

Utility Assessment in Cancer Patients:

Adjustment of Time Tradeoff Scores for the Utility of Life Years and Comparison with Standard Gamble Scores

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The standard gamble (SG) and the time tradeoff (TTO), two frequently used methods of utility assessment, have often been found to lead to different utilities for the same health state. The authors investigated whether adjustment of TTO scores for the utility of life years (risk attitude) eliminated this difference. In addition, the association between risk attitude and sociodemographic and medical variables was studied. In 30 disease-free testicular cancer patients, SG and TTO were used to assess the utilities of four health profiles relevant to testicular cancer. Utility of life years was estimated from certainty equivalents (CEs). SG scores were significantly higher than unadjusted TTO scores for all profiles. As the majority of patients (85%) were risk-averse, CE-adjusted TTO scores were higher than unadjusted scores, and were not significantly different from those obtained from the SG for three of the four profiles. However, adjusted scores were still slightly but consistently lower than SG scores. Possible explanations for this discrepancy are discussed. An association was found between risk aversion and medical treatment: patients who had received chemotherapy for their cancers were more risk-averse than were patients who had been in a surveillance protocol only. As risk aversion can have an impact on treatment decisions, it is important to assess the risk posture of the patient to whom the decision pertains. *Key words:* utility assessment; QALY; risk aversion; oncology; treatment preferences. (*Med Decis Making* 1994;14:82-90)

In medical decision analyses, outcomes are often expressed in terms of survival (length of life). However, at least one other dimension of an outcome is frequently relevant: quality of life. These two outcome dimensions can be combined into a single measure, a quality-adjusted life year (QALY), that can be used in expected utility decision making (see, e.g., Sox et al.¹). As a quality-adjustment factor utility is used: a measure of the strengths of the preferences of an individual for outcomes of decisions.

Utility assessment has not been used frequently in cancer patients, yet in oncology decisions often have to be made that involve tradeoffs between length of life and quality of life. When utility assessment has

been used in oncology, utilities of health care workers, students, or members of the general public have usually been assessed.²⁻⁴ As it has been shown that patients' valuations of health states are different from those of health care workers or members of the general population,^{5,6} patients rather than proxies should be interviewed in medical decision making.

There are several ways to measure utilities, of which the most often used in medicine are the standard gamble (SG), the time tradeoff (TTO),* and direct scaling.

A direct way to assess the utility of a period in ill health is by means of the SG, also called the variable probability equivalent method.⁷ In this method, subjects are asked to compare a sure outcome (the health state to be evaluated) with a gamble with probability p of the best possible outcome (perfect health) and $(1 - p)$ of the worst possible outcome (usually immediate death). The utility of the health state is then equal

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*Generally, a distinction is made between utility and value, where the former is a measure of the strength of preference under uncertainty, or in risky situations, the latter under certainty, in riskless situations. Formally speaking, the TTO score is not a utility but a value, as no risk is involved in the elicitation. However, in this paper we denote both SG scores and TTO scores with the term "utility."

to the value of p at which a subject is indifferent between the health state and the gamble.

In the TTO⁸ a subject is asked how much time x in a state of perfect health he or she considers equivalent to a period y in ill health. The TTO thus assesses the *perfect health equivalent* x . The simplest—and most frequently used—way to transform this perfect-health equivalent to a utility (ranging from 0 to 1) is to divide x by y .⁹ In this paper this is called the *unadjusted* TTO. This unadjusted TTO score is equivalent to utility only if the patient values all years of life equally. However, not all patients will have such a constant marginal utility for length of life, that is, the patients' utilities for living the next year will not be the same as for living each subsequent year.^{1,9,10} For most people, utility increases more rapidly in the short term than in the long term. The unadjusted TTO in that case overestimates the reduction in utility due to ill health. A solution of this problem is to combine the TTO with a measure of the utility for length of life, which is obtained from "certainty equivalents,"¹¹ also called the variable certainty equivalent method.⁷

Certainty equivalents (CEs) are elicited in the following way. The patient is asked for the number of years in good health for certain (the certainty equivalent) that he or she considers equivalent to a gamble involving a 50% chance of a long and a 50% chance of a short length of life in good health as best and worst outcomes, respectively.¹¹ Subjects who value nearby years higher than years further away will accept CEs that are less than the expected value of the gamble. In classical terminology, they display so-called *risk aversion*. Much discussion has originated from the use of the term "risk aversion" (see, e.g., Gafni and Torrance¹² and Loomes¹³). Nonetheless, we use this terminology, as it is customary. In the case of risk aversion, the resulting utility curve (utility plotted on the ordinate against length of life—chronological time—on the abscissa) is concave. A subject who always prefers the gamble to the expected value of the gamble is *risk-seeking* (risk-prone) and has a convex utility function.

Miyamoto and Eraker¹⁰ show a mathematical way of combining the TTO and the CE, which Sox et al.¹ in their textbook explain in a graphic way. They describe a utility function for outcomes that are expressed in quality of life and life years (an elaboration of a model for QALYs originally developed by Pliskin et al.¹⁴). Quality adjustment is assessed by means of the TTO, but corrected for risk aversion.

The SG and the *unadjusted* TTO have been shown to yield different utilities for the same health state, with SG scores usually being higher than TTO scores¹⁵⁻¹⁷ (see Nord¹⁸ for an overview). This has usually been explained by the above-mentioned risk aversion which leads to underestimation of utility by the unadjusted TTO. Combining the TTO and the CE should eliminate the difference.¹

In addition, subjects' perceptions of the probabilities involved in gambles may be "distorted." Subjects tend to overestimate small probabilities and underestimate large probabilities.¹⁹ If people underestimate the probability of obtaining perfect health in the SG, or equivalently, overestimate the probability of immediate death, the value of p will be inflated. This will happen mainly at the upper and lower ends of the scale (large and small probabilities, i.e., very good and very poor health states, respectively). It might be expected that this nonlinear transformation of probabilities would be less for the CEs than for the SG, as the gambles involved in the CEs are 50-50 gambles and less transforming is found at probabilities of 0.50.¹⁹

The purpose of this study was twofold. The *primary purpose* of this study was to assess in a group of cancer patients whether the TTO and the SG lead to different utilities and, if so, whether adjustment of the TTO scores for the utility of life years eliminates this difference. Even though a textbook on medical decision making proposes this adjustment,¹ to our knowledge, no study apart from the original ones^{10,14} has been published in which this technique has been applied.

A complication is caused by the non-chronic nature of many health states in oncology, while most of the discussion in the literature on utility assessment has concerned chronic states. As non-chronic diseases form a major part of the disease spectrum, it is important to find ways to apply the methods to these diseases. We therefore decided to evaluate the use of (non-chronic) health profiles instead of health states.

A *secondary purpose* of the study was to assess the risk attitude of a population of cancer patients and to see whether the utility for life years is associated with sociodemographic or medical characteristics of patients. In a study of lung cancer patients, McNeil et al.⁹ found a very strong risk aversion in seriously ill patients. According to their report, young, healthy students and university faculty members are frequently risk-neutral or mildly risk-averse. Most other studies of risk aversion have been done with students or the general population (see, e.g., Lopes²⁰). As risk attitude might vary with health⁹ it is important to assess the risk attitudes of patients, especially in situations where it might affect preferences for treatments.

Methods

PATIENTS

We interviewed a group of disease-free testicular cancer patients. The reason for selecting this group of patients is that it is a fairly homogeneous group of young men with a very good prognosis. We assumed that the methods would not be too threatening to them and that this group therefore was a suitable pop-

ulation for comparing various utility-elicitation methods. Thirty-one patients who had been successfully treated for non-seminomatous germ cell testicular cancer and who were in the follow-up schedule of the Daniel den Hoed Clinic, Rotterdam, and the University Hospital, Leiden, were approached. The only entry requirement was that patients have been disease-free for at least two years. All patients consented. One interview was broken off due to cognitive problems of the respondent.

PROCEDURES

Two hypothetical treatment-related health states relevant to testicular cancer were evaluated, each of two durations (two and ten years, followed by death). This resulted in four health profiles. The first health state was life during a "wait and see" policy following orchidectomy, implying mainly regular follow-up visits. The second was life during a six-month period of (adjuvant) chemotherapy after orchidectomy, followed by surveillance. The profiles were described in a standardized point-form format using three "dimensions": physical, psychological, and social (the latter including role activities). The health state descriptions are given in appendix A.

Three methods were used: the TTO, the SG, and the CE.†

The TTO elicited from the respondent the number of years x in perfect health that he considered equivalent to a period y (of two and ten years, respectively, followed by death) in the health profile.

Let $(x;p;y)$ denote a gamble of outcomes x (with chance p) and y (with chance $1 - p$). The SG then elicited from the respondent the probability p at which he was indifferent between the health profile and the following gamble: (perfect health for the same duration as the health profile, i.e., two or ten years; p ;immediate death).

The CEs were elicited, as reported by McNeil et al.⁹ and Sutherland et al.,²¹ at three value levels, 25%, 50%, and 75% (the CE25, CE50, and CE75, respectively), of the upper reference level, ten years in perfect health. Initially, the respondent was asked to choose between either five years in perfect health for certain or the gamble (ten years in perfect health; 0.5 ;immediate death). Subsequently the number of years for certain health

was varied systematically until the respondent would reach the number of years that he considered equivalent to the gamble. When the utility for the maximum length—ten years—is set at 100 and that for immediate death at 0, it follows that the expected utility of this certainty equivalent is 50%. It is therefore called the CE50, the 50% certainty equivalent. Subsequently, this number of years, CE50, was used to elicit the CE25 in the gamble (CE50 years in perfect health; 0.5 ;immediate death). Finally, the gamble (ten years in perfect health; 0.5 ;CE50 years in perfect health) was used to elicit the CE75.

We administered the TTO first, in order to avoid the anchoring effect that has been found when riskless methods such as the TTO are preceded by lottery questions.²² The TTO was followed by the SG and the CE.

The patients were interviewed at home, unless they preferred to be interviewed in the clinic ($n = 4$), by one of two authors (AMS, GMK). During the utility assessment the patients were asked to think aloud. All interviews were tape-recorded and transcribed. This permitted a qualitative evaluation of the assessment methods. In addition, we evaluated the methods used by means of semi-structured questions at the end of the interview.

DATA ANALYSIS

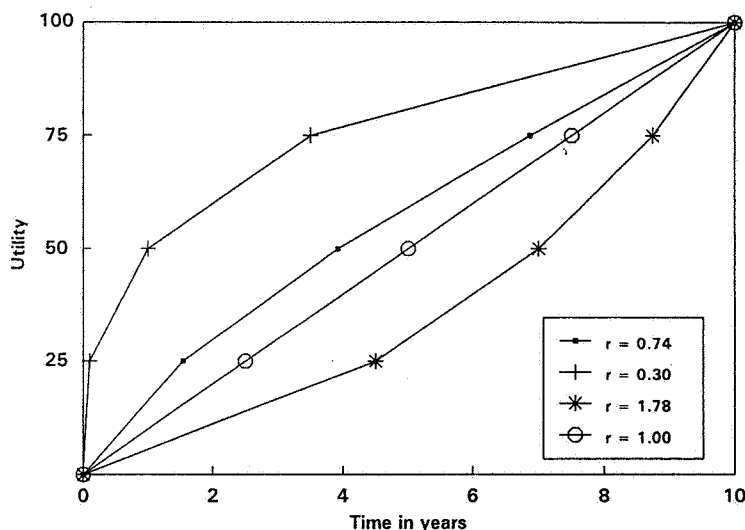
In the SG the estimate of the utility of a health state is the value of p at which the respondent is indifferent between the health state and the gamble (perfect health; p ;immediate death), as the expected outcome of the gamble is:

$$p \cdot \text{utility}(\text{perfect health}) + (1 - p) \cdot \text{utility}(\text{immediate death}) = p \cdot 1.0 + (1 - p) \cdot 0 = p$$

In the TTO a simple estimate of the utility of a health state is the *unadjusted* TTO score: the number of years x in perfect health divided by y , the number of years in the health state (in our study two and ten years, respectively). We combined this unadjusted TTO score with certainty equivalents (measuring utility for length of life) to obtain an *adjusted* TTO score (adjusted for risk aversion) in the following way. We plotted CE25, CE50, and CE75. From the curve of the utility for life years thus obtained the parameter r was estimated as explained by Miyamoto and Eraker¹⁰ (see appendix B). This parameter is a measure of the concavity or convexity of the utility function and ranges from 0 to infinity; for $0 < r < 1$ the utility function is concave (risk-averse), for $r > 1$ it is convex (risk-seeking), and for $r = 1$ it is linear (risk-neutral). Raising the unadjusted TTO to the power of this parameter r leads to the adjusted TTO score: $(x/y)^r$ (see also appendix B). For all patients, means and medians were calculated for

†We distinguish between SGs and CEs, even though standard gambles are used to elicit CEs. The abbreviation SG in this paper is used only for the standard gamble that is used to assess the utilities of the health profiles. This is a so-called probability equivalence method in which, in our case, the probability of the gamble is varied until the respondent is indifferent between the gamble and the (certain) profile. This in contrast to the certainty equivalence method, in which the attractiveness of the certain outcome is varied until the respondent is indifferent, and the probabilities are kept constant.

FIGURE 1. Utility for life years as assessed by means of certainty equivalents (CEs) in a group of testicular cancer patients. CEs are plotted for three values of the risk parameter r : mean ($r = 0.74$), minimum ($r = 0.30$), and maximum ($r = 1.78$).



the unadjusted TTO, SG, and CE, r , and the adjusted TTO. Differences between methods in means and medians were tested using t-tests, Wilcoxon's matched-pairs signed-rank test, and repeated-measurement analysis of variance (both parametric and nonparametric).

The association of the risk parameter r with patient characteristics was assessed both by analysis of variance and Pearson's correlation coefficient and by non-parametric methods. The following variables were evaluated: age, level of education, job classification ("high," "intermediate," "low"), and treatment (whether or not chemotherapy had been part of the treatment).

Results

PATIENT CHARACTERISTICS AND INTERVIEW DURATION

The mean age of the patients was 31 years, SD 7.4 (range 20 to 56). Eight of the 30 subjects had been treated by orchidectomy only, followed by a wait and see policy; the remaining 22 had had chemotherapy at some time after surgery (in some cases followed by retroperitoneal lymph-node dissection or partial lung resection).

The durations of the interviews ranged from one hour to two and a half hours, mean 1.6 hours. The durations of the utility assessments ranged from about 25 minutes to one hour and 15 minutes.

UTILITY SCORES

Data quality. One of the respondents could not answer any of the TTO questions; one could not score the ten-year chemotherapy-and-follow-up profile on either the TTO or the SG; four could not score the CEs. The predominant reason given for these inabilities was

that the questions were too hypothetical. When scatterplots were constructed comparing the TTO and SG scores, outliers were found on the TTO for three of the respondents. When reviewing these interviews, it appeared that these respondents had not understood the TTO or the implications of the scores (e.g., one subject considered both chemotherapy and follow-up profiles equivalent to zero year of perfect health). We therefore decided to delete the data for the respective profiles on the TTO (eight scores in total).

A nearly significant difference in r was found between the two interviewers: $r = 0.65 \pm 0.30$ ($n = 15$) and 0.87 ± 0.35 ($n = 11$), respectively, $p = 0.08$ (Mann-Whitney U-test). This was mainly due to a difference in the CE50s ($p = 0.05$). This difference could not be explained by confounding by correlates of r .

Utility for length of life. The mean and median scores for CE25, CE50 and CE75 are given in table 1, as are those for r . Most subjects were risk-averse ($r < 1$), meaning that their scores on the CEs were lower than the expected values of the gambles (2.5, 5, and 7.5 years, respectively, for CE25, CE50, and CE75 for a risk-neutral person). Only four subjects (15%) had values of r equal to or higher than 1.0, indicating risk-neutral ($r = 1$) or risk-seeking ($r > 1$) behavior. In figure 1 the CEs are plotted for three values of r in our population: the minimum ($r = 0.30$), the maximum ($r = 1.78$), and the mean ($r = 0.74$).

A nearly significant association was found between r and the treatments that subjects had received for their testicular cancers. Patients who had received chemotherapy at some time following orchidectomy were more risk-averse than were patients who had not ($r = 0.68 \pm 0.23$, $n = 18$ vs 0.92 ± 0.50 , $n = 8$; $p = 0.10$). None of the sociodemographic variables investigated showed an association with risk attitude.

Comparison of assessment methods. As the mean r was less than 1.0, scores for the adjusted TTO— $(x/y)^r$ —were higher than those for the unadjusted TTO

Table 1 • Utilities for Length of Life, as Assessed by Means of Certainty Equivalents*: Means (\pm SD), Medians, and Ranges of the 25%, 50%, and 75% Certainty Equivalents (in Years) and of the Risk Parameter r ($n = 26$)

	Mean \pm SD	Median	Range
25% certainty equivalent	1.55 \pm 1.05	1.50	0.10–4.50
50% certainty equivalent	3.68 \pm 1.73	4.00	1.00–7.00
75% certainty equivalent	5.68 \pm 2.22	6.00	1.00–9.50
Risk parameter r	0.74 \pm 0.33	0.73	0.30–1.78

*See Miyamoto and Eraker¹⁰ for the estimation of r from certainty equivalents.

Table 2 • Scores for Four Health Profiles as Assessed by Standard Gamble (SG) and by Time Tradeoff (TTO), Both Unadjusted and Adjusted by Means of Certainty Equivalents, for Those Respondents Who Had Scores for All Three Methods*

	Two-year Profile	Ten-year Profile
Wait and see		
TTO unadjusted	0.84 \pm 0.16 (25) ^{Ta†,S†}	0.89 \pm 0.15 (26) ^{Ta†}
TTO adjusted	0.88 \pm 0.13 (25)	0.92 \pm 0.11 (26)
SG	0.91 \pm 0.13 (25)	0.93 \pm 0.10 (26)
Chemotherapy and follow-up		
TTO unadjusted	0.64 \pm 0.20 (24) ^{Ta†,S†}	0.79 \pm 0.15 (25) ^{Ta†,S†}
TTO adjusted	0.71 \pm 0.21 (24) ^{S†}	0.85 \pm 0.11 (25)
SG	0.81 \pm 0.18 (24)	0.88 \pm 0.13 (25)

*In our study the two- and ten-year profiles cannot be compared directly, due to the nature of the profile in which the health state was not constant, but improved over time, leading to a relatively more favorable situation in the ten-year profile. Therefore, respondents were less willing to trade off life years in the ten-year profile than in the two-year profile. This is in contrast to some of the results found for chronic health states, where people were more willing to trade off a larger proportion of a longer than of a shorter time span.²⁶

^{Ta}Significantly different (paired t-test) from adjusted TTO.

^SSignificantly different from SG.

[†] $p \leq 0.05$.

[‡] $p \leq 0.001$.

$-x/y$ (table 1). For all profiles, differences were significant at the 5% level. Utilities obtained by the SG were consistently and significantly higher than those obtained by the unadjusted TTO (see table 2). Only for the ten-year wait-and-see profile was the difference not significant (mean difference 0.04, standard deviation of difference 0.02, t-test: $p = 0.07$). Differences between the adjusted TTO and the SG were small and not significant, save that for the two-year chemotherapy-and-follow-up profile (difference 0.10, SD of difference 0.02, $p = 0.05$). The repeated-measurements analysis of variance (which avoids the multiple testing problem) showed a significant main effect for the method used (unadjusted TTO, adjusted TTO, SG).

Differences between the unadjusted TTO and the adjusted TTO or SG were more pronounced for the chemotherapy-and-follow-up profiles than for the wait-and-see profiles.

Identical results were obtained for all these comparisons when Wilcoxon matched-pairs signed-rank tests were used.

Discussion

It was the purpose of this study to assess whether the SG and the TTO lead to different utilities and, if so, whether CE-adjusted TTO scores would be similar to SG scores. Specifically, we were interested to evaluate this in a group of cancer patients using (non-chronic) health profiles. Techniques of utility assessment have been compared in several studies^{15,16,17} and considerable differences have been found between methods. Most of the studies have found differences between utilities obtained by the SG and by the TTO, with higher scores obtained from the SG. In our study this same difference was found. Only for the ten-year wait-and-see profile was this difference not large, and not statistically significant. This might have been due to the fact that the quality of life in this profile was quite good, leading to values clustering at the upper end of the range, with little possibility for variation. Thus the opportunity for a difference between methods to arise was limited (a so-called ceiling effect). Such a ceiling effect (or in this case, the absence of it) might also explain the large differences between techniques for the two-year chemotherapy-and-follow-up profile relative to all other profiles. This profile was the "worst" with respect to quality of life and in all methods received scores in the middle of the range. Consequently, more opportunity for differences between methods to arise existed for this profile than for the other profiles.

The difference between the SG and the TTO has usually been explained by an effect of risk attitude.^{1,10,18} By definition, a person who always prefers a certain outcome to a gamble with the same expected utility is risk-averse. For a risk-averse individual, the TTO overestimates the reduction in utility due to poor health (and thus underestimates the utility of the outcome state). It has therefore been advocated to assess subjects' utilities for life years by means of CEs and use these utilities to adjust their TTO scores. As most people are risk-averse, TTO scores will usually be adjusted upward, in the direction of SG scores.

Two mechanisms may underlie risk aversion. Many people will have a positive *time preference*—or a decreasing marginal utility for time—meaning that they value close-by years higher than years further away in the future. This time effect should be distinguished from a *gambling effect*.^{12,15} As the SG involves a gamble with one's life, and most people are averse to this gamble, the utility from the SG will be higher than that from the unadjusted TTO (the value of p at which one is indifferent will be inflated, such that the risk of "immediate death," $1 - p$, is small). In addition, a

strong gambling effect for the SG can be explained in terms of prospect theory, a so-called nonexpected utility theory that has been formulated by Tversky and Kahneman¹⁹ to accommodate for the finding that subjects seldom behave according to expected utility theory. They show that the utility of a risky prospect is not linear in outcome probabilities. People tend to overweight low probabilities and underweight high probabilities. Therefore, the probability of obtaining the best outcome in a SG might be perceived as much smaller than its objective probability, leading to a strong gambling aversion.

In our opinion, in risk aversion the gambling effect will generally outweigh the time-preference effect (decreasing marginal utility for length of life). This might especially be the case when the time span of the problem is relatively short, as the time effect is small in this case. Loomes¹³ has pointed out that the differences between the TTO and the SG have indeed been found to be more pronounced in studies that use longer time horizons (see also Nord¹⁸). This finding might also result from a gambling effect, though, if people are less willing to gamble with a long time period than with a shorter period.

Another finding also tells against a time effect. The difference between the wait-and-see profile and the chemotherapy-and-follow-up profile, when assessed by the unadjusted TTO, was twice as big as when assessed by the SG, *irrespective of the duration* of the profile (0.20 vs 0.10 for the two-year profile, 0.10 vs 0.05 for the ten-year profile). People thus were willing to trade life years (TTO) in order to avoid chemotherapy, but they would not accept an increase in the risk of immediate death (SG) proportional to the tradeoff in the TTO, and this finding was identical for the two time periods. A respondent who had been willing to trade life years on the TTO stated about the SG: "as long as there's a chance of dying, even if it is only one percent, I won't take the risk."

In our study, CE-adjusted TTO-scores were lower than those obtained by means of the SG for all four health profiles. Although this difference was consistent, it was statistically significant only for the two-year chemotherapy-and-follow-up profile. It might be explained by a difference in *gambling effect* between the SG and the CE. The elicitation of CEs might lead to a smaller gambling effect than that involved in the SG in at least two ways. First, the value of r was estimated using three data points, CE25, CE50, and CE75. The most unfavorable (unpleasant) gambles were the ones used to obtain the CE25 and the CE50: (a number of years survival;0.5;immediate death). The least unfavorable gamble was the one to obtain CE75: (maximum survival;0.5;survival for CE50 years), as no risk of immediate death was involved. The SG, however, involved the unfavorable gamble of ten years and immediate death, thereby introducing a stronger gambling effect. Second, a stronger gambling effect for the

SG can also be explained in terms of prospect theory. The probability of obtaining the best outcome in the SG might be perceived as smaller than its objective probability, leading to a strong gambling aversion. For the elicitation of the CEs, 50-50 gambles are used, and—according to prospect theory—differential weighting of probabilities is expected to be less at probabilities of 0.50. This differential weighting of probabilities may also explain why a much larger difference between SG and adjusted TTO is found for the two-year chemotherapy-and-follow-up profile than for the other profiles. The utility of this health profile, as assessed by the SG, is 0.81, which, according to prospect theory, is the probability at which the discrepancy between the actual value and the perceived value is the largest (see Tversky and Kahneman,¹⁹ fig. 3). Therefore, for this health profile the strongest difference in gambling effect between the SG and the CE can be expected, leading to much higher scores on the SG than on the adjusted TTO.

An additional explanation for the difference between the SG and the adjusted TTO might be the difference in the elicitation methods. The SG is a so-called probability-equivalence method, and probability-equivalence methods have been found to result in higher utilities than certainty equivalence methods.^{23,24} However, if no other effect would be interfering, the same effect should have been seen in similar amounts in all four profiles.

The finding of a large and statistically significant difference between the SG and the adjusted TTO for the two-year chemotherapy-and-follow-up profile might have been due to the use of a ten-year time frame in the CE elicitation. It is possible that the CE technique using a particular time frame (in this case ten years) cannot be applied to scenarios using different time frames (in this case two years) and that CEs should be used over the same time horizon in which one is eliciting TTOs. However, if this were the only explanation for the difference between the SG and the adjusted TTO for this profile, it remains unclear why a similar difference was not found for the two-year wait-and-see profile. Nevertheless, it will be of interest to estimate the parameter r using two different time frames, to see whether different estimates are obtained.

Thus the use of CEs to transform TTO-scores to utilities leads to ambiguous results. The utility for life years, as assessed by means of CEs, involves both a gambling effect and a time effect, and it is difficult to disentangle these two effects. Both our results and the comments made by the respondents suggest a larger role for a gambling effect (possibly reinforced by non-linearity in the outcome probabilities). More research is needed, however, to draw firm conclusions about the distinction between gambling effect and time effect. On the other hand, the CEs probably suffer less from differential weighting of probabilities than the SG, which makes their use attractive. Calculation of a

TTO score by division of x by y does not take into account the discounting of time, and therefore underestimates the utility of the health state. An improvement might be to include traditional time-preference questions, not involving gambles, as suggested by Gafni and Torrance.^{12‡} However, in the non-chronic oncology setting, such questions would necessarily be hypothetical, whereas the TTO would pertain to the patient's situation. Therefore, it has to be shown that the results are comparable. In the meantime, an easier way of obtaining information about the effect of time preference on TTO scores would be to repeat the TTO for various time periods, and to try to infer from the resulting data points a "time preference function."

It turned out to be feasible to use profiles for a non-chronic health condition. Utilities for the wait-and-see profile were higher than those for the chemotherapy-and-follow-up profile, while those for the two-year profiles were lower than those for the ten-year profiles. This is inherent to the nature of the disease: as time goes by the prognosis improves. Besides, six months of chemotherapy are weighed more heavily on a life span of two years than on a span of ten years. These results are in the expected direction, which supports the validity of the elicitation procedure.

A further purpose of our study was to appraise the risk attitude of a group of cancer patients and to correlate this risk posture with sociodemographic and medical characteristics of the subjects. We found risk aversion with respect to survival duration in all but four subjects. This finding is in accordance with the finding of McNeil et al.⁹ of a very strong risk aversion in seriously ill patients. According to their report, young, healthy students and university faculty members are frequently risk-neutral or mildly risk-averse. The patients in their study were very risk-averse, "perhaps because they were older and seriously ill."⁹ We found an association between risk aversion and medical treatment. Patients who had undergone chemotherapy were more risk-averse. This difference failed to reach statistical significance, which probably was due to small patient numbers (only eight patients in the "no chemotherapy" group). As the patients who had received chemotherapy could be considered to have been more "seriously ill" (they had had a higher stage of disease), this corroborates the suggestion by McNeil et al. We did not find a correlation between age and risk aversion. As the mean age of our population was 31 years and the standard deviation only 7.4, our population possibly lacked the variation in age needed to

show an association between risk posture and age.

Caution is warranted when interpreting the results with respect to risk aversion in our study. Even though the interviewers had been trained so as to obtain a standardized interview, we found an interviewer effect for the CEs. We could not find a plausible explanation for this effect. It was not caused by a confounding effect of other variables we measured. It might have been that the unrealistic and difficult procedure caused susceptibility to (unintended) influences of the interviewer. Payne and Bettman²⁵ have hypothesized that the more uncertainty (ambiguity) in one's preferences, the more one's expressed preferences will be subject to effects of the method of elicitation. It is conceivable that this might hold not only for effects of the method of elicitation, but also for effects of interviewers.

In summary, we found that the utilities obtained by the SG were higher than those obtained by the unadjusted TTO. This can be explained by risk aversion. Eighty-five percent of the population were risk-averse. This risk aversion might have been due to both a gambling effect and a time effect. CE-adjusted TTO scores were not significantly different from SG scores. An indication for a larger gambling effect with the SG than with the CE-adjusted TTO was found, though, which might have been caused by the use of a less unfavorable gamble in the estimation of r or by a differential weighting of probabilities in the SG.

The calculation of a utility by combining the TTO and the CE is ambiguous, since the gambling effect and the time effect are difficult to disentangle. One should decide which effects are to be included in the analysis, and base the selection of the method(s) on this decision. If one decides that a gambling effect is not to be included, the TTO seems to be a more relevant method than the SG. In that case, one would still need to correct for a time effect, though. One could measure the patient's time preference using traditional time-preference questions, or, simpler, obtain an estimate by using several time periods. If risk is involved in the problem studied, one could use the SG that matches the particular situation. However, the more realistic nature of this gamble has to be weighted against differential weighting of probabilities in the SG. Even though CEs are less realistic, their use to adjust TTO scores remains an option in the risky situation, in order to reduce the problem of nonlinear probability transformation.

Risk aversion was stronger in the patients who had received chemotherapy and thus had had more life-threatening stages of the disease. As risk attitude can influence treatment preferences, it is important to evaluate this factor in patients to whom treatment decisions relate.

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‡ Example from Gafni and Torrance²¹: "one treatment approach will produce one time period of relief now. The second approach will produce x time periods of relief starting t time periods from now. Which approach would you select?" By varying x and/or t one can find the indifference point, and the person's time preference pattern for health gains, which can then be expressed as a constant discount rate (or a non-constant discount function, as appropriate).

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APPENDIX A

*Descriptions of the Health Profiles**Wait and see following orchidectomy*

Medical status

- Operation performed
- Regular follow-up visits in the hospital

Physical

- Normal functioning

Psychological

- No problem, though now and then worried that tumor might recur

Social

- Can work, exercise and participate in sports, and undertake social activities as usual

Chemotherapy following orchidectomy, followed by surveillance

Medical status

- Operation performed
- During a period of six months, hospitalization for chemotherapy one week a month, weekly check-ups in hospital during the remaining weeks
- Regular follow-up visits in the hospital afterwards

Physical

- Side effects of chemotherapy
- Nausea, vomiting, weakness and fatigue, sometimes fever
- Numbness/tingling in hands/feet
- Hair loss (baldness)
- Possibly sexual problems
- Possibly infertility
- During the first year still quite troubled by fatigue and a chance that numbness/tingling in arms/legs remains

Psychological

- Varying moods, especially early on, now and then worried that tumor might recur

Social

- During chemotherapy probably not able to work and exercise and participate in sports and lacking the energy for normal social pursuits; after chemotherapy all these activities will become possible

APPENDIX B

Let $U(Y,Q)$ be the utility of Y years in health state Q . According to Pliskin et al.,¹⁴ a possible utility function for life years Y in quality Q can have the form $U(Y,Q) = bY^rH(Q)$, where $H(Q)$ is a quality-adjustment factor, scaled from 0 to 1. The following argument is taken from Miyamoto and Eraker¹⁰:

For CE_n , $n = 25, 50, 75$:

$$n/100 = U(CE_n, Q) / U(CE_{100}, Q)$$

Expanding the right side by the utility function yields:

$$n/100 = bCE_n^r H(Q) / bCE_{100}^r H(Q) = (CE_n / Y_{max})^r$$

Taking logarithms and dividing through yields:

$$(1/r) \log(n/100) = \log(CE_n / Y_{max})$$

A least-squares estimate can be obtained for $(1/r)$:

$$\frac{\sum(\log(n/100) \log(CE_n / Y_{max}))}{\sum(\log(n/100))^2}$$

It can be shown that $H(Q)$, the measure of health quality, is estimated by (x/y) from the TTO raised to the power of r :

If a subject is indifferent between (x, Q_{max}) and (y, Q) , then $U(y, Q) = U(x, Q_{max})$; the utility model yields:

$$by^r H(Q) = bx^r H(Q_{max}) = bx^r \text{ as } H(Q_{max}) = 1.0$$

Thus $H(Q) = (x/y)^r$.

SOCIETY FOR MEDICAL DECISION MAKING

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<i>Position</i>	<i>Term of Office</i>
President-elect	
Vice President-elect	
Secretary-Treasurer	Two years
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We urge you to submit the names of SMDM members whom you believe would serve the Society well. Self-nominations also are encouraged.

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