Original Article

Diabetic foot ulcers and amputations: estimates of health utility for use in cost-effectiveness analyses of new treatments

WK Redekop1, EA Stolk1, E Kok1, K Lovas2, Z Kalo2, JJV Busschbach3

SUMMARY

Objectives: Diabetic foot ulcers (DFU), infections and amputations are associated with high costs of care and loss of health. To evaluate new treatments, both the extra costs incurred and the health utility gained need to be examined. However, evaluations of treatments in diabetes are hampered by the lack of utility values for health states such as DFU. We estimated utility values for health states seen amongst DFU patients.

Methods: We identified 13 unique health states based on presence/type of DFU and amputation. Members of the general public (n = 107) received a description of each health state. They were then asked to indicate how undesirable each health state was (using the time trade-off method). Each answer was then transformed to create a value representing the “utility” of the health state, the utility value represented on a 0-1 scale.

Results: Valid responses could be obtained from 96 persons. Mean values included: 0.84 (diabetes with no DFU or amputation), 0.75 (uninfected DFU, no amputation), 0.68 (no DFU, previous foot amputation), and 0.63 (uninfected DFU, previous amputation of other foot). The impact of an ulcer depended on amputation status.

Conclusions: Our values correspond with previously published results but are more detailed. In addition, since our values were derived from the general public, economic evaluations that incorporate them will use the generally preferred societal perspective. Therefore, these values are appropriate, practical and sensitive weights to calculate QALYs for cost-effectiveness analyses of foot ulcer treatments.

Key-words: Diabetic foot ulcers · Amputations · Health-related quality of life · Quality-adjusted life years · Health utility.

RéSUMÉ

Objectifs : Les ulcères de pieds chez les diabétiques (UPD), les infections et les amputations sont associés à des coûts de santé élevés et une « perte » de l’état de santé. Evaluer de nouveaux traitements est à la fois en estimer les surcoûts induits et leur utilité en gain de santé. Toutefois, de telles évaluations thérapeutiques sont pénalisées, chez des patients diabétiques, par l’absence d’indicateurs fiables d’utilité dans le domaine des UPD. Ce travail a pour but de déterminer des valeurs d’utilité dans ce domaine.

Méthodes : Nous avons identifié 13 situations de perception de santé selon la présence et le type d’un UPD et/ou d’une amputation. Des sujets non diabétiques recrutés dans la population générale (n = 107) ont été interrogés sur leur perception de l’utilité de chacune de ces situations (technique de l’« échange » de 1 à 0). Chaque réponse était ensuite transformée en une valeur d’utilité de 0 à 1.

Résultats : Des réponses fiables furent obtenues chez 96 personnes. Les moyennes étaient de 0,84 (diabète sans UPD ni amputation), 0,75 (UPD isolée), 0,68 (amputation précédente sans UPD) et 0,63 (UPD isolée). L’impact d’un UPD dépend de l’existence d’une amputation antérieure.

Conclusions : Nos valeurs correspondent à celles de travaux antérieurs mais sont plus détaillées. Elles sont appropriées, pratiques et sensibles pour calculer QALYs dans des analyses de coûts-éfficacité. Ces valeurs correspondent à une perspective sociétale et sont appropriées pour les evaluations économiques.

Mots-clés : Ulcère de pied diabétique · Amputations · Qualité de vie en santé · Utilité en santé · QALYs.

1 Institute for Medical Technology Assessment, Erasmus Medical Center, Rotterdam, Netherlands
2 Novartis Pharma, Basel, Switzerland
3 Department of Medical Psychology and Psychotherapy, Erasmus Medical Center, Rotterdam, Netherlands.


Address correspondence and reprint requests to:
K Redekop. Institute for Medical Technology Assessment, Erasmus University Medical Center, P.O. Box 1738, 3000 DR Rotterdam, Netherlands. redekop@bmg.eur.nl

Received: May 24th, 2004; revised: October 26th 2004

Diabetes Metab 2004,30,549-556 • © 2004 Masson, all rights reserved
Diabetic foot ulcers and amputations are important consequences of diabetes in terms of both health and costs [1]. Several new treatment options have been developed to supplement the general good wound care practices of sharp debridement and offloading [2]. While clinical trials provide evidence of superior effectiveness compared to GWC alone [3], this does not necessarily mean that all such treatments should be made available on a large scale. Since new treatments may result in higher initial costs that may or may not be offset by long term cost savings, the cost-effectiveness of these therapies should be carefully considered. Some studies have concluded that net cost-savings as well as improved effectiveness are possible with new therapeutic approaches (e.g., skin grafts [4], becaplermin [5, 6]) while others have concluded that newer treatments will result in increased costs alongside improved effectiveness [7].

One important difficulty in comparing the results of different cost-effectiveness studies arises when these studies use different measures of effectiveness. For example, how can the health benefits from skin grafting to treat a foot ulcer [4] be compared with benefits from Losartan therapy for patients with proteinuria [8] if the first study reports the costs per additional ulcer healed and the second study reports the costs per end-stage renal disease day avoided? Is it more important to prevent ulcers than to prevent end-stage renal disease? It would therefore be useful to have some way to compare the benefits of different kinds of interventions. This need for a universal measure has resulted in the increasing use of measures of health-related quality of life (or utilities) and quality-adjusted life years (QALY's), where the therapy’s effects on quality of life and life expectancy can be combined. A QALY places a weight on the time spent in different health states. These weights, or “utility weights”, represent the subjective value (or favourability) of a health state. Utility weights range from 0 to 1, where 0 represents the value equal to death and 1 represents the value for perfect health. If the utilities of different health states are known, one can calculate the incremental costs required by a therapy to generate one year of perfect health (i.e., one QALY). Using these cost-utility ratios, interventions for all sorts of disorders can be compared.

To measure cost-utility, we first need to determine how much health utility could be gained by providing a certain treatment. One way is simple: prospectively measure the amount of utility gain following this treatment, ideally by means of a randomised controlled trial such as the UKPDS study [9]. However, there are several reasons why this will not be possible. Firstly, one may be interested in estimating the health utility improvement before a large-scale clinical trial has begun or if no clinical trial has ever examined the effect of a treatment on HRQOL. Secondly, it is possible that the therapy can lead to a health utility gain that is primarily visible long after therapy is initiated. This can certainly happen in diabetes, where the health benefits of improved glycaemic control may be evident only years after (by reducing the risk of complications). This is an important reason why many diabetes models have been developed to examine the long-term cost-effectiveness of different interventions [10, 11]. However, in order to use any of these models to estimate the gain in health utility following an intervention, one needs to know how big the differences in health utility are between the disease states. For example, some patients with a foot ulcer will also have a previous amputation. How much might their health utility improve once the ulcer has healed? By combining the possible change in health utility with the observed clinical effects of a treatment (e.g., a faster healing time or a reduced amputation risk), one can estimate the health utility gain that is attainable by treating a patient with a particular therapy. The aim of the present study was to derive health utility values for use in cost-effectiveness analyses. We asked respondents from the general public to provide utility values for health states involving foot ulcers and amputations by using a commonly used approach (time trade-off method) [12-14].

Methods

Health states

Table I shows the 13 different health states used in this study. These 13 states are based on the presence and type of foot ulcer and amputation. The general approach we used corresponds with the health states used by Persson et al. [5], Ghatnekar et al. [6], and in a previous study of the cost-effectiveness of the skin substitute Apligraf [4].

Regarding foot ulcers, the choice of ulcer states is based on the widely known Wagner ulcer classification system [15]. Health states involving no active ulcer correspond with Wagner grade 0 (no open lesions), health states with an uninfected ulcer correspond with Wagner grade 2 (deep ulcer), and health states with an infected ulcer correspond with Wagner grade 3 (abscess and/or osteomyelitis). The Wagner classification system has previously been used for cost-effectiveness analyses [5, 6]. Wagner grades 1 (superficial ulcer), 4 (gangrene of toe or forefoot) and 5 (gangrene requiring amputation) were not examined in this study.

Regarding amputations, previous studies distinguish between minor amputations, where the level of amputation is below the level of the ankle (e.g., toe or mid-foot), and major amputations (e.g., foot or leg) [16, 17]. We took this one step further by making an extra distinction between foot and leg amputations. Health states 8, 9, 11 and 12 address the situation where a patient has an active ulcer on one foot in addition to an amputated foot or leg. Health state 13 involves major amputations of both feet/legs.
Health utility of ulcers and amputation

Table I
Possible health states seen amongst diabetes patients with a history of foot ulcers.

<table>
<thead>
<tr>
<th></th>
<th>No previous amputation</th>
<th>Only 1+ toes amputated</th>
<th>One foot amputated</th>
<th>One leg amputated</th>
<th>Both feet or legs amputated</th>
</tr>
</thead>
<tbody>
<tr>
<td>No active ulcer</td>
<td>1</td>
<td>4</td>
<td>7</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td>Active uninfected ulcer</td>
<td>2</td>
<td>5</td>
<td>8</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Active infected ulcer</td>
<td>3</td>
<td>6</td>
<td>9</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

Elicitation of utility values

Each health state was described by means of a vignette (i.e., a short but concise description of the health state) printed on a plasticised card. On the basis of these vignettes, the subjects were asked to value each health state on a scale from 0 to 1 using the time trade-off method (0 = death, 1 = no DFU and no amputation). The time trade-off is one of the most preferred valuation methods in health economics used to determine the values or ‘utilities’ of health states. The methodology of this interview technique is described in detail in Drummond et al. [18]. A respondent expresses his or her utility regarding a health state by indicating how many life-years he or she would be willing to give up in order to avoid the health state. The state involving no active ulcer and no previous amputation implicitly received a value of 1.0, corresponding to the logical outcome that respondents will not trade off life years if their health status can not be further improved.

Study participants and methods

The health states were valued by a sample of the general public (aged 17-70) of Rotterdam (Netherlands). We applied quota-stratified sampling to ensure that this sample was representative of the Dutch population in terms of gender and age. By using respondents of the general public, health utility values were estimated using the societal perspective. Note that this societal perspective may differ from the perspective of diabetes patients. Nevertheless, in health economics the societal perspective is the preferred perspective, because in these analyses the costs and benefits relating to these patients can be compared with those involving other patients in society [19]. For this reason, the health economics guidelines developed by the health authorities in various countries advise use of the societal perspective when performing a cost-effectiveness analysis (e.g., NICE in the UK [20], CVZ in the Netherlands [21], CCOHTA in Canada [22]).

The respondents were invited to attend a session during which a number of health states were valued. In order to avoid selection bias, the invitations were made without any reference to diabetes, foot ulcers and amputations.

An adaptation to the time trade-off method was that participants were interviewed in groups. As the answers were still recorded individually, this does not imply a great deviation from standard time trade-off research. This valuation method has previously been used and proven valid in several other studies [23, 24]. Prior to the valuations of the foot ulcer health states, respondents practised the time trade-off method using three general health states based on the EuroQol EQ-5D questionnaire. This exercise allowed the interviewers to ensure that all respondents were capable of performing the time trade-off valuation for the DFU health states.

The health states were then described by means of an oral presentation that included descriptions of the health states and what they entailed, including photos of uninfected foot ulcers, infected ulcers (e.g., osteomyelitis), and various types of amputations. All participants were asked to apply their own personal perspectives when performing the valuations. In this way, values represent the societal perspective, the preferred perspective in health economics. Participants were encouraged to imagine being in each of the given health states. Each health state was to be viewed as being chronic in form, meaning that the participants had to imagine the impact of staying in a particular health state for the rest of their lives. The trade-off in time was measured relative to the life expectancy of the subjects, which was set at 85 years for all participants. The health states were presented on cards in a random order and subjects were allowed to reshuffle the cards in order to facilitate their task. Subjects were also allowed to return to a response if they changed their mind during the interview.

All health state valuations made by a respondent were considered invalid if any of the following occurred: a) more than two missing health state valuations; b) clear lack of comprehension of the task; c) presence of a lexicographic response regarding the EQ-5D states, where the respondent refused to make a trade-off regardless of how favourable the alternative choice was; or d) insensitivity to dominant scenarios (where the respondent assigned a higher level of utility to a health state involving severe pain than to a health state involving mild pain which was otherwise identical).
Statistical analyses

After excluding any invalid health state valuations, the mean and standard deviation of the utilities for the different health states were calculated. We then checked for any associations between the sex and age of the participants and the utility values they assigned to the different health states. This was conducted using linear regression analysis.

We also examined whether the effect of an ulcer on health utility would vary depending on whether or not a previous amputation had taken place. We checked this by assessing whether or not the utility for an ulcer without amputation multiplied by the utility for an amputation without an ulcer equaled the utility value for an ulcer with a previous amputation. This assumption was also tested using regression analysis.

Lastly, we combined the utility values for the health states with the utility value given for diabetes without major complications, in order to estimate utility values for the health states involving both diabetes and a foot ulcer and/or amputation. This was done because the implicitly assumed value of 1.0 for the state involving no ulcer and no amputation is a problem-specific value that only refers to the absence of ulcers and amputations and not to the absence of diabetes. After all, patients cannot return to perfect health once their foot ulcer is cured, since these patients will still suffer from diabetes. In that respect, disease-specific values overestimate the actual improvement in quality of life resulting from treatment, because proportional tradeoffs at the top of the scale (i.e., close to the value of 1.0) result in greater absolute differences than at points lower down the scale [25]. To correct this, one can convert disease-specific utilities into a generic scale by multiplying them by the average utility for the health state in the absence of a particular condition for a person of the same age and gender [25, 26]. For example, to estimate the adjusted utility of diabetes with an infected DFU, it is necessary to multiply the unadjusted utility of an infected DFU by the utility for diabetes without a DFU.

Results

In total, 107 subjects were included in the study. Of these 107 respondents, the results for 11 were considered invalid for the following reasons: 9 due to a lexicographic response, 2 due to an age outside the age range of 17-70, and 1 due to inconsistency in the valuation of the EQ5D health states. The age and sex distribution of the remaining 96 participants corresponded reasonably well with the age and sex distribution in the general population (mean age, 45 years (SD, 16); 53% females).

An overview of the utility values is provided in Table II. As expected, both DFU status (absent, uninfected ulcer, infected ulcer) and amputation status (none, toe, foot, leg, 2 legs) influenced the utility value given to a health state. In addition, a more severe ulcer or amputation resulted in a lower utility value.

For each of the 13 health states we analysed, there was a statistically significant association between the age of the respondents and the utility values that they assigned to that health state. Namely, the older participants assigned utility values that were on average lower than those assigned by younger participants. The gender of the participants was not related to the utility values they assigned to the different health states.

We then examined whether the effect of an ulcer on health utility changed with a previous amputation. In all cases, we found that the impact of a DFU was less with a previous amputation than without a previous amputation. For example, respondents assigned a utility value of 0.89 to an uninfected DFU (and no previous amputation) and a utility value of 0.79 to a previous toe amputation (and no current DFU). The multiplication of these two utility values (0.89*0.79, or 0.70) was lower than the utility value actually assigned to the situation involving both an uninfected DFU and a previous toe amputation (0.80). This was true for all possible combinations of ulcer and amputation states.

Table II
Mean utility values of health states involving foot ulcers and amputations (95% confidence intervals in brackets).

<table>
<thead>
<tr>
<th></th>
<th>No previous amputation</th>
<th>Only 1+ toes amputated</th>
<th>One foot amputated</th>
<th>One leg amputated</th>
<th>Both feet or legs amputated</th>
</tr>
</thead>
<tbody>
<tr>
<td>No active ulcer</td>
<td>Reference state</td>
<td>0.87</td>
<td>0.79</td>
<td>0.73</td>
<td>0.58</td>
</tr>
<tr>
<td>(value = 1)</td>
<td>(0.84, 0.90)</td>
<td>(0.76, 0.83)</td>
<td>(0.68, 0.77)</td>
<td>(0.53, 0.62)</td>
<td></td>
</tr>
<tr>
<td>Active</td>
<td>0.89</td>
<td>0.8</td>
<td>0.74</td>
<td>0.66</td>
<td></td>
</tr>
<tr>
<td>uninfected ulcer</td>
<td>(0.86, 0.91)</td>
<td>(0.76, 0.84)</td>
<td>(0.70, 0.78)</td>
<td>(0.62, 0.71)</td>
<td></td>
</tr>
<tr>
<td>Active</td>
<td>0.82</td>
<td>0.75</td>
<td>0.68</td>
<td>0.62</td>
<td></td>
</tr>
<tr>
<td>infected ulcer</td>
<td>(0.79, 0.85)</td>
<td>(0.71, 0.79)</td>
<td>(0.64, 0.72)</td>
<td>(0.57, 0.67)</td>
<td></td>
</tr>
</tbody>
</table>
The values shown in Table II were obtained using a reference health state of no ulcer and no amputation; this health state was given the highest possible utility value of 1. However, in reality, when an ulcer heals, patients actually return to a health state with diabetes. Since we would prefer to give the utility value of 1 to a perfect state of health and not to a health state with diabetes, we need to adjust these utility values accordingly. This is done by combining the utility value for diabetes in general (i.e., 0.84) with the utility value for an ulcer/amputation state (Tab II). Table III contains these kinds of utility values, which are calculated by multiplying the utility of 0.84 for diabetes in general by the utility value for a particular ulcer/amputation state. For example, the utility value for a health state consisting of diabetes, an uninfected foot ulcer and no previous amputation was calculated by multiplying 0.84 (for diabetes) by 0.88 (for an uninfected foot ulcer and no previous amputation; Tab II) to produce an overall utility value of 0.75.

**Discussion**

The aim of this study was to assign utility values to health states relating to diabetic foot ulcers and amputations. As expected, the presence of a DFU or amputation led to lower utility values than the absence of a DFU or an amputation, and a more severe type of ulcer or amputation was associated with a lower utility value. In combination with life expectancy, utility values can be used to express the health benefits of new DFU therapies in terms of QALYs.

The impact of a health state on health-related quality of life is usually measured by means of observational studies of DFU patients. For example, Ragnarson et al. used the EQ-5D instrument in a population of Swedish diabetes patients with a current or previous DFU, subdividing these patients into current DFU with no previous amputation (n = 56), primary healed DFU with no previous amputation (n = 176), minor amputation only (with or without a current DFU) (n = 52), and major amputation (with or without a current DFU)(n = 26) [27]. The average utility scores in their study were lower than our average utility values, the greatest difference relating to foot and leg amputations (Tab IV). This might be due to a bias in our results, for example because respondents may have underestimated the consequences of diabetic complications and therefore assigned utility values which were higher than those found in the Swedish study. Alternatively, it could also be argued that the Swedish study is biased since many of their patients also suffered from other diabetes-related complications (besides DFU and amputation), which caused their utility scores to drop. Unfortunately, Ragnarson et al. did not provide information about the presence of such complications (or comorbid conditions). However, it is very likely that the presence of other diabetes complications led to the lowest possible EuroQol score of -0.594 in their study (Tab IV).

Coffey et al. [28] estimated how much other comorbidities may affect health utility. Coffey et al. estimated the influence of specific factors on health utility using multivariate analysis. They reported that type 2 diabetes patients with a previous amputation had an average utility score of 0.438 (based on the Quality of Well Being scale) versus the score of 0.689 for men on diet therapy with no complications, a difference of -0.251 points. However, after adjusting for other patient characteristics such as other complications and therapy type, the impact of a previous amputation was reduced to -.105 points, close to the reductions in health utility that we found (-0.10 for a toe amputation, -0.16 for a foot amputation). This similarity supports the validity of our findings.

The time trade-off method used in this study has been used in other diabetes studies. For example, Brown et al. measured utility values in a diabetes population and observed that the average utility value reported by patients with diabetic neuropathy was not really different from the values reported by other patients (0.89 vs 0.87, p = 0.69) [29]. However, since they categorised all patients with neuropathy into one category, we cannot compare their results with

---

**Table III**

Mean utility values of health states involving foot ulcers and amputations after adjustment for utility value for diabetes without ulcers or amputations (95% confidence intervals in brackets).

<table>
<thead>
<tr>
<th>Health State</th>
<th>No previous amputation</th>
<th>Only 1+ toes amputated</th>
<th>One foot amputated</th>
<th>One leg amputated</th>
<th>Both feet or legs amputated</th>
</tr>
</thead>
<tbody>
<tr>
<td>No active ulcer</td>
<td>0.84 (0.81, 0.87)</td>
<td>0.74 (0.70, 0.78)</td>
<td>0.68 (0.63, 0.72)</td>
<td>0.62 (0.57, 0.67)</td>
<td>0.51 (0.46, 0.55)</td>
</tr>
<tr>
<td>Active uninfected ulcer</td>
<td>0.75 (0.71, 0.79)</td>
<td>0.68 (0.64, 0.73)</td>
<td>0.63 (0.59, 0.68)</td>
<td>0.57 (0.53, 0.62)</td>
<td></td>
</tr>
<tr>
<td>Active infected ulcer</td>
<td>0.70 (0.66, 0.75)</td>
<td>0.65 (0.60, 0.69)</td>
<td>0.59 (0.54, 0.63)</td>
<td>0.55 (0.50, 0.59)</td>
<td></td>
</tr>
</tbody>
</table>
our results. In a study of diabetic peripheral neuropathy, Sullivan et al. measured the health state preferences amongst diabetes patients using the standard gamble and rating scale methods [30]. The agreement between their standard gamble results and our values supports the validity of our outcomes. Although small differences between standard gamble and time trade-off results are often seen [31], the similarity of the results corresponds with the widely shared belief that both methods result in similar utility values. One limitation of the study by Sullivan et al. is that they did not study the situation where a patient has both a foot ulcer and an amputation. In our study, we found that the combination of the two leads to less of a reduction in health utility than one would expect if their effects on health utility were constant. In other words, we found that the reduction in health utility from a foot ulcer was less with a previous amputation than without a previous amputation.

Since the average age in our study population was younger than that often seen in diabetes populations (i.e., 45 years vs 60-70 years) [32], the question can be raised as to whether young people are able to estimate the impact of diabetic foot ulcers on health-related quality of life. Therefore, some people may consider it more appropriate to use values of patients, or at least the values of people as old as most diabetes patients. The necessity of using only older people may find support in our finding that older participants in our study assigned lower utility values to all health states than younger participants. The regression analysis indicated that the utility values for 65-year old participants were approximately 0.04 points lower (based on a reduction of 0.002 points per 1-year increase in age). While this adjustment slightly reduced the utility values, it did not change the overall findings of the study. Also, while the life expectancy of 85 years that we used was sometimes longer than what would be expected based on population mortality rates, the results of the older participants indicate that the impact was minimal. In any case, the heterogeneity in the utility scores raises the fundamental question of whose values should be used. This issue is difficult to resolve, because apart from the matter of the public’s awareness of a patient’s condition, there are other reasons why differences between patients’ and public’s values might exist [26].

### Table IV
Comparison of utility values of health states involving foot ulcers and amputations.

<table>
<thead>
<tr>
<th></th>
<th>No previous amputation</th>
<th>Only 1+ toes amputated</th>
<th>One foot amputated</th>
<th>One leg amputated</th>
<th>Both feet or legs amputated</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No active ulcer</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present study</td>
<td>0.84</td>
<td>0.74</td>
<td>0.68</td>
<td>0.62</td>
<td>0.51</td>
</tr>
<tr>
<td></td>
<td>(0.81, 0.87)</td>
<td>(0.70, 0.78)</td>
<td>(0.63, 0.72)</td>
<td>(0.57, 0.67)</td>
<td>(0.46, 0.55)</td>
</tr>
<tr>
<td>Sullivan et al. [30]</td>
<td>not studied</td>
<td>0.74</td>
<td>0.61</td>
<td>not studied</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.67, 0.81)</td>
<td></td>
<td>(0.53, 0.69)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ragnarson Tennvall &amp; Apelqvist [27]</td>
<td>0.60</td>
<td>0.61</td>
<td>0.31</td>
<td>0.31</td>
<td>0.31</td>
</tr>
<tr>
<td></td>
<td>[-0.2, 1]</td>
<td>[-0.02, 1]</td>
<td>[-0.59, 1]</td>
<td>[-0.59, 1]</td>
<td>[-0.59, 1]</td>
</tr>
<tr>
<td><strong>Active uninfected ulcer</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present study</td>
<td>0.75</td>
<td>0.68</td>
<td>0.63</td>
<td>0.57</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.71, 0.79)</td>
<td>(0.64, 0.73)</td>
<td>(0.59, 0.68)</td>
<td>(0.53, 0.62)</td>
<td></td>
</tr>
<tr>
<td>Sullivan et al. [30]</td>
<td>0.76</td>
<td>not studied</td>
<td>not studied</td>
<td>not studied</td>
<td></td>
</tr>
<tr>
<td>(mild ulceration)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(severe ulceration)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ragnarson Tennvall &amp; Apelqvist [27]</td>
<td>0.62</td>
<td>0.61</td>
<td>0.31</td>
<td>0.31</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.54, 0.70)</td>
<td>[-0.02, 1]</td>
<td>[-0.59, 1]</td>
<td>[-0.59, 1]</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Active infected ulcer</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present study</td>
<td>0.70</td>
<td>0.65</td>
<td>0.59</td>
<td>0.55</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.66, 0.75)</td>
<td>(0.60, 0.69)</td>
<td>(0.54, 0.63)</td>
<td>(0.50, 0.59)</td>
<td></td>
</tr>
<tr>
<td>Ragnarson Tennvall &amp; Apelqvist [27]</td>
<td>0.44</td>
<td>0.61</td>
<td>0.31</td>
<td>0.31</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[-0.59, 1]</td>
<td>[-0.02, 1]</td>
<td>[-0.59, 1]</td>
<td>[-0.59, 1]</td>
<td></td>
</tr>
</tbody>
</table>

NB: Ranges represent 95% confidence intervals except those for Ragnarson Tennvall & Apelqvist which are simply minimum and maximum values. *Previous foot ulcer (healed).
example, patients may adapt to illness and the public may not predict this adaptation. Decisions about whose values should be used in economic analyses such as cost-effectiveness analyses of new therapies should take such potentially valuable factors into account. Although the balance may differ between studies, the use of public’s values is generally recommended instead of patients’ values [19, 33]. The rationale for this is that economic analyses are meant to guide social policies and not individual patient decisions. Some might not realise that the UKPDS study of intensive glucose and blood pressure control and health-related quality of life used the public’s values of health states and not the utility values given by patients [9]. If there are strong reservations about using the public’s values for a cost-effectiveness analysis of a new therapy, then a pragmatic approach would be to examine the importance of this issue in a sensitivity analysis. If the choice of whose values to use does not affect the cost-effectiveness of the therapy, then this would effectively allay any concerns about whose values were used in the analysis. However, if the choice of values is found to influence the cost-effectiveness results, this would warrant a more careful consideration of the study’s objectives.

A practical implication of the present study is that future economic evaluations in the field of diabetes are facilitated. Economic factors will play an ever-increasing role since third party payers cannot reimburse all therapies. Utility values can be used to estimate the impact of new DFU therapies in terms of cost per QALY gained. Our study provides extra information for use in such analyses since our study identified and valued individual DFU-related health states, in contrast to studies that present average health-related quality of life results in a heterogeneous DFU patient population (i.e., often having other complications). In addition, as the orientation steadily shifts from purely clinical outcomes to outcomes such as health-related quality of life and QALYs, there is growing concern about how these outcomes can be measured. While the responsiveness of a generic utility questionnaire such as the EQ-5D used in the UKPDS study may be doubted [34], interview techniques like the time trade-off method we used in the present study may be costly and time-consuming. The values we found using the time trade-off method can be used to quantify potential QALY gains following DFU treatment and prevention strategies. However, if one chooses to ascertain the utility values regarding DFUs and amputations from diabetes patients and not from the general public, then the results reported by Sullivan et al. are sufficient to some extent [30]. What remains to be confirmed amongst diabetes patients is our finding that the impact of a DFU on health utility is less severe if a previous amputation has already taken place than if an amputation has not taken place. This phenomenon can have some influence on the results of economic evaluations using QALY analysis.

Acknowledgements – Funding for this study was provided by an unrestricted grant of Novartis Pharma AG, Basel Switzerland.

References


