment has not been used frequently in cancer patients, even though in

oncology trade-offs often have to be made between quality of life and length of life. In a previous study [3] we used the TTO in testicular cancer patients to elicit utilities for health states that were related to testicular cancer, but hypothetical at the time of the assessment. In this particular patient group with a very good prognosis (patients had been disease free for over 2 years), the method proved feasible to elicit the utilities of hypothetical health states. In the present study we wished to explore the use of this method in the evaluation of the *actual* situation of cancer patients, both in patients with a good prognosis and in patients with a poor prognosis. In this latter group utility elicitation might be especially relevant, as the weighing of quality and length of life is more pertinent in a situation where cure is not possible any longer.

The first purpose of the study was to assess the feasibility of the TTO for the valuation of health states actually experienced by cancer patients: is the method acceptable and not too difficult, both for respondents and interviewers? More in particular, does the use of life expectancy—inevitable in the method—pose difficulties in patients with incurable disease? The second purpose was to assess whether TTO-scores depend on the length of the period t. We tested this in two ways. In the first place, we compared TTO-scores for three periods t (intra-respondent). Our hypothesis was that due to time discounting respondents would be willing to trade off a larger proportion off longer periods than off shorter. In the second place, we investigated whether people in the same health state but with longer life expectancies were more willing to trade off than people with shorter life expectancies (inter-respondent).

METHODS

Patients

We interviewed three groups of cancer patients. The first group consisted of consecutive testicular cancer patients with a good prognosis who had received treatment in the previous 2 years, or were still receiving treatment for their disease, in the Daniel den Hoed Clinic, Rotterdam, the University Hospital Leiden, or the Hospital of the Free University, Amsterdam. Fifty-eight non-seminomatous germ cell testicular cancer patients were approached, 54 patients agreed to participate (93%). The second group consisted of disease free colorectal cancer patients. These patients had been disease free for less than 5 years and were in the follow up schedule of the Diaconessen Hospital or the University Hospital Leiden. Seventy-seven patients were selected through the outpatient clinic appointment system, of whom 72 (94%) were willing to participate. The third group consisted of patients diagnosed with an incurable recurrence of a colorectal cancer treated at or referred to one of the two latter hospitals. Thirty-four patients were approached, of whom 29 (85%) agreed to participate.

Procedures

In all three patient groups the TTO formed part of an interview in which patients' attitudes towards treatment or follow-up were assessed, as well as their quality of life and the utilities of their health states. The TTO elicited the number of years x in perfect health that the respondent considered equivalent to a period t in his or her health state during the week before. Three lengths were used for the period t: the subject's own remaining life expectancy and two shorter periods. The life expectancy for the young testicular cancer group was approximated by taking the number of years remaining from their current age to the average male life expectancy at birth in the Netherlands, i.e. 75 years. The two shorter periods for the testicular cancer group were 20 and 5 years respectively. For the disease free colorectal cancer group the remaining life expectancy was based on Life Tables of the Netherlands Central Bureau of Statistics [4] and rounded to the nearest 5-year period. For these patients the length of the two shorter periods depended on the life expectancy of the subjects. For those with a life expectancy of 15 years or longer, periods of 10 and 3 years were used as the intermediate and the short length respectively (except for two relatively young subjects who had a life expectancy of 45 years: for them an intermediate period of 20 years was used). For those with a life expectancy of 10 years or less, periods of 5 and 3 years were used as the shorter life expectancies.

The use of the shorter periods was explained to the subjects in these two groups as follows. Subjects were told that life expectancies are an average figure for a population and that their personal life expectancy was unknown; that the way in which they replied to the question might depend on the length of time involved; and that

therefore we wished to ask the same question three times, for three periods.

For the incurable colorectal cancer patients, mostly periods of 10, 5 and 3 years were chosen. It was explained to the subjects that the interviewer was not aware of the subject's life expectancy ("that probably the doctor could not even tell?") and that therefore three arbitrary periods were used. For some subjects of whom the interviewer felt they were not fully aware or had not accepted their poor prognosis psychologically, the three periods of the disease free group were used, so as not to make the questions too confronting.

Testicular cancer patients were interviewed in the outpatient clinic. Colorectal cancer patients were interviewed at home, unless they preferred to be interviewed in the outpatient clinic ($N = 4$). Patients were interviewed by one of three interviewers (GMK, AS, or a research assistant). Remarks and comments made by the interviewees about the TTO were written down.

Data analysis

Acceptability and difficulty of the TTO method were appraised by counting the number of missing values, and the reasons for missing data. Remarks made by respondents that pertained to acceptability were evaluated.

Estimates of the utility of the health state from the three TTO questions were the number of years x in perfect health divided by t, the number of years in the actual health state (in our study the patients life expectancy and the two shorter periods). The independence of TTO-scores x/t and period t was evaluated in two ways. First, the difference in TTO-scores for the three periods was tested by means of the Friedman test. In addition, individual trade-off patterns were tabulated. Second, the association between life expectancy and corresponding TTO-score for subjects in the same health state was assessed by means of Spearman's rank correlation coefficient. For this latter analysis only TTO-scores for the long period have been used, as the lengths of the intermediate and short periods were the same for the majority of subjects in the same health state.

*For this temporary health state patients were asked for the number of years $t - x$ they were willing to trade off off their life expectancy t in order to avoid the period of chemotherapy.

RESULTS

Patient characteristics

Age, sex, and treatment characteristics of the two study groups are given in Table 1. Of the 54 testicular cancer patients, 7 patients were interviewed between two courses of chemotherapy* and 47 were disease free, either after surgery only ($N = 15$), or after surgery followed by chemotherapy ($N = 32$). Of the latter, 12 had undergone a retroperitoneal lymph node dissection.

Of the 29 incurable colorectal cancer patients, five were undergoing chemotherapy treatment at the time of the interview (with very minor side effects). These patients were interviewed between two courses. Thirteen of the patients were symptomatic (defined as patients in whom a recurrence would be detected based on their symptoms), 16 were asymptomatic (patients who had no symptoms that would lead to evaluation and detection of the metastases).

Feasibility

In all groups, the task often had to be explained twice. Several patients stated that the questions required considerable thought. Some patients made remarks pertaining to the TTO method that offer insight into the acceptability of the method and the wide variation in scores (see Appendix). A difficulty was encountered in some patients with an incurable recurrence. The interviewer had to decide during the interview whether the use of a shortened life expectancy was too confronting or not.

Frequencies of missing TTO-scores in the three study groups are given in Table 2. None of the testicular cancer patients had missing data for the TTO.

Of the four disease free colorectal cancer patients who had missing values for all three periods, two would not answer for religious reasons ("Life is given and life shall be taken when the time is right" and "Answer a fool according to his folly"), for one the task was cognitively too difficult, and one refused because she thought the questions nonsensical. For the five patients who had missing scores for one or two of the periods, the reason was in all five cases the old age of the respondent, which made the life expectancies too similar and the question too difficult to answer.

Of the four incurable colorectal cancer patients who had scores for all three periods missing, one respondent was very ill and would

Table 1. Patient characteristics

	Testicular cancer (treated with curative intent) ($N = 54$)	Colorectal cancer (treated with curative intent) ($N = 72$)	Colorectal cancer (incurable) ($N = 29$)
Age: mean ± SD	30 ± 8	60 ± 12	68 ± 12
Sex: male	54 (100%)	31 (43%)	15 (52 %)
female	–	41 (57%)	14 (48%)
Time since surgery (months)	16 ± 11	27 ± 16	
Time since detection of recurrence (months)			6 ± 5

only give the maximal amount of time she thought would be endurable in her state; for one respondent the task was cognitively too difficult; one—a missionary—found it impossible to imagine his remaining life being like the week before: he was about to return Zaire in the near future, and the situation there would be very different; finally, one subject refused pertinently because she thought the questions nonsensical. Two additional patients in this group had missing scores for one and two of the three periods respectively. In both cases this was due to a very poor health state, for which the respondent would again only give the maximal endurable time. Thus, the problem in answering was related to a poor medical situation in three of the six patients. Of the 13 recurrent cancer patients that were symptomatic, five (38.5%) had one or more scores missing.

Proportional trade-off

Comparison of the three periods. As the willingness to trade off might depend on the length of the period, three different life expectancies were evaluated. Our hypothesis was that respondents would be willing to trade off proportionally more off the longer periods than off the shorter. At the group level, this effect was indeed found (see Table 3), and the differences in TTO-scores between the three periods was statistically significant for the total group (Friedman test: $p < 0.001$). For all patient groups the median scores for the intermediate and short periods were 1.00, meaning that at least half of the subjects were not willing to trade off.

The hypothesis that the TTO-scores would be smaller for the longer periods than for the shorter did not hold true for all subjects. Looking at the individual data, various patterns of trade-offs could be discerned (Table 4). The majority of our patients were not willing to trade off at all: 68 (49%) had TTO-scores of 1.00 for all three periods. A second group of 46 patients (33%) behaved according to our hypothesis: they traded off proportionally more off the longest period than off the shorter. Of these, a large majority (29, or 21% of the total) was only willing to trade off off the long period, TTO-scores for the intermediate and short period being 1.00. A third group of patients (8, or 6%) traded off most off the short period, opposite to our hypothesis. Finally, a large group (18, or 13%) showed another pattern, e.g. were willing to trade off off the long and short periods, but not on the middle.

From Table 4 it can be seen that patients with an incurable recurrence were more willing to trade off than the others: 35% were unwilling to trade off at all, whereas for the other patients this was 51% ($p > 0.10$). Still, eight (35%) were unwilling to trade off off the short period, whereas in these patients this was the life expectancy that was probably the most realistic.

Given the variety of trade-off patterns found, we decided not to estimate a functional form for the relation between period and trade-off.

Table 2. Feasibility of the Time Trade-Off method: missing data in three groups of cancer patients

		Number of respondents who had none, 1 or 2, or all three TTO-scores missing		
	N	0	1 or 2	3
Testicular cancer (treated with curative intent)	54	54 (100%)	0 (0%)	0 (0%)
Colorectal cancer (treated with curative intent)	72	63 (88%)	5 (7%)	4 (6%)
Colorectal cancer (incurable)	29	23 (79%)	2 (7%)	4 (14%)
Asymptomatic	16	15 (94%)	0 (0%)	1 (6%)
Symptomatic	13	8 (62%)	2 (15%)	3 (23%)

Table 3. Time Trade-Off scores for three groups of cancer patients, for three periods (long, intermediate, short): means ± standard deviations, and medians ± interquartile ranges

TTO-scores	Testicular cancer (treated with curative intent) ($N = 54$)	Colorectal cancer (treated with curative intent) ($N = 63$)	Colorectal cancer (incurable) ($N = 23$)	
Long	Mean ± SD	0.93 ± 0.14	0.91 ± 0.15	0.80 ± 0.22
	median ± IQR	0.99 ± 0.09*	1.00 ± 0.10**	0.86 ± 0.40***
	median l.e. (yr)	45.5	15	10
Intermediate	mean ± SD	0.97 ± 0.09	0.96 ± 0.09	0.90 ± 0.16
	median ± IQR	1.00 ± 0.03	1.00 ± 0.03	1.00 ± 0.20
	median l.e.	20	10	5
Short	mean ± SD	0.95 ± 0.10	0.98 ± 0.10	0.95 ± 0.12
	median ± IQR	1.00 ± 0.03	1.00 ± 0	1.00 ± 0
	median l.e.	5	3	3

Friedman test of differences between three periods: *$p = 0.11$; **$p = 0.023$; ***$p = 0.001$.

Association of scores with length of period evaluated

We hypothesized that people in the same health state with longer life expectancies might be willing to trade off proportionally more than people with shorter life expectancies. No correlation between length of time and willingness to trade off (i.e. negative correlation between length of time and TTO-score) was found. The largest correlation coefficient was 0.18, for the recurrent colorectal cancer group.

DISCUSSION

The purpose of this study was 2-fold: to assess whether the TTO is a feasible instrument to assess utilities in cancer patients of their actual situation, especially in patients with a poor prognosis, and to test whether the customary TTO-score x/t is similar for varying periods t. To our knowledge no other studies have been published that discuss extensively empirical problems of feasibility of the TTO in cancer patients. Torrance [5] has demonstrated its feasibility in the general public, Mohide [6] in family caregivers, Churchill [7] in end stage renal disease. In a former study [3] we found the TTO a feasible method for use in testicular cancer patients who could be considered cured, to evaluate hypothetical health states pertaining to testicular cancer.

The method turned out to be feasible in the actual situation in testicular cancer and colorectal cancer patients with a good prognosis. Often the questions had to be explained twice. However, the interviewers felt the method to be feasible, even though it sometimes took a while for subjects to grasp the concept. A problem was encountered in a small minority of subjects, who either thought the questions ridiculous, or would not answer for reasons of a religious nature, or for whom the questions were cognitively too difficult. The possibility of difficulties of religious nature has been put forward by Bursztajn and Hamm [8]. Sutherland *et al.* [9] also mention it in their discussion of the concept of maximal endurable time (see below).

Trade-offs between quality of life and length of life are most relevant in those for whom cure is not possible anymore. In this group we encountered the most problems of feasibility. In

Table 4. Individual Trade-Off patterns among three groups of cancer patients on the Time Trade-Off method using three periods of time

	Testicular cancer (treated with curative intent)	Colorectal cancer (treated with curative intent)	Colorectal cancer (incurable)
No trade-off	25 (46%)	35 (56%)	8 (35%)
Most traded off long period	15 (28%)	19 (30%)	12 (52%)
Off long period only	10 (19%)	12 (19%)	7 (30%)
Off long and intermediate periods	4 (7%)	5 (8%)	1 (4%)
Off long > off intermediate > off short	1 (2%)	2 (3%)	4 (17%)
Most traded off short period	6 (11%)	2 (3%)	
Off short period only	1 (2%)		
Off short > off intermediate > off long	5 (9%)	2 (3%)	
Other trade-off pattern	8 (15%)	7 (11%)	3 (13%)
Total	54 (100%)	63 (100%)	23 (100%)

the symptomatic recurrent cancer group almost 40% had missing data. It seems that the clinical utility of the method itself is at stake. In particular, in some of these patients the existence of a period of "Maximal Endurable Time" (see Sutherland *et al.* [9]) interfered with the method. We found that for three of our patients a continuation of their health state was only endurable for a limited period of time. They argued that for instance one year would be the maximum, whichever length of time t was offered. The question is whether one should then continue using one year as t. It would solve problems of feasibility (for continuing with the —longer— period t that had been decided upon beforehand is impossible in such a case), but can this score be compared in a valid way to scores of the other subjects for whom maximal endurable time is not the case?

The use of the subject's own life expectancy can cause difficulties for other reasons too. Life tables are based on mortality rates of a large population, including both extremely healthy, "longeve" subjects, and diseased people. Life expectancy thus is a statistic, and perhaps not always meaningful to an individual. For instance, in our study there were subjects of old age who—when offered their statistical life expectancies (e.g. of 10 years for a 75 year old man)—reported that they would not want to live longer than 5 years. Subsequently, in a TTO, these subjects would easily be willing to trade off 5 years to "obtain" perfect health, even though they only had very minor symptoms. This does not seem to lead to a valid TTO-score, though. Moreover, in some subjects with a poor prognosis the interviewers judged it too confronting to use the subjects' (shortened) life expectancies and therefore used the life expectancies for the disease free group. Such a judgment poses a difficulty for the interviewer. Furthermore, the resulting TTO-scores might not reflect realistic trade-offs.

Thus the choice of the length of the period t to be used in the TTO method is not obvious, as, especially in cancer patients, estimates of life expectancy are difficult to make. We are not aware of studies in the literature that have solved (or even discussed) this matter. Our findings suggest that patients only give valid answers if the TTO is performed using life expectancies that they consider realistic. Many patients were not willing to trade off off shorter durations. Other patients gave erratic answers if the time period at stake was clearly longer than the length of life they expected, or were willing, to live. In such cases, the TTO should perhaps be performed in a two step process, the first being the assessment of the life expectancy that the patient considers realistic. This time span (the Subjective Expected Life Years, or SELYs) would vary between a maximum equal to the statistical life expectancy of the patient, and a minimum being defined by the disease adjusted life expectancy or by the maximum endurable time. These SELYs would subsequently form the basis for TTO-questions.

A second purpose of the study was to test whether TTO-scores depend on the length of the period t. We hypothesized that subjects would be willing to trade off proportionally more off longer periods than off shorter due to time discounting (see e.g. [10]). TTO-scores for the three periods were indeed significantly different. As expected, most was traded off off the long period. Many subjects were willing to trade off off the long life expectancies, but to a lesser extent or not at all off the intermediate and short life expectancies. There results thus indicate a violation of the assumption of proportional time trade-off. This has also been found by Sackett and Torrance [11] in healthy subjects, and by Stalpers [12] in students, but not by Hall [13] in healthy women and women with breast cancer.

A violation of the proportionality assumption invalidates the calculation of a TTO-score x/t and subsequent application of this score to periods other than t in QALY-calculations. This has been the motivation for Mehrez and Gafni to develop the Healthy Years Equivalent (HYE) as an alternative to QALYs [14, 15]. As shown by Johannesson *et al.* [16], however, the HYE can be obtained directly from a TTO-question which is less elaborate than the two-stage lottery of the HYE. The price to pay for either the HYE or such a TTO is an increased complexity: trade-offs need to be assessed for all possible durations of health states in a profile. A more feasible solution seems that proposed by Johannesson *et al.* in the same paper: the utility for healthy life years (and thus for each possible x) is estimated from a utility function constructed by means of certainty equivalents as done by McNeil *et al.* [17].

Originally we had thought it might be possible to construct a function from the three data points. This would have permitted the adjustment of TTO-scores for one period of time to other periods of time. However, as the majority

of subjects were either not willing to trade off at all, or would only trade off off the long period, we abandoned this idea.

It can be argued that the only period to be used validly in the TTO is the subject's life expectancy (or better: subjective expected life years). The argument here is that other periods are not part of the endowment of the subject and a meaningful trade-off can therefore not be made. If only the subject's life expectancy can be used, however, this first way (intra-respondent) in which we—among others—have tried to test the proportionality assumption, is biased. One has to resort to other ways to test this assumption.

A second way in which we evaluated the interdependence of TTO-scores and period was by testing whether people in the same health state but with longer life expectancies were more willing to trade off than people with shorter life expectancies. The hypothesis of a positive correlation between life expectancy and proportion traded off did not hold true. On the one hand, the lack of a correlation between life expectancy and trade-off might be due to a lack of variation in TTO-scores (the median for patients treated with curative intent being 1.00 or slightly less). On the other hand in might be due to other factors that we did not control for. For instance, willingness to trade might be a personal characteristic associated with age, making it impossible to test independence in this way.

It is remarkable that many subjects were not willing to trade off at all, even though from the viewpoint of a healthy subject their quality of life was impaired. In the recurrent cancer group many patients were willing to trade off off the long and intermediate periods, but not off the short period, although for them this was probably the most realistic life expectancy. Fryback *et al.* [18] also found a population median TTO-score of 1.00 when using the remaining life expectancy, indicating that at least 50% of the respondents would trade off no life years for remediation of their health problems. The sensitivity of the method to decreases in utilities for impaired health might be lower for patients than for healthy subjects. In a former study [3] we found that cured (healthy) testicular cancer patients assigned lower scores to hypothetical health states related to testicular cancer, than the patients in the present study did to their own situations. It has usually been found that utilities from patients are higher than those from healthy subjects [11, 19]. This may imply a difference in sensitivity has implications for the relevance of the method in medical decision making as compared to that in technology assessment. In technology assessment it is custom to use the values of healthy subjects—who are to pay the insurance premiums—in the analysis [20]. In medical decision making, where one wants to evaluate the utility of outcomes of treatment decisions in the groups that have experienced those outcomes to optimize treatment, patients' utilities are assessed.

In conclusion, we found that the TTO was feasible in the actual situation of cancer patients treated with curative intent. In patients with an incurable cancer, problems were encountered with respect to the choice of the life lengths to be used. A solution might be to assess from the patient the life expectancy he or she considers realistic (the SELY), and to use this as the period t in the TTO.

We found a violation of the assumption of proportional time trade-off when comparing scores obtained for three periods. Whether this was due to time discounting or to the use of periods other than the subjects' life expectancies or life expectancies they considered realistic, we cannot tell.

In patients the method seems not very sensitive to detect decreases in utility due to impaired health. Only subjects with a very poor health state were willing to trade off, but not so much off the life expectancy that was probably theirs, but off a hypothetical longer life expectancy. Patients who had been or were treated with curative intent were very unwilling to trade off. The majority of patients seemed to have accepted their disease and were not willing to trade off life years for the remediation of the remaining problems related to this disease.

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REFERENCES

1. Torrance GW, Thomas WH, Sackett DL. A utility maximization model for evaluation of health care programs. **Health Services Res** 1972; 7: 118–133.
2. Loomes G, McKenzie L. The use of QALYs in health care decision making. **Soc Sci Med** 1989; 28: 299–308.
3. Stiggelbout AM, Kiebert GM, Kievit J, Leer JWH, Stoter G, Haes JCJM de. Utility assessment in cancer

patients: adjustment of Time Tradeoff scores for the utility of life years and comparison with standard gamble scores. **Med Decis Making** 1994; 14: 82–90.
4. Netherlands Central Bureau for Statistics. **Vademecum of Health Statistics in the Netherlands 1992**. The Hague: SDU Uitgeverij; 1992.
5. Torrance GW. Social preferences for health states: an empirical evaulation of three measurement techniques. **Socio-Econ Plan Sci** 1976; 10: 129–136.
6. Mohide EA, Torrance GW, Streiner DL, Pringle DH, Gilbert R. Measuring the wellbeing of family caregivers using the time trade-off technique. **J Clin Epidemiol** 1988; 41: 475–482.
7. Churchill DN, Torrance GW, Taylor WD, Barnes CC, Ludwin D, Shimizu A, Smith EKM. Measurement of quality of life in end-stage renal disease: the time trade off approach. **Clin Invest Med** 1987; 10: 14–20.
8. Bursztajn H, Hamm RM. The clinical utility of utility assessment. **Med Decis Making** 1982; 2: 161–165.
9. Sutherland HJ, Llewellyn-Thomas H, Boyd NF, Till JE. Attitudes toward quality of survival. The concept of "Maximal Endurable Time". **Med Decis Making** 1982; 2: 299–309.
10. Lipscomb J. Time preference for health in cost-effectiveness analysis. **Med Care** 1989; 27: S233–S253.
11. Sackett DL, Torrance GW. The utility of different health states as perceived by the general public. **J Chron Dis** 1978; 31: 697–704.
12. Stalpers L. Clinical decision making in oncology with special reference to patiens with cancer of the head and neck. Ph.D. thesis. Nijmegen, The Netherlands. University of Nijmegen. 1991.
13. Hall J, Gerard K, Salkeld G, Richardson J. A cost utility analysis of mammography screening in Australia. **Soc Sci Med** 1992; 34: 993–1004.
14. Mehrez A, Gafni A. Quality-adjusted life years, utility theory, and healthy-years equivalents. **Med Decis Making** 1989; 9: 142–149.
15. Mehrez A, Gafni A. Healthy-years Equivalents versus Quality-adjusted Life Years: in pursuit of progress. **Med Decis Making** 1993; 13: 287–292.
16. Johannesson M, Pliskin JS, Weinstein MC. Are Healthy-years Equivalents an improvement over Quality-adjusted Life Years. **Med Decis Making** 1993; 13: 281–286.
17. McNeil BJ Weichselbaum R, Pauker SG. Speech and survival: tradeoffs between quality and quantity of life in laryngeal cancer. **N Engl J Med** 1981; 5: 191–213.
18. Fryback DG, Dasbach EJ, Klein R, Klein BEK, Dorn N, Peterson K, Martin PA. The Beaver Dam Health Outcomes Study; initial catalog of health-state quality factors. **Med Decis Making** 1993; 13: 89–102.
19. Boyd NF, Sutherland HJ, Heasman KZ, Tritchler DL, Cummings BJ. Whose utilities for decision analysis? **Med Decis Making** 1990; 10: 58–67.
20. Drummond MF. Resource allocation decisions in health care: a role for quality of life assessments. **J Chron Dis** 1987; 40: 605–616.

APPENDIX

Motivations given for TTO scores or for incapability to answer:

(1) *Religious*, e.g. "Answer a fool according to his folly.." (Proverbs 26, 4–5, Moffat translation); "Life will be taken when time has come". In total, four respondents made religious comment, of which two refused to give a score.
(2) *Nature of task*. Two respondents refused because they thought the questions nonsensical.
(3) *Maximal Endurable Time*. Three respondents felt that one or more of the periods offered exceeded the time they would be able to endure in their health state, which made the task impossible.
(4) *Advanced age*. Three subjects thought the period offered in the health state of the week before too long, and preferred a shorter life expectancy. Therefore they were very willing to trade, but the objective of the tradeoff was not to obtain better health, but simply to live less long.
(5) *Adaptation*. Two subjects remarked that they had become used to their situation and therefore were not willing to trade.
(6) *Personal circumstances*: One respondent would not trade on the short term because she had small children living at home. Willingness to trade started at the period of time at which the youngest would be grown up.