Cost Effectiveness of Interventions for Lateral Epicondylitis

Results from a Randomised Controlled Trial in Primary Care

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Abstract

Objective: Lateral epicondylitis is a common complaint, with an annual incidence between 1% and 3% in the general population. The Dutch College of General Practitioners in The Netherlands has issued guidelines that recommend a wait-and-see policy. However, these guidelines are not evidence based.

Design and setting: This paper presents the results of an economic evaluation in conjunction with a randomised controlled trial to evaluate the effects of three interventions in primary care for patients with lateral epicondylitis.

Patients and interventions: Patients with pain at the lateral side of the elbow were randomised to one of three interventions: a wait-and-see policy, corticosteroid injections or physiotherapy.

Main outcome measures and results: Clinical outcomes included general improvement, pain during the day, elbow disability and QOL. The economic evaluation was conducted from a societal perspective. Direct and indirect costs (in 1999 values) were measured by means of cost diaries over a period of 12 months. Differences in mean costs between groups were evaluated by applying non-parametric bootstrap techniques. The mean total costs per patient for corticosteroid injections were €430, compared with €631 for the wait-and-see policy and €921 for physiotherapy. After 12 months, the success rate in the physiotherapy group (91%) was significantly higher than in the injection group (69%), but only slightly higher than in the wait-and-see group (83%). The differences in costs and effects showed no dominance for any of the three groups. The incremental cost-utility ratios were (approximately): €7000 per utility gain for the wait-and-see policy versus corticosteroid injections; €12 000 per utility gain for physiotherapy

versus corticosteroid injections, and €34 500 for physiotherapy versus the wait-and-see policy.

Conclusions: The results of this economic evaluation provided no reason to update or amend the Dutch guidelines for GPs, which recommend a wait-and-see policy for patients with lateral epicondylitis.

Lateral epicondylitis (tennis elbow) is a common complaint. In general, it is self-limiting and has a rather benign character. It is considered to be an overload injury, typically following a minor and often unrecognised trauma. The annual incidence is between 1% and 3% in the general population,^[1,2] and in general practice the incidence of lateral epicondylitis is estimated at 4–7 per 1000 patients per year.^[3] The average duration of a typical episode is reported to be between 6 months and 2 years.^[4,5]

In primary care, patients with lateral epicondylitis are often treated with corticosteroid injections or physiotherapy.^[2,3] Review articles, however, demonstrate that the currently published randomised controlled trials present conflicting results.^[6,7] Considering the lack of scientific support for the effectiveness of active interventions and the relatively benign course of lateral epicondylitis, the Dutch College of General Practitioners issued guidelines in 1997 that recommended a wait-and-see policy, with the prescription of pain medication if necessary.^[8] This approach is already considered to be common practice in many countries and settings.

As yet, no studies have investigated the cost effectiveness of commonly used treatments for lateral epicondylitis. Insight into the cost effectiveness of various healthcare interventions can be used to support decision making to determine the allocation of scarce resources and to achieve maximum health outcomes (prevent sick leave and disability). Cost effectiveness can be assessed in an economic evaluation that compares both the costs and the effectiveness of two or more alternatives.^[9,10]

Therefore, an economic evaluation was conducted alongside a randomised controlled trial to evaluate the cost effectiveness of corticosteroid injections, physiotherapy and a wait-and-see policy for

patients with lateral epicondylitis. An evaluation of the clinical effects of this trial has been reported elsewhere.^[11]

Patients and Methods

Study Population

Patients were recruited by 85 GPs in two cities in The Netherlands from September 1997 to October 1998. The patients were included in the trial if they met the following criteria: (i) pain at the lateral side of the elbow for at least 6 weeks; (ii) pain increasing with pressure on the lateral epicondyl and during resisted dorsiflexion; (iii) age between 18 and 70 years; (iv) willingness to comply with treatment and follow-up measurements; and (v) written informed consent.

Patients were excluded from the trial if they had: (i) received physiotherapy or corticosteroid injections for lateral epicondylitis in the previous 6 months; (ii) bilateral elbow symptoms; (iii) surgery of the elbow; (iv) contraindications for corticosteroid injections; or (v) if there was evidence of any specific pathology (e.g. malignancy, fracture or inflammation).

Interventions

After inclusion and baseline measurements, patients were randomly assigned to 6 weeks of physiotherapy, corticosteroid injections or a wait-and-see policy.^[11] All co-interventions were discouraged, but patients were allowed to get prescriptions of pain medication if necessary.

Corticosteroid Injections

Patients were given a single local corticosteroid injection of 1mL triamcinolone (10 mg/mL) and 1mL lidocaine 2% on up to three separate occasions.

The patient was injected until free of pain, with a maximum of 2mL per injection.

Physiotherapy

Physiotherapy consisted of treatment with pulsed ultrasound (2 W/cm², applied for 7.5 minutes), deep friction massage and an exercise program, over a period of 6 weeks.^[12] Treatment sessions of approximately 30 minutes were scheduled twice a week, with a maximum of nine treatment sessions.

Wait-and-See Policy

Patients visited their GP once during the 6-week intervention period. During this visit, the GP discussed with the patient any activities that caused pain and disability. Medication (paracetamol [acetaminophen] or NSAIDs) was prescribed, if necessary.

Clinical Outcome Measures

Clinical outcomes included general improvement, pain during the day, elbow disability and utility. Patients rated their general improvement on a six-point ordinal scale, ranging from 'much worse' to 'completely recovered'. Success was defined as 'much improved' or 'completely recovered'. The patients rated their pain during the day, in the week preceding their periodic assessment, on an 11-point numerical scale (0 indicating no pain). Elbow disability was measured by means of the modified Pain Free Function Questionnaire.^[13] This questionnaire consists of common situations that might cause elbow pain (0 indicating no pain). All outcome values for the pain scale and the modified Pain Free Function Questionnaire were transformed into a 100-point scale to facilitate interpretation and allow comparison across outcome measures. QOL was measured with the EuroQol,^[14,15] and expressed as utility values ranging from 0 to 1, where 1 represents perfect health.^[16]

Outcome measures were assessed by means of self-reported patient questionnaires at baseline and 3, 6, 12, 26 and 52 weeks after randomisation. Patients visited the research centre on these occasions, and during the visit completeness of the questionnaires was checked.

Economic Evaluation

The aim of the economic evaluation was to determine and compare the total costs related to elbow complaints for patients receiving corticosteroid injections, physiotherapy and a wait-and-see policy, and to relate these costs to the effects.

Firstly, relevant categories of resource utilisation were identified. Secondly, the volume of each category for each individual patient was measured, and these volumes were multiplied by the resource costs.

A societal viewpoint was used as the basis for the economic evaluation. Direct healthcare costs, direct non-healthcare costs and indirect costs due to lateral epicondylitis were used as economic indicators. Direct healthcare costs included the costs of the interventions (i.e. number of sessions with a physiotherapist or visits to a GP, number of corticosteroid injections), additional visits to a healthcare provider (GP, physiotherapist, medical specialist/outpatient care, other healthcare professionals), prescribed medication, professional home care, diagnostic interventions and hospitalisation. Direct non-healthcare costs included out-of-pocket expenses (i.e. over-the-counter medication), costs of paid and unpaid help. Indirect costs of loss of production due to tennis elbow-related absence from work, or days of inactivity, were also included. All costs are given in 1999 values.

The number of treatment sessions for physiotherapy, the number of visits to the GP and the number of injections during the intervention period were recorded by the healthcare providers on standardised forms. Data regarding the use of other healthcare resources were assessed by means of five cost diaries per patient for the entire follow-up period of 52 weeks.^[17] These diaries were completed by the patients and returned to the research assistant at the research centre.

The direct healthcare and direct non-healthcare costs (table I) were estimated according to recently published Dutch guidelines for cost analysis in healthcare research.^[18,19] For cases to which these guidelines did not apply, the tariffs of the Dutch Central Organisation for Health Care Charges^[20] were used to estimate costs. Visits to other health-

Table 1. Prices used in the economic evaluation of interventions for lateral epicondylitis^[18-21] (1999 values)

	€ ^a
Direct healthcare costs	
GP (session of 20 minutes maximum)	16.60
Physiotherapist (session of 30 minutes maximum)	18.15
Injection of 1mL triamcinolone (10 mg/mL) and 1mL lidocaine 2%	1.94
Medical specialist/outpatient care	40.85
Hospitalisation (per day) ^b	170.15
Professional home care (per hour)	22.70
Direct non-healthcare costs	
Homeopaths (per session) ^c	30.60
Alternative therapist (per session) ^c	27.20
Acupuncture (first consult) ^c	93.35
Acupuncture (subsequent consult) ^c	46.70
Help from partner/friends (per hour)	7.94
Indirect costs	
Absenteeism paid labour (per day)	Valuation by the friction cost method ^d
Absenteeism unpaid labour (per hour)	7.94

a €1 = \$US0.90.

b Surgical treatment of tennis elbow as an outpatient procedure.

c Prices according to the Dutch Association for acupuncture and Dutch Association for chiropractice.

d For paid labour, these costs were calculated using a valuation of the friction period for employees according to age and gender.^[18]

care professionals, acupuncturist or homeopath were estimated on the basis of fees or prices charged by the professional organisations. The costs of medication were estimated on the basis of prices charged by the Royal Dutch Society for Pharmacy.^[21] To calculate travel expenses, the mean distance from a patient's home to a practitioner was estimated. The time spent by a patient when visiting a practitioner was also included in the cost calculations, for which a shadow price of €7.94 per hour was used.^[18] Only one patient underwent a diagnostic procedure (an x-ray) so the tariff of the Dutch Central Organisation for Health Care Charges was used just for this specific procedure.

Indirect costs of loss of production due to tennis elbow, for both paid and unpaid labour, were calculated. For paid labour, these costs were calculated

according to the friction cost approach, based on a mean income of the Dutch population according to age and gender for employees.^[22-24] The basic concept of the friction cost approach is that the amount of production lost (and/or the costs of maintaining production) because of sick leave depends on the time span needed to restore the initial level of production and costs. Sick employees can be replaced after a necessary period of adaptation, the so-called friction period, which was estimated to be 122 days in The Netherlands.^[18] For unpaid labour (e.g. voluntary work or household work), the indirect costs were estimated using a shadow price of €7.94 per hour.^[18]

Statistical Analysis

The economic evaluation was carried out according to the intention-to-treat principle. The patients remained in the group to which they were allocated at baseline. The primary clinical outcomes of the trial, i.e. general improvement, pain during the day and elbow disability, were included in the cost-effectiveness analysis. A cost-utility analysis was also performed, in which the effects were expressed as utilities (based on the EuroQol). Because the percentage of missing data was less than 5%, missing cost estimates were substituted by the mean of the measured estimates from the intervention group in the relevant follow-up period.

Bootstrapping (2000 replications) was used for pair-wise comparison of the mean costs between wait-and-see and injection, wait-and-see and physiotherapy, and physiotherapy and injection groups. On each set of bootstrap replications Tukey's post hoc test was performed. 95% confidence intervals for the mean differences in costs were obtained by bias corrected and accelerated (BCa) bootstrapping.^[25] The cost-effectiveness and cost-utility ratios were also calculated with bootstrapping (5000 replications), according to the bias corrected percentile method using the primary outcome measures (in-house developed software to perform these calculations is obtainable as shareware at <http://www.simtel.net/product.php?id=71029>).^[26]

The effects were expressed as mean differences within each intervention group between baseline and 52 weeks. The bootstrapped cost-effect pairs were graphically represented on a cost-effectiveness plane. Acceptability curves were calculated, which show the probability that a treatment is cost effective at a specific ceiling ratio.^[27,28] Efficient frontiers were drawn in which the slope of this frontier reflects incremental cost effectiveness, i.e. the additional cost at which an additional unit of effects can be purchased.

Results

A total of 185 patients were included in the trial, and were randomised to corticosteroid injections (n = 62), physiotherapy (n = 64) or a wait-and-see policy (n = 59). Only two patients dropped out, both of whom were in the injection group. One hundred and eighty-three patients (99%) completed the 1-year follow-up measurement.

Every patient had to fill in five cost diaries, covering the entire 52-week follow-up period, which resulted in a maximum total of 925 cost diaries. Only 14 cost diaries were not returned; the research assistant spent a considerable amount of time and effort in collecting these cost diaries, accounting for the small number of missing diaries. Complete cost data were available for 55 (93%) patients in the wait-and-see group, 58 (94%) in the injection group, and 60 (94%) in the physiotherapy group.

Clinical Effects

The success rate in the physiotherapy group (91%) was significantly higher compared with that in the injection group (69%) but not compared with that in the wait-and-see group (83%) after 52 weeks. The difference in success rates between the wait-and-see policy and injections was not statistically significant. General improvement after 52 weeks on the ordinal scale was: physiotherapy 0.90; wait-and-see policy 0.83; and corticosteroid injections 0.71.

For pain during the day, the mean (95% CI) differences in improvement were -4 (-13 to +6) for injection versus wait-and-see, 7 (-2 to +17) for physiotherapy versus wait-and-see, and -11 (-20 to -2) for injection versus physiotherapy after 52 weeks. For elbow disability, the mean (95% CI) differences in improvement were -8 (-16 to +1) for injection versus wait-and-see, 5 (-3 to +13) for physiotherapy versus wait-and-see, and -13 (-20 to -5) for injection versus physiotherapy after 52 weeks. These differences were statistically significant in favour of physiotherapy compared with injections, but not for physiotherapy versus the wait-and-see policy or injections versus the wait-and-see policy (table II).^[11]

There were no significant differences between the groups with regards to utility.

Utilisation of Healthcare Resources

Table III presents data on the utilisation of the main healthcare resources for lateral epicondylitis in the three groups. There were no significant differences between the groups in resource utilisation.

Table II. Primary outcome measures for interventions for lateral epicondylitis after 52 weeks

Outcome measure	Effects [mean (SD)]		
	wait-and-see policy	corticosteroid injections	physiotherapy
Pain during the day (0–100 scale) ^a	39 (26)	35 (26)	46 (28) ^b
Elbow disability (Pain Free Function Questionnaire; 0–100) ^a	35 (21)	27 (23)	40 (22) ^b
Utility (EuroQol; 0–1) ^c	0.81 (0.12)	0.78 (0.14)	0.82 (0.14)

a Differences in mean effects within each intervention between 0 and 52 weeks. A greater effect reflects a greater level of improvement.

b Effect significantly different from the corticosteroid injection group. No other between-group comparisons were statistically significant.

c Utility after 52 weeks.

Table III. Utilisation of healthcare resources and work absenteeism for lateral epicondylitis, according to intervention group during the 52-week follow-up period

Type of utilisation [unit of measurement]	Level of utilisation [mean per patient (SD)]		
	wait-and-see policy (n = 59)	corticosteroid injections (n = 62)	physiotherapy (n = 64)
General practice (no. of visits) ^a	1.5 (1.0)	4.0 (1.4)	0.4 (0.9)
Physiotherapy (no. of treatment sessions) ^a	1.0 (4.1)	3.0 (8.6)	11.0 (4.9)
Medical specialist care (no. of outpatient appointments)	0.05 (0.2)	0.1 (0.5)	0 (0)
Alternative therapy (no. of treatment sessions)	0 (0)	0.01 (3.9)	0.1 (1.1)
Professional home care (no. of hours)	0 (0)	0 (0)	0 (0)
Help from partner/friends (no. of hours)	3.1 (13.2)	5.7 (42.9)	0.4 (2.0)
Absenteeism paid labour (no. of days)	4.1 (12.8)	0.8 (2.4)	6.3 (27.0)
Absenteeism unpaid labour (no. of hours)	3.9 (16.6)	9.6 (47.0)	3.2 (15.5)

a Including the number of visits for the allocated intervention.

Most of the physiotherapy sessions took place during the 6-week intervention period. However, the number of physiotherapy sessions was substantial in the injection group, and most of these sessions took place after the 6-week intervention period. The number of visits to GPs and other healthcare providers was very small for patients in the wait-and-see group.

As was expected, the percentage of patients who took medication was less in the physiotherapy group compared with the wait-and-see group and patients in the injection group (16% vs 36% vs 36%, respectively). Pain medication was not included as part of the protocol in the physiotherapy intervention. Only a few patients (n = 24) took over-the-counter medication.

Only one patient reported having had an x-ray examination. None of the patients had received professional home care. During the trial, only three patients had visited an outpatient department of a hospital to undergo surgery for lateral epicondylitis; one patient from the wait-and-see group and two patients from the injection group. Only four patients reported a visit to an alternative therapist.

The distance and time spent travelling to the physician and the number of hours of paid help were very low; all patients lived within a one kilometre range of their physician.

At baseline and during the complete follow-up period, 44 (75%) patients in the wait-and-see group, 37 (60%) in the injection group and 42 (66%) in the physiotherapy group were employed. Eight patients

in the wait-and-see group reported absenteeism from paid labour because of pain in their elbow during the entire follow-up period of 52 weeks, compared with 12 patients in the injection group and six patients in the physiotherapy group. The mean differences in absenteeism between the three groups were mainly caused by a small number of patients in the physiotherapy group (n = 3) and the wait-and-see group (n = 2) who reported long-term absenteeism (more than 50 days). Six patients in the wait-and-see group reported absenteeism from unpaid work, six patients in the injection group and seven patients in the physiotherapy group.

Costs

Table IV shows the mean (SD) per patient costs for each intervention group during the follow-up period.

Direct Healthcare Costs

Direct healthcare costs in the wait-and-see group and the physiotherapy group consisted mainly of the costs of treatment according to the trial protocol. The injection group showed an increase in direct healthcare costs after the 6-week intervention period. The largest percentage of these additional costs was attributable to physiotherapy, surgery and medication.

The mean direct healthcare costs were significantly lower in the wait-and-see group, compared with the physiotherapy group and the injection group, and were significantly lower in the injection

group than in the physiotherapy group. The mean direct healthcare costs in the wait-and-see group were 61% (€87) lower than in the injection group, and 74% (€158) lower than in the physiotherapy group.

Direct Non-Healthcare Costs

The direct non-healthcare costs showed no statistically significant differences between the three groups (see table IV).

Total Direct Costs

The mean total direct costs in the wait-and-see group were 58% (€153) lower than in the injection group, and 64% (€196) lower than in the physiotherapy group. The differences in total direct costs at 52 weeks for the wait-and-see group versus the injection group and the wait-and-see group versus the physiotherapy group, respectively, were statistically significant (see table IV).

Indirect Costs

Indirect costs contributed substantially to the total costs of lateral epicondylitis. The indirect costs in the injection group were considerably lower than in the other two groups. Patients in the physiotherapy group reported more absenteeism from work and were less able to perform their daily household activities at the end of the trial, whereas the wait-and-see group reported more absenteeism at the beginning of the trial.

The mean indirect costs in the injections group were 68% (€354) lower than in the wait-and-see group, and 73% (€448) lower than in the physio-

therapy group; the mean indirect costs in the wait-and-see group were 15% (€94) lower than in the physiotherapy group. The 95% CIs showed that this difference was statistically significant for the injection group versus the physiotherapy group and also for the injection group versus the wait-and-see group (see table IV).

Total Costs

The mean total costs per patient for the corticosteroid injection group were €430, compared with €631 for the wait-and-see policy group and €921 for the physiotherapy group. Although the total direct costs in the wait-and-see group were lower, compared with the injection group and the physiotherapy group, the total costs in the injection group were the lowest, because of the low indirect costs.

The mean total costs in the injection group were 53% (€491) lower than in the physiotherapy group, a difference which was statistically significant. The mean total costs in the wait-and-see group were 47% (€201) higher than in the injection group and 31% (€290) lower than in the physiotherapy group. None of these differences were statistically significant (see table IV).

Cost-Effectiveness and Cost-Utility Analyses

Incremental cost-effectiveness and cost-utility ratios are presented in table V. The cost-effectiveness ratios (general improvement, pain during the day, disability) indicated that no intervention was dominant (less costly and more effective) over any

Table IV. Mean (SD) total costs per patient (€; 1999 values)^a for interventions for lateral epicondylitis during the follow-up period of 52 weeks

Costs	WS (n = 59)	I (n = 62)	PT (n = 64)	Difference ^b		
				WS-I	WS-PT	I-PT
Direct healthcare costs	56 (100)	143 (187)	214 (92)	-87 (-148; -39)*	-158 (-189; -117)*	-71 (-114; -11)*
Direct non-healthcare costs	57 (182)	125 (379)	96 (101)	-68 (-202; 9)	-39 (-79; 31)	29 (-38; 190)
Total direct costs	113 (241)	268 (467)	309 (163)	-153 (-297; -32)*	-196 (-266; -119)*	-43 (-150; 93)
Indirect costs	518 (1549)	164 (507)	612 (2456)	354 (23; 921)*	-94 (-1044; 474)	-448 (-1543; -35)*
Total costs	631 (1627)	430 (872)	921 (2468)	201 (-185; 797)	-290 (-1435; 242)	-491 (-1770; -89)*

a €1 = \$US0.90.

b Differences in mean costs between the treatment groups (95% CI [according to bias corrected and accelerated bootstrapping]).

I = corticosteroid injections; PT = physiotherapy; WS = wait-and-see policy; * indicative of a statistically significant difference.

Table V. Incremental cost-effectiveness and cost-utility ratios for general improvement, pain during the day, elbow disability and EuroQol for interventions for lateral epicondylitis^a

Outcome measure	Determinants	Ratio		
		WS-I	PT-WS	PT-I
Cost-effectiveness ratios				
General improvement (6-point scale)	Additional cost (€) per additional 1-point improvement on the ordinal General Improvement Scale	WS €2035	PT €4675	PT €3089
Pain during the day (0–100 scale)	Additional cost (€) per additional 1-point improvement in pain during the day	WS €43	PT €64	PT €53
Elbow disability (Pain Free Function Questionnaire [PFFQ]; 0–100)	Additional cost (€) per additional 1-point improvement on the PFFQ ^b	WS €29	PT €72	PT €46
Cost-utility ratio				
Utility (EuroQol; 0–1)	Additional cost (€) per utility gain	WS 6807	PT 34 461	PT 12 158

a Patients with missing data on either outcome measures or costs were excluded.

b Indicating less elbow pain in common situations.

I = corticosteroid injections; PT = physiotherapy; WS = wait-and-see policy.

other intervention. The corticosteroid injections were less costly compared with physiotherapy and the wait-and-see policy, but they were also less effective.

Physiotherapy versus Corticosteroid Injections

Figure 1 shows the cost-utility plane for the comparison physiotherapy and corticosteroid injection as an example that most of the incremental cost/effect pairs are located in the north-east quadrant (94%). This indicates that physiotherapy is more effective as well as more costly than corticosteroid injection. For the other outcome measures the percentage of incremental cost/effect pairs located in the north-east quadrant of the cost-effectiveness plane ranged from 94% to 98%.

The acceptability curve (figure 2) shows the probability that physiotherapy is cost effective at a certain ceiling ratio. The higher the ceiling ratio the more likely the treatment, in this case physiotherapy, would be accepted as cost effective. If a treatment costing €20 000 per improvement in outcome is considered cost effective, the probability that physiotherapy will be a cost-effective alternative to corticosteroid injections is approximately 80%.

Corticosteroid Injections versus Wait-And-See Policy

For the wait-and-see policy compared with corticosteroid injections the percentage of incremental

cost/effect pairs located in the north-east quadrant on the cost-effectiveness planes ranged between 67% and 80% for all outcome measures.

Physiotherapy versus Wait-And-See Policy

For the comparison of physiotherapy and wait-and-see policy, the percentage in the north-east quadrant varied between 73% and 78% for general improvement, pain during the day and elbow disability. The cost-utility ratio showed 55% of the incremental cost/utility pairs in the north-east quadrant, 12% in the south-east quadrant, 6% in the

Fig. 1. Cost-effectiveness plane for utility comparing physiotherapy and corticosteroid injection for lateral epicondylitis (1999 values).

Fig. 2. Acceptability curve for utility comparing physiotherapy and corticosteroid injections for lateral epicondylitis (1999 values).

south-west quadrant and 27% in the north-west quadrant.

In figure 3 and figure 4, the efficient frontiers for general improvement and utility showed that physiotherapy results in more effect but also more costs compared with wait-and-see policy and corticosteroid injection.

Discussion

After the 1-year follow-up, physiotherapy showed more beneficial effects than the wait-and-see policy and corticosteroid injections. However, only the difference between physiotherapy and corticosteroid injections was statistically significant in favour of physiotherapy.^[11] Comparing the mean total costs of these interventions, a difference was found between corticosteroid injections and physiotherapy in favour of corticosteroid injections. With regard to cost effectiveness, none of the interventions was found to be superior.

The direct healthcare costs and the indirect costs were the main determinants of the total costs. The direct healthcare costs were lower for the wait-and-see policy compared with physiotherapy and corticosteroid injections, and lower for corticosteroid injections than for physiotherapy. The direct non-healthcare costs were minimal and showed no differences. The total direct costs in the wait-and-see

group were significantly lower than those in the physiotherapy group and the injection group. The indirect costs were higher in the physiotherapy group and the wait-and-see group than in the injection group. The results of both costs and effects (cost-effectiveness ratio) showed no dominance for any one of the three interventions.

Although corticosteroid injections were significantly less costly, they were significantly less effective than physiotherapy after 52 weeks; the incremental cost-utility ratio for physiotherapy compared with corticosteroid injections was approximately €12 000 per utility gain. Physiotherapy shows somewhat better clinical effects than the wait-and-see policy, while the wait-and-see policy is slightly less costly. The incremental cost-utility ratio for physiotherapy compared with the wait-and-see policy was more than €34 000 per utility gain. Furthermore, the incremental cost/effect pairs on the cost-effectiveness plane were located around zero. Therefore, we concluded that this cost-utility ratio should not lead to a firm recommendation in favour of physiotherapy over a wait-and-see policy. The wait-and-see policy produced slightly better clinical results at an increased cost compared with corticosteroid injections, resulting in an incremental cost-utility ratio of approximately €7000 per utility gained. The sample size calculation to demonstrate a difference in the clinical trial might not be enough to prove cost effectiveness, because the variation in cost data is usually larger compared with clinical

Fig. 3. Cost-efficient frontier for general improvement for lateral epicondylitis (1999 values). I = corticosteroid injections; PT = physiotherapy; WS = wait-and-see policy.

Fig. 4. Cost-efficient frontier for utility for lateral epicondylitis (1999 values). **I** = corticosteroid injections; **PT** = physiotherapy; **WS** = wait-and-see policy.

outcomes. Therefore, it is difficult to determine a statistically significant difference for cost data.^[29]

There is still no consensus about the most valid and reliable statistical method to compare costs in pragmatic trials.^[29-33] Thompson and Barber^[30] are of the opinion that statistical analysis based on transformed cost data may result in misleading conclusions. These authors suggest that the most accurate results are obtained by analysing raw costs instead of log-transformed costs and recommend using a T-test. The validity of these results should be checked by applying bootstrapping. In our study, the data were strongly skewed to the right (i.e. higher values were relatively scarce, whereas low values for costs were frequent). Therefore, using confidence intervals obtained by BCa bootstrapping was considered to be the best way to analyse the data, instead of basing the conclusions only on the confidence intervals of Tukey's test statistic. As to the bootstrapped Tukey test, it should be noted that, because of the nature of the statistic, it is computationally elaborate to obtain simultaneous confidence intervals in contrast to the original statistic. Therefore, confidence intervals resulting from Tukey's test should be interpreted with care if bootstrapping is used.

Conclusions

Although physiotherapy was found to be more effective than corticosteroid injections for all primary outcome measures after 52 weeks, it was also associated with higher costs. Since the differences in

costs and effects showed no dominance, it is difficult to decide whether physiotherapy, corticosteroid injections or a wait-and-see policy is the optimal treatment for lateral epicondylitis. Physiotherapy shows somewhat better clinical effects, while the wait-and-see policy is slightly less costly than physiotherapy but still produces slightly better clinical results than corticosteroid injections. The clinical guidelines for GPs in The Netherlands recommend a wait-and-see policy.^[8] The results of this cost-effectiveness analysis provide no reason to update or amend these guidelines.

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