

# BMJ Open The burden of stroke in the Netherlands: estimating quality of life and costs for 1 year poststroke

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## ABSTRACT

**Objectives:** To assess and explore over 1 year poststroke (1) the societal costs, (2) changes in costs and quality of life (QoL) and (3) the relation between costs and QoL.

**Design:** The current study is a burden of disease study focusing on the cost-of-illness (in Euros) and QoL (in utilities) after stroke.

**Setting:** Adult patients with stroke were recruited from stroke units in hospitals and followed for 1 year.

**Participants:** Data were collected from 395 patients with stroke.

**Main outcome measures:** Costs and QoL expressed in utilities.

**Methods:** Cost categories were identified through a bottom-up method. The Dutch 3-level 5-dimensional EuroQol (EQ-5D-3L) was used to calculate utilities. Non-parametric bootstrapping was applied to test for statistical differences in costs. Subgroup analyses were performed to identify predictors for costs and QoL. Robustness of results was tested via sensitivity analyses.

**Results:** The total societal costs for 1 year poststroke were €29 484 (n=352) of which 74% were in the first 6 months. QoL remained stable over time. The discharge location was a significant predictor for cost and QoL; men had a significantly higher QoL than women and younger patients (<65) had significantly more costs than older patients (>65). Ceiling effects appear on all dimension of the EQ-5D-3L. Costs and QoL show a weak correlation ( $r=-0.29$ ). Sensitivity analyses showed robustness of results.

**Conclusions:** We found lower patient costs and higher QoL than expected. This may be explained by the good state of health of our study population and by change in the Dutch healthcare system, which has led to considerable shorter hospitalisation poststroke. Future research must question the use of the EQ-5D-3L in a similar population due to ceiling effects.

**Trial registration number:** NTR3051.

## INTRODUCTION

In 2011, 1.03% of the Dutch population suffered a stroke and faced decreased physical, social and psychological functioning.<sup>1</sup> Innovations and major improvements in acute stroke care have been raising poststroke

## Strengths and limitations of this study

- We conducted a multicentre study enabling the inclusion of a wider population, hence increasing the generalisability of study results.
- The current study included a large group of patients with stroke in which quality of life and costs after stroke were investigated from a societal perspective.
- To estimate costs, we used a bottom-up approach which is considered preferable when investigating chronic patients.
- We used self-reported measurements to collect data—a method which might be subject to recall bias and missing items. However, literature review showed that questionnaire design and respondent motivation have more influence on recall bias than period of recall, few missing records or items reported, and the validity of self-reported trials was confirmed in a large trial.

survival rates. Accordingly, more people experience long-term difficulties in terms of quality of life (QoL),<sup>2</sup> social reintegration,<sup>3</sup> life satisfaction,<sup>4</sup> and emotional functioning, including depression and anxiety.<sup>5</sup> In addition, stroke creates considerable social and economic burdens for individuals and society.

In cost studies, QoL is usually expressed in utilities which is a score between zero (death) and one (full health). In previous research, a utility of 0.68,<sup>6</sup> 0.63<sup>7</sup> and 0.68<sup>8</sup> was found for moderate stroke survivors. Other research showed a significantly lower utility for women 3 months poststroke, in comparison with men.<sup>9</sup> Research on the economic burden of stroke found that stroke induces considerable costs: significant cost categories in the first year poststroke were informal care,<sup>10–12</sup> rehabilitation,<sup>10 11 13</sup> and hospital costs.<sup>10 11 14</sup> According to a Dutch report, an estimated 1.5 billion Euros was spent on stroke in the Netherlands in 2005; this is over 2.2% of total Dutch healthcare costs.<sup>15</sup>

Previous research is subject to several limitations such as small sample size, narrow perspective, top-down methods of costing, and outdated study results particularly in the Dutch context. The decentralised healthcare system and changes in stroke care, such as more patients being directly admitted to the stroke unit, early start of rehabilitation, and early discharge strengthen the need for new up-to-date evidence.<sup>16</sup>

The current study is a multicentre, prospective, bottom-up burden of disease (BoD) study conducted from a societal perspective. The aims of the study were to estimate and explore over 1 year poststroke: (1) the societal costs, (2) changes in costs and QoL and (3) the relation between costs and QoL.

## METHODS

### Study design

This BoD study focuses on the cost-of-illness (in Euros) and QoL (in utilities) of a disease. This study is embedded in the Restore4Stroke Cohort study. Further information can be found elsewhere.<sup>17 18</sup>

### Setting and participants

Patients were recruited from stroke units in six general hospitals in the Netherlands between March 2011 and March 2013. Eligible patients with stroke had suffered a clinically confirmed stroke (both first ever and recurrent) within the last 7 days. All participants had to be at least 18 years old. Patients were excluded if they: (1) had serious other conditions whereby an interference with the study outcomes might be expected; (2) were already dependent regarding the activities of daily living before their stroke as defined by a Barthel Index (BI) score of 17 or lower; (3) had insufficient command of the Dutch language to understand and complete the questionnaires (based on clinical judgement) or (4) were already suffering from cognitive decline before their stroke, as defined by a score of 1 or higher on the Heteroanamnesis list Cognition. The medical ethics committees of all participating hospitals approved the Restore4Stroke Cohort study and informed consent was obtained from all included patients.

### Procedure

Participants were informed regarding the nature of the study by the nurse practitioner or the trial nurse of the participating hospital. After informed consent, the first assessment (T1) was conducted during the patient's hospital stay. Cost measurements were conducted at 2 months (T2), 6 months (T3) and 12 months (T4) post-stroke. Questions were asked about the previous period: 2 months at T2, 4 months at T3 and 6 months at T4. At T2 and T3, a research assistant visited patients at home or at the institution the patients were residing in at that time. At T3 and T4, patients could choose to fill in an online form or paper questionnaire. Previous research had found no differences between online questionnaires

and questionnaires administered on paper.<sup>19</sup> All questions administered on paper were checked by the research assistant to prevent missing data. All patients were contacted several times in case of delay or non-response.

### Measures

The primary measures of this study were costs (Euros) and QoL expressed in utilities. Cost information was retrieved through a specially designed 14-item cost questionnaire with open answers that was based on an existing questionnaire used in previous research.<sup>20</sup> The questionnaire focused on healthcare resource use (eg, number of hospital days/nights, medication) and non-healthcare resource use (eg, paid and unpaid help, and absence from work).

QoL was assessed with the Dutch three-level five-dimensional EuroQoL (EQ-5D-3L) consisting of the dimensions mobility, self-care, usual activities, pain/discomfort and anxiety/depression. Each dimension was scored on a three-point scale representing 'no problems', 'some problems' and 'extreme problems'. The EQ-5D-3L has shown reasonable validity and reliability, with more limited responsiveness in German patients with stroke.<sup>21</sup> Utilities were derived from the EQ-5D-3L using Dutch tariffs.<sup>22</sup>

### Cost analysis and valuation

A bottom-up costing approach was used, meaning that cost data were obtained from individual patients with stroke who were included in a large cohort. The valuation of healthcare costs was based on the updated Dutch Manual for Cost Analysis in Health Care Research.<sup>23</sup> Medication costs were based on the price per dosage of the drug in the Netherlands, and the price of over-the-counter drugs was based on their market prices (including 6% tax). Productivity costs were estimated with the friction cost method, calculating production losses confined to the period needed to replace a sick employee (160 days).<sup>23</sup> In case of uncertainty, we used a conservative estimate (eg, lowest cost price). Informal care was valued by using standard cost prices based on the average hourly wages of healthcare professionals doing the same tasks (eg, domestic help). Costs were calculated and if necessary, indexed for the year 2012. Further information can be found in online supplementary table I.

### Statistical methods

#### Missing data

Patients were excluded from the analyses if they missed two or more complete assessments of either one of the primary outcomes. The last observation carried forward was used to replace missing items at T2 and T4, using T3 data as reference. Missing items at T3 were replaced with mean data from T2 and T4. We assumed that this method resulted in the best estimation and diminished the risk of overestimation and/or underestimation.

Deceased patients were included in the analysis; they induced no costs from their death onward for the remaining of the follow-up period, and we estimated the lowest possible utility score for these patients.

### Statistics

All statistical analyses were performed using the SPSS V.21. Cost data was skewed; therefore, non-parametric bootstrapping (1000 replications) was used to test for statistical differences (with the 95% CI based on the 2.5th and 97.5th percentile) in costs between the first 6 months poststroke and the subsequent 6 months. Estimates, such as mean, median, SD and CI, were extracted.

Changes in utility scores were reported and interpreted according to minimal important change (MIC). Since no evidence exists on the MIC of the EQ-5D-3L conducted in a stroke population, we chose MIC values used in cancer research by Pickard *et al.*<sup>24</sup> This approach suggests that  $0.5 * SD$  is a good estimate for MIC on the EQ-5D-3L. Floor and ceiling effects over 15% were considered critical.<sup>25</sup>

To further analyse the changes in utilities, patients were divided into three groups: improved, diminished or equal utility score over time. Six subgroup analyses were conducted to identify predictors for high/low costs and utilities. Subgroups were based on gender, age (>65 or <65 years), stroke type (infarction or haemorrhage), recurrent stroke (yes or no), education (high or low), and discharge location (home; yes or no). The non-parametric Mann-Whitney test was used to test for significance. Furthermore, we explored the correlation between total costs and utility scores expressed in a Pearson's correlation coefficient, where a correlation score  $>(-)0.35$  is considered strong and a score between 0 and  $(-)0.35$  weak.<sup>26</sup> The critical p value was set at 0.05.

### Sensitivity analyses

We performed five one-way sensitivity analyses to check the potential influence of base case assumptions on our

study findings. The method of imputation and choices of cost prices may have led to differences in results; therefore, we analysed base case imputation method versus mean imputation, and figured the costs of day treatment for rehabilitation as equal to the costs of a hospital day (€266.53) versus the costs of a rehabilitation treatment (€116.81), and the friction cost method versus the human capital approach to estimate productivity costs.<sup>23</sup> The choice of perspective is an ambivalent subject,<sup>27</sup> so we analysed total societal costs versus total healthcare costs. As different sets of tariffs exist to calculate utilities, we compared Dutch tariffs versus UK tariffs.

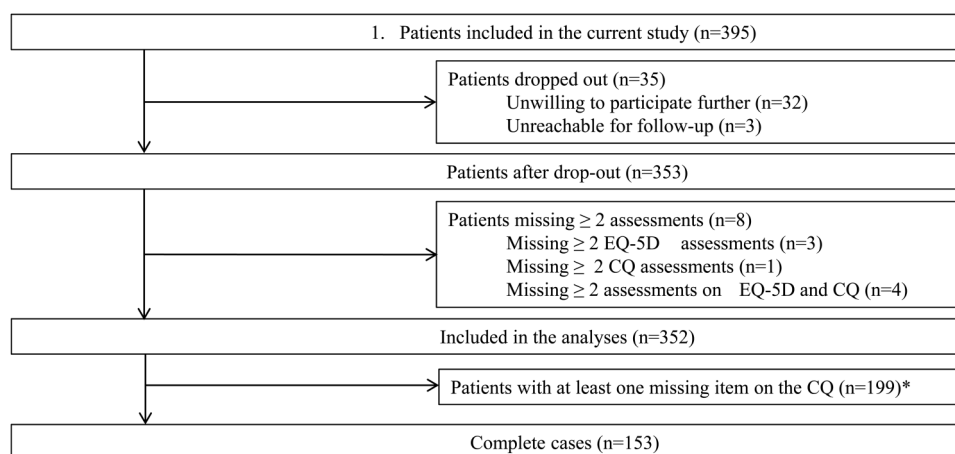
## RESULTS

Data were collected from 395 patients with stroke (figure 1 and online supplementary material). Forty-three patients dropped out (11%) as they were unwilling to participate ( $n=32$ ), unreachable ( $n=3$ ), or missed assessments ( $n=8$ ). Therefore, the data of 352 patients were available for analysis, of which 153 were complete cases (no missing values). The seven deceased patients were included in the analyses.

The majority of patients were male (64.8%) and the mean age of patients was 66.8 years (SD 12.27). The majority of patients ( $n=200$ ) suffered from a minor stroke and had a mean score of 2.57 (SD 2.96) on the National Institutes of Health Stroke Scale (NIHSS). Seventy-one per cent of patients went home after hospital discharge, 14% went to a rehabilitation clinic and 15% to geriatric rehabilitation. Ninety-three per cent of the patients suffered an ischaemic stroke. Demographic and stroke-related characteristics were similar for the subsample of complete cases (table 1 and online supplementary material).

### Total resource use and total societal costs

Patients stayed on average 7.8 nights in a hospital and 11.5 nights in a rehabilitation clinic, and had 20.0



**Figure 1** Inclusion of patients.

**Table 1** Patient characteristics

Patient characteristics (n=352)	N		SD*
Demographic characteristics			
Male gender, %	228	64.8	
Age in years, mean		66.8	12.27
Marital status, % (living together)	243	69	
High education level†, % (n=349)	94	27	
Stroke-related characteristics			
Ischaemic stroke, %	327	92.9	
Left hemisphere, %	133	38.2	
Severity of stroke, mean		2.6	2.96
No stroke symptoms (NIHSS 0), %	87	24.7	
Minor stroke symptoms (NIHSS 1-4), %	200	56.8	
Moderate stroke symptoms (NIHSS 5-12), %	60	17.2	
Moderate to severe stroke symptoms (NIHSS ≥13), %	5	1.3	
ADL four days post stroke, mean		16.9	4.64
ADL dependent (BI ≤17), %	117	33.2	
Residence after discharge, %			
Home	251	71.3	
Rehabilitation center	50	14.2	
Geriatric rehabilitation	51	14.5	

\*SD: standard deviation

† High education was categorized as 'attended at least the school of higher general secondary education'

consults with allied health professionals (eg, physiotherapist, social worker). Informal care was provided 10.9 h/week, and patients were unable to perform unpaid labour for 28.2 days and paid labour for 34 days. After discharge, 94% of stroke survivors used general practitioner services and 95.3% had specialist contacts. Five patients (1.4%) spent night(s) in a psychiatric hospital, 28 patients (8.0%) spent night(s) in a nursing home, and 75 patients (21.3%) spent nights in a rehabilitation clinic.

Total societal costs were on average €29 484 (SD €3867; median €29 316) per patient (table 2). Healthcare costs were 61% (€18 068) and non-healthcare costs accounted for 39% (€11 416) of total societal costs. Healthcare costs were for the largest part costs of rehabilitation treatment days (€6179) and nights spent in a hospital (€3794) or a rehabilitation clinic (€4172). Categories within non-healthcare costs were evenly distributed between 7% and 12% of societal costs with paid home care being largest (€3384) and informal care, the smallest (€2029).

### Changes in societal costs and QoL

In the first 6 months (period T1–T3) poststroke, 74% (on average €21 731 per patient) of the yearly total societal costs occur and in the subsequent 6 months (period T3–T4) 26% (€7711). In period T1–T3, 66% of the total costs were healthcare costs and 34% non-healthcare costs, whereas period T3–T4 showed an equal distribution of 50%. The costs of rehabilitation treatment days were a major category in periods T1–T3 (22%) and T3–T4 (19%), and show a significant decrease over time (from €4760 to €1451). The costs of hospital and rehabilitation clinic stays also decreased significantly

(from €3426 to €380 and from €3487 to €676, respectively). Production losses of €3026 accounted for the majority of non-healthcare costs (13.9%) in period T1–T3. On average, paid home care increases over time from €1327 up to €2041, and informal care decreases from €1252 to €762 on average.

Total healthcare costs were not significantly different between periods T1–T3 and T3–T4. Costs due to the inability to do unpaid labour and due to production losses decrease significantly. Non-healthcare costs and total societal costs show significant differences between both periods (table 3).

At T2, the average utility was 0.73 (SD 0.24), in comparison with 0.74 (SD 0.25) at T3 and 0.74 (SD 0.27) at T4. No average MIC was found, but 19% of patients between T2 and T3 and 16% of patients between T3 and T4 improved with a MIC or more. Utility improved in 36% (n=128) of all patients between T2 and T3, decreased in 29% (n=105), and was equal in 33% (n=119). Between T3 and T4, 33% (n=118) showed improved utility scores, 29% (n=104) had diminished utility scores, and 37% (n=130) were equal in utility score. Ceiling effects in all dimensions of the EQ-5D-3L were in the range of 36.6–77.8%, and no floor effects were found. Details are given in table 4 and online supplementary table III.

### Relation between total societal costs and QoL

A correlation score was calculated between total costs and utilities at 12 months poststroke, resulting in a weak Pearson's correlation coefficient of  $-0.29$  ( $p=0.00$ ), which convinced us not to explore the relation between total costs and QoL further.

**Table 2** Total resource use and costs during 12 months poststroke (bootstrapped)

	Unit	Users		Resource use per patient		Costs per patient			
		N	Per cent	Mean	SD	Mean	SD	Median	Per cent
<b>Healthcare costs</b>									
General practitioner	Contact	331	94.0	7.2	5.75	214.2	10.32	214.0	0.73
Specialist	Contact	332	95.3	8.1	8.08	1021.3	58.25	1021.3	3.46
Allied health professionals	Contact	232	65.9	20.9	30.56	682.3	56.66	681.5	2.31
Mental healthcare professionals	Contact	63	17.9	1.5	8.51	138.8	44.98	134.5	0.47
Rehabilitation treatment	Day	230	65.3	23.2	32.95	6178.7	489.09	6173.5	20.95
Hospital	Night	285	81.0	7.8	8.90	3793.9	245.51	3785.9	12.87
Rehabilitation clinic	Night	75	21.3	11.5	36.06	4172.0	751.45	4127.7	14.15
Nursing home	Night	28	8.0	5.2	29.00	1345.4	423.94	1325.3	4.56
Psychiatric clinic	Night	5	1.4	0.1	0.67	14.7	9.76	13.2	0.05
Medication	Various	345	98.0			506.9	26.32	506.3	1.72
Total healthcare costs						18 068.2	2116.28	17 983.2	61.28
<b>Non-healthcare costs</b>									
Paid home care	h/week	108	30.7	5.2	16.80	3383.6	767.68	3329.8	11.5
Informal care	h/week	190	54.0	10.9	24.46	2029.3	293.70	2022.4	6.88
Inability to do unpaid labour	Day	177	50.3	28.2	58.15	3000.0	355.43	2996.2	10.17
Production losses	Day	102	29.0	34.0	72.17	3003.1	333.48	2984.1	10.18
Total non-healthcare costs						11 416.0	1750.30	11 332.5	38.72
Total societal costs						29 484.2	3866.58	29 315.7	100.00

### Subgroup analyses

Male gender (p value of 0.024, 0.006 and 0.005 at T2, T3 and T4, respectively) and home discharge (p value of 0.004, 0.000 and 0.000, respectively) were significant positive predictors for utilities (table 5). Furthermore, significant positive predictors of costs were male gender (p=0.034 at T4), old age (>65 years) (p value of 0.025, 0.048 and 0.007 at T2, T3 and T4, respectively) and so was discharge to a rehabilitation clinic or nursing home (p value of 0.000, 0.000 and 0.000, respectively). The total costs between >65 and <65 years age categories were significantly different (−€1628.6, p=0.15), and a significant difference was also found between home discharge and other postdischarge destinations (−€39 391.1, p=0.000). The other clinical variables showed no significant difference in the prediction of either QoL or costs.

### Sensitivity analyses

No significant differences in total costs were found in testing the method of imputation (−€905; CI −€5963 to €3999), the rehabilitation treatment day price estimate (−€3274; CI −€8053 to €1640) or the calculation of production costs (€2165; CI −€3065 to €7896). A significant difference was found between total societal costs and total healthcare costs (−€11 443, CI −€15 978 to −€6796). Finally, all utility scores were significantly lower when calculated by means of UK tariffs instead of using the Dutch tariffs (table 6).

## DISCUSSION

We found that the societal cost for each stroke survivor in the first year poststroke was €29 484 per patient.

Seventy-four per cent of total costs are induced in the first 6 months, mainly due to hospital, rehabilitation and productivity costs. The majority of cost categories decrease significantly over time where only the costs of paid home care increases. Younger patients incur higher costs than older patients; age was a significant predictor of costs on all measurement points due to productivity costs being a major cost category for the <65 years age group and zero for the >65 years age group. Patients who were sent home after hospital discharge had significantly fewer costs. Gender was a significant predictor for QoL on all measurement points, with men scoring significantly higher than women. QoL increased slightly over time and did not result in MIC. Patients who were sent home after discharge showed significantly higher utility scores on all measurement points compared with patients discharged to (geriatric) rehabilitation. Ceiling effects were reported for all domains of the EQ-5D-3L. The sensitivity analyses showed an overall robustness of the results; however, significant differences were found while calculating costs from a societal and from a healthcare perspective, and between utilities calculated with Dutch or with UK tariffs. Differences in costs due to the perspective were expected, since fewer cost categories were considered from the healthcare perspective. Despite the sensitivity analyses, an overestimation of rehabilitation treatments is still a factor in the current study, mainly due to difficulties with interpreting questions on the cost questionnaire.

It is difficult to compare these results with other studies due to the large variety in patient populations, methodology, data collection, follow-up period and perspective.

**Table 3** Division of cost per patient during 12 month follow-up (bootstrapped)

	Unit	Stroke—6 months			6–12 months			Difference	
		Mean (€)	SD	Per cent	Mean (€)	SD	Per cent	Mean	CI*
<b>Healthcare costs</b>									
General Practitioner	Contact	133.7	6.94	0.61	81.3	4.79	1.06	−52	(−69 to −36)†
Specialist	Contact	751.0	42.84	3.45	266.0	25.54	3.46	−485	(−584 to −288)†
Allied health professionals	Contact	414.5	36.11	1.90	264.7	31.84	3.44	−150	(−243 to −57)†
Mental healthcare professionals	Contact	83.6	30.30	0.38	54.3	18.63	0.71	−29	(−110 to 30)
Rehabilitation treatment	Day	4760.3	380.15	21.86	1451.3	270.02	18.87	−3309	(−4196 to −2365)†
Hospital	Night	3426.4	232.7	15.74	379.8	89.04	4.94	−3047	(−3553 to −2563)†
Rehabilitation clinic	Night	3487.7	534.54	16.02	675.5	298.12	8.78	−2812	(−4030 to −1638)†
Nursing home	Night	957.7	246.15	4.40	364.8	218.31	4.74	−593	(−1209 to 73)
Psychiatric clinic	Night	7.5	8.3	0.03	7.1	4.40	0.09	0	(−19 to 15)
Medication	Various	258.8	13.88	1.19	248.9	14.80	3.24	−10	(−51 to 29)
<b>Total healthcare costs</b>		<b>14 281.2</b>	<b>1531.91</b>	<b>65.59</b>	<b>3793.7</b>	<b>975.49</b>	<b>49.33</b>	<b>−10 450</b>	<b>(−12 713 to −8243)</b>
<b>Non-healthcare costs</b>									
Paid home care	h/week	1326.8	239.40	6.09	2040.9	690.20	26.54	714	(−525 to 2305)
Informal care	h/week	1252.0	188.60	5.75	761.5	200.50	9.90	−491	(−1000 to 100)
Inability to do unpaid labour	Days	1886.7	223.56	8.67	1093.9	229.59	14.24	−792	(−1417 to −145)†
Production losses*	Days	3026.2	343.25	13.90	0	0	0.00	−3026	(−3714 to −2380)†
<b>Total non-healthcare costs</b>		<b>7491.4</b>	<b>584.52</b>	<b>34.41</b>	<b>3903.9</b>	<b>773.89</b>	<b>50.67</b>	<b>−3587</b>	<b>(−5261 to 1660)‡</b>
<b>Total societal costs (100%)</b>		<b>21 730.5 (74%)</b>	<b>1161.99</b>	<b>100</b>	<b>7710.8 (26%)</b>	<b>1057.06</b>	<b>100</b>	<b>−14 020</b>	<b>(−17 252 to −10 807)†</b>

\*CI (2.5th centile, 97.5th percentile).

†Statistical significant difference (p&lt;0.05).

**Table 4** Quality of life group analysis

Group	N	Utility 2 months poststroke (SD)	Utility 6 months poststroke (SD)	Utility 12 months poststroke (SD)	Utility difference
Increased utility 2–6 months poststroke	128	0.62 (0.24)	0.81 (0.20)		+0.19
Decreased utility 2–6 months poststroke	105	0.79 (0.18)	0.60 (0.26)		–0.19
Equal utility 2–6 months poststroke	119	0.78 (0.25)	0.78 (0.25)		0
Increased utility 6–12 months poststroke	118		0.62 (0.25)	0.80 (0.17)	+0.18
Decreased utility 6–12 months poststroke	104		0.76 (0.21)	0.58 (0.31)	–0.18
Equal utility 6–12 months poststroke	130		0.83 (0.23)	0.83 (0.23)	0

**Table 5** Sensitivity analyses

Imputation and costs	Base case analysis*		Sensitivity analysis		Mean difference	CI†
	Total costs €	SD	Total costs €	SD		
Method of imputation, mean €	29 429.7	1977.41	28 524.4	1666.51	–905	(–5963 to 3999)
Rehabilitation treatment day, mean €	29 363.3	1864.74	2689.3	1674.97	–3274	(–8053 to 1840)
Production losses, mean €	29 356.0	1858.82	31 521.3	2099.90	2165	(–3065 to 7896)
Perspective, mean €	29 490.6	1929.14	18 047.6	1335.40	–11 443	(–15 978 to –6796)
Quality of life	Utility	SD	Utility	SD	Mean difference	p Value‡
Average utility score 2 months poststroke	0.73	0.24	0.67	0.28	–0.049	0.000
Average utility score 6 months poststroke	0.74	0.25	0.69	0.29	–0.049	0.000
Average utility score 12 months poststroke	0.74	0.24	0.70	0.32	–0.037	0.000

\*Base case analysis uses the original method of imputation, values a rehabilitation day as a hospital treatment day, calculates production losses by means of the friction cost method, uses the societal perspective to calculate total costs and calculates utilities with a Dutch tariff. Sensitivity analyses uses mean imputation to calculate total costs, values a rehabilitation treatment day as a rehabilitation contact, calculates production losses with the human capital approach, estimates of total healthcare costs and utilities are calculated with a UK tariff.

†If CI includes 0, no significant difference is found.

‡Significant differences estimated by means of the Wilcoxon signed-rank test; Critical p=0.005.

**Table 6** Subgroup analyses**Subgroup analysis quality of life**

Characteristics	Group	2 months poststroke		6 months poststroke		12 months poststroke	
		Mean difference (utility)	p Value	Mean difference (utility)	p Value	Mean difference (utility)	p Value
Gender	Male–female	0.053	0.024*	0.057	0.006*	0.0458	0.005*
Age (years)	65+ to 65–	–0.014	0.953	–0.009	0.806	–0.0599	0.088
Stroke type	Infarction–haemorrhage	0.016	0.988	0.007	0.600	–0.0555	0.610
Recurrent stroke	Yes–no	0.053	0.244	0.016	0.896	0.0052	0.643
Education	High–low	0.025	0.487	0.053	0.144	–0.0133	0.955
Home discharge	Yes–no	0.088	0.004*	0.112	0.000*	0.125	0.000*

**Subgroup analysis costs**

Characteristics	Group	2 months poststroke		6 months poststroke		12 months poststroke		Mean difference (€)	Total costs
		Mean difference (€)	p Value	Mean difference (€)	p Value	Mean difference (€)	p Value		
Gender	Male–female	–1344.7	0.434	941.4	0.508	–1145.4	0.034*	–1548.8	0.298
Age (years)	65+ to 65–	–1602.1	0.025*	–2740.9	0.048*	5970.8	0.007*	–1628.6	0.015*
Stroke type	Infarction–haemorrhage	–2553.2	0.437	1139.7	0.735	–4146.6	0.384	–5560.1	0.657
Recurrent stroke	Yes–no	–2193.4	0.366	–2263.0	0.798	379.1	0.177	–4077.2	0.704
Education	High–low	48.8	0.720	573.1	0.762	–1666.5	0.391	–1044.6	0.899
Home discharge	Yes–no	–17 371.7	0.000*	12 001.1	0.000*	–10 018.3	0.000*	–39 391.1	0.000*

\*Statistically significant (p&lt;0.05).



Fattore *et al*<sup>11</sup> estimated the 1-year poststroke societal costs in Italy at €20 000 per patient. They conclude that the costs of informal care (33.4%) and costs due to rehabilitation (20%) were major cost components during the follow-up period. Our findings show an even larger cost component for rehabilitation (45%), but fewer costs due to informal care (7%). A recent incidence-based Swedish study found that 9% of total costs were due to production losses and 6% due to informal care.<sup>13</sup> Our results are consistent with these findings as we found that productivity losses accounted for over 12% of total costs and informal care 7% of total costs. According to our findings of €29,484 per stroke patient and an incidence of 26 200 Dutch patients with stroke,<sup>1</sup> stroke costs the Dutch society almost 775 million Euros annually. This is significantly less than findings from 2005,<sup>15</sup> possibly related to the relative good health of our study population, but also due to changes in stroke care which has led to more patients being directly admitted to the stroke unit, early start of rehabilitation and early hospital discharge.<sup>16</sup> Our QoL results are in line with previous research<sup>6–9</sup> in which utility scores 1 year poststroke remained stable. The rather high, constant utility score obtained in this study might be explained by the nature of the study population, since high scores were also found on other outcome measures. High ceiling effects may have influenced minor changes in QoL, raising the question of whether the EQ-5D is the most valid instrument for measuring QoL in patients poststroke.

### Strengths and limitations

The current study has several strengths. First, a large group of patients with stroke was included in this study. Second, the current study is a multicentre study enabling the inclusion of a wider population, and therefore, increasing the generalisability of study findings. Third, a societal perspective was used. Fourth, a bottom-up approach was used for costing, which is considered preferable in terms of estimating costs for chronic patients.<sup>28–29</sup> Finally, we consider it a strength that our imputation method proved to be robust in the sensitivity analysis.

Our study was subject to several limitations as well. First, we used a self-reported questionnaire to estimate healthcare consumption. This may cause recall bias, although an extensive literature review showed that questionnaire design and respondent motivation have more influence on recall bias than period of recall.<sup>30</sup> Second, we used self-reported measurements to collect data causing possible missing items. However, few missing records or items were reported and the validity of self-reported trials was confirmed in a large trial.<sup>31</sup> Third, the majority of patients were recruited from general instead of academic hospitals, which may have influenced study findings. Finally, the choice to use the EQ-5D-3L to measure QoL may have been a limitation. As mentioned before, due to the high proportion of ceiling effects conceivable improvement in QoL was not possible. Therefore, for future research, we recommend

the possibility of using other questionnaires for measuring generic health-related QoL in stroke populations.

### CONCLUSION

The societal costs incurred by a Dutch stroke patient are on average €29 484 in the first year poststroke; 74% of these costs can be accounted for within the first 6 months. These costs are lower than previously reported. This may be explained by our study population's good state of health and by changes in the Dutch healthcare system, which have led to considerable fewer inpatients days poststroke. Costs decreased over time, although some cost categories (eg, rehabilitation) remained a major part of total costs. Male gender was a significant predictor for fewer costs, low age for better QoL, and discharge location for both. Sensitivity analyses proved that the imputation method, rehabilitation day treatment, and productivity cost calculation had no influence on total costs. Choice of tariff and perspective did have a significant influence on total costs. Future research must question the use of the EQ-5D-3L in a similar population due to ceiling effects.

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