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# Future costs of stroke in the Netherlands: The impact of stroke services

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**Objectives:** In the next decades, the number of stroke patients is expected to increase. Furthermore, organizational changes, such as stroke services, are expected to be implemented on a large scale. The purpose of this study is to estimate the future healthcare costs by taking into account the expected increase of stroke patients and a nationwide implementation of stroke services.
**Methods:** By means of a dynamic multistate life table, the total number of stroke patients can be projected. The model calculates the annual number of patients by age and gender. The total healthcare costs are calculated by multiplying the average healthcare costs specified by age, gender, and healthcare sector with the total number of stroke patients specified by age and gender.
**Results:** In the year 2000, the healthcare costs for stroke amounted to €1.62 billion. This amount is approximately 4.4 percent of the total national healthcare budget. Projections of the total costs of stroke based on current practice result in an increase of 28 percent (€2.08 billion) in the year 2020. A nationwide implementation of stroke services in 2020 would result in a substantial reduction of the costs of stroke (€1.81 billion: 13 percent cost reduction) compared with the regular care scenario.
**Conclusions:** A nationwide implementation of stroke services is a strong policy tool for cost containment of health care in an aging population like that in the Netherlands. Policy makers should optimize the organization of stroke care.

**Keywords:** Scenario analysis, Healthcare costs, Stroke services, Healthcare utilization

Numerous studies have documented the economic costs of stroke, and several review studies have been performed (2;9). Currently, approximately 3–4 percent of the total healthcare expenditures in the Western countries is spent on stroke (2). Due to the ongoing aging of the Dutch population, the incidence and prevalence of stroke are expected to increase 20 percent and 39 percent, respectively, during the period 2000–20 (16). As a result, there is a growing demand for stroke care, although the resources are limited. Due to this discrepancy, economic studies on how to allocate the limited healthcare resources effectively are increasingly used by healthcare providers and policy makers. To date, scenario analyses on stroke in the Netherlands have not included economic cost calculations but have focused on the future dynamics in stroke epidemiology in terms of incidence, prevalence, mortality rates, and potential years of life lost (8;16). The outcomes of epidemiological scenario analyses cannot be transformed easily into healthcare costs by

multiplying the total number of stroke patients by an average cost per patient, because the total healthcare costs of stroke depend on the age and gender distribution of the future stroke population.

In general, cost transformations do not consider important changes in stroke care management, such as stroke services, which have originated in the past decades. Organizing stroke care in stroke services recently has been demonstrated to result in improved functional status and quality of life for patients (6;19;20). A stroke service can be defined as a regional chain of caregivers—that is, medical, nursing, and therapy staff—who together as a network warrant integrated, expert, and coherent treatment and care for stroke patients in all phases, that is, acute rehabilitation and chronic, of the ailment (5;15). Although there are different models of organized care, some common elements of a stroke service are a hospital stroke unit, a specialist multidisciplinary team of caregivers, protocol-based care, special staff training, and agreements about transfers from one institute to another to reduce hospital discharge delay (19). These organizational changes in stroke services have resulted in a more efficiently regulated patient flow from the hospital to (nursing) home through capacity planning and improved hospital discharge procedures. As a consequence, the volume of the phenomenon of "blocked beds" has been reduced significantly (6;19;20). Based on these results, current healthcare policy in the Netherlands aims to implement stroke services on a broader scale to improve the quality and management of stroke care in the Netherlands.

The purpose of this study is to perform a scenario analysis in which the expected increase in stroke costs in the Netherlands in the year 2020 is estimated. First, we investigated the effects of demographic changes and trends in the prevalences of hypertension and smoking on future healthcare costs by using costs estimates based on regular care (regular care scenario). Second, we estimated the economic consequences of a nationwide implementation of stroke services on total stroke costs (in addition to the regular care scenario) (stroke services scenario). Special attention was given to the substitution of costs between institutional care and noninstitutional care.

## METHODS

### Model

A dynamic multistate life table is used to estimate future stroke incidence, prevalence, and mortality in the Dutch population over the period 2000–20. The model calculates the yearly number of new patients by age and gender by using incidence rates, specified by age, gender, and presence of major risk factors (hypertension and smoking). A version of the model was used to forecast the future incidence and prevalence of stroke (16) and chronic obstructive pulmonary disease (COPD) (3;11) in the Netherlands.

The change in the annual number of stroke patients is the result of incident cases minus mortality numbers. Mortality consists of stroke-specific and other cause mortality. Stroke-specific mortality is calculated by adapting age-specific case fatality rates for both the first year and the subsequent years after the onset of stroke.

The age- and sex-specific demographic data in the model (mortality rates, birth-, and migration prognosis) are derived from Statistics Netherlands (13). The age- and gender-specific prevalence of hypertension in the Netherlands were estimated on the basis of two studies (4;12). The age- and gender-specific prevalence rates of smokers and former smokers in the Netherlands are derived from the yearly population monitoring studies of the Foundation on Smoking and Health (14). Potential changes in the prevalence rates of hypertension and smoking are calculated by extrapolating the observed trends during the period 1997–2000 over the period 2000–20. For a more detailed description of the model and the input data see reference 16.

### Healthcare Utilization and Related Direct Healthcare Costs

We use a bottom-up method for cost calculation; starting with the number of patients and then combining these numbers with the costs per patient. The total direct healthcare costs of stroke are calculated by adding the product of the estimated number of new patients with the estimated costs per patient in the first year to the product of the estimated number of patients minus the new number of patients multiplied by the costs per patient after the first year.

Data on healthcare utilization were obtained from the Evaluation of Dutch Integrated Stroke Service Experiments (EDISSE) study (19) and the Research On Stroke Amsterdam (ROSA) study. The EDISSE study (2000–01), aimed to evaluate three different experimental stroke services (and three control groups) in terms of health outcomes and costs. Data about healthcare utilization, patient outcome, and costs were collected during the first 6 months after hospitalization. Three main sectors of health care were distinguished: (i) hospital care, (ii) institutional care, and (iii) noninstitutional care, that is, general practitioner (GP) care, medication, home care, paramedical care, home adaptations, and assistive devices (19). We used data on healthcare utilization and costs from the most efficient stroke services (Delft). Costs of regular care were obtained from the three control groups ($n = 187$).

For data on long-term healthcare utilization ($> 6$ months), we used data from the ROSA study. In the ROSA study, a large sample of consecutively hospitalized stroke patients ($n = 760$) was followed up to 5 years, from 1991 until 1996, to quantify long-term healthcare utilization, including hospital care, institutional care (nursing home and rehabilitation care), and noninstitutional care (1). Data on



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**Table 1.** Costs (€) of Stroke Care per Patient at Constant Treatment Pattern in 2000, Specified for Age, Gender, and Healthcare Services

| | | Hospital care | Noninstitutional care | Institutional care | Total |
|---|---|---|---|---|---|
| Costs of regular stroke care | | | | | |
| First year after the stroke | | | | | |
| Men | <65 | 5,023 | 3,220 | 11,291 | 19,533 |
| | 65–74 | 8,198 | 2,087 | 10,637 | 20,921 |
| | 75–84 | 6,585 | 3,029 | 7,463 | 17,077 |
| | >85 | 8,021 | 1,420 | 7,371 | 16,812 |
| Women | <65 | 5,543 | 3,462 | 7,593 | 16,598 |
| | 65–74 | 7,526 | 2,896 | 10,088 | 20,510 |
| | 75–84 | 9,078 | 2,423 | 10,448 | 21,948 |
| | >85 | 10,919 | 1,844 | 9,686 | 22,448 |
| Yearly after the first year after stroke | | | | | |
| Men | <65 | 1,257 | 710 | 2,369 | 4,336 |
| | 65–74 | 2,047 | 460 | 2,232 | 4,739 |
| | 75–84 | 1,644 | 668 | 1,566 | 3,878 |
| | >85 | 2,003 | 313 | 1,547 | 3,864 |
| Women | <65 | 1,364 | 752 | 1,570 | 3,686 |
| | 65–74 | 1,879 | 639 | 2,117 | 4,635 |
| | 75–84 | 2,267 | 534 | 2,192 | 4,993 |
| | >85 | 2,727 | 407 | 2,033 | 5,168 |
| Costs of stroke services care | | | | | |
| First year after the stroke | | | | | |
| Men | <65 | 4,526 | 3,115 | 12,216 | 19,858 |
| | 65–74 | 5,618 | 2,390 | 8,367 | 16,375 |
| | 75–84 | 4,691 | 5,071 | 8,333 | 18,095 |
| | >85 | 4,214 | 1,194 | 5,129 | 10,537 |
| Women | <65 | 4,393 | 5,672 | 8,170 | 18,235 |
| | 65–74 | 5,323 | 4,462 | 6,544 | 16,329 |
| | 75–84 | 4,554 | 2,625 | 9,561 | 16,739 |
| | >85 | 4,503 | 4,884 | 4,336 | 13,723 |
| Yearly after the first year after stroke | | | | | |
| Men | <65 | 1,132 | 687 | 2,563 | 4,383 |
| | 65–74 | 1,441 | 527 | 1,756 | 3,724 |
| | 75–84 | 1,133 | 1,118 | 1,749 | 4,000 |
| | >85 | 1,041 | 263 | 1,077 | 2,381 |
| Women | <65 | 1,089 | 1,233 | 1,689 | 4,010 |
| | 65–74 | 1,361 | 984 | 1,373 | 3,719 |
| | 75–84 | 1,105 | 579 | 2,006 | 3,690 |
| | >85 | 1,128 | 1,078 | 1,083 | 3,289 |

the use of pharmaceuticals outside the hospital were not registered.

We used the estimated costs per patient in the first year after the stroke and for the subsequent years of the ROSA study. We assumed that the proportion of costs made after the sixth month in the EDISSE study was similar to the proportion of costs made after the sixth month in the ROSA study.

Table 1 presents the healthcare costs per incident and prevalent stroke patient for each healthcare sector specified for age and gender. The costs are shown separately for regular care and stroke services care. In the cost estimates of stroke services care, the nonrecurrent coordinating costs are not taken into account. All costs (€) presented in this study were inflated to the year 2000 and assume a constant price level. The cost estimates are confined to the direct medical costs of stroke.

### Scenarios

To gain insight into the future healthcare costs, we formulated the following scenarios: (i) A *baseline scenario* in which the healthcare costs for the year 2000 are estimated. The calculated healthcare costs in this scenario are based on costs estimates of current practice. This baseline scenario will be used as the reference scenario. (ii) A *regular care scenario* in which both demographic changes (aging) and changes in risk factor prevalences (hypertension and smoking) are taken into account. The calculated healthcare costs for the year 2020 in this scenario are based on costs estimates of stroke patients in regular care. Changes in risk factor prevalences are based on model projections (16). (iii) A *stroke services scenario* in which a nationwide implementation of stroke services is assumed. The projected changes in healthcare costs for the year 2020 comprise demographic changes, trends in major risk factors, and costs estimates of stroke patients participating in stroke services. The results of the scenarios will be presented in total costs (€) per year specified for men, women, and the total population.

## RESULTS

### Healthcare Costs

Figure 1 shows the total healthcare costs of stroke in 2000, the baseline scenario, and the total healthcare costs of stroke in the regular care and stroke services scenario for the year 2020. The total healthcare costs of stroke in the Netherlands in the *baseline scenario* are estimated at €1.62 billion (for the year 2000). Male stroke patients account for 46 percent of the costs. Institutional care is the largest cost component, with approximately 57 percent of the total cost (approximately €930 million). This finding is caused by the larger number of patients in the chronic phase, who use more nursing home and rehabilitation care compared with patients in the acute phase (not shown in Figure 1). In addition, 28 percent of the total healthcare costs are devoted to inpatient hospital care (approximately €450 million).

The combined effects of demographics and trends in risk factors in the *regular care scenario* result in an increase in the healthcare costs of approximately 28 percent, up to €2.08 billion in the year 2020 compared with the *baseline scenario*. The greater part of the increase in healthcare costs is the result of the demographic changes in size and composition of the population (not shown in Figure 1) (16).

Compared with the baseline scenario, the *stroke services scenario* will yield an increase in the total healthcare costs of 12 percent, that is, from €1.62 billion to €1.81 billion. In the *stroke services scenario*, the total healthcare costs are substantially lower than in the *regular care scenario* (13 percent;



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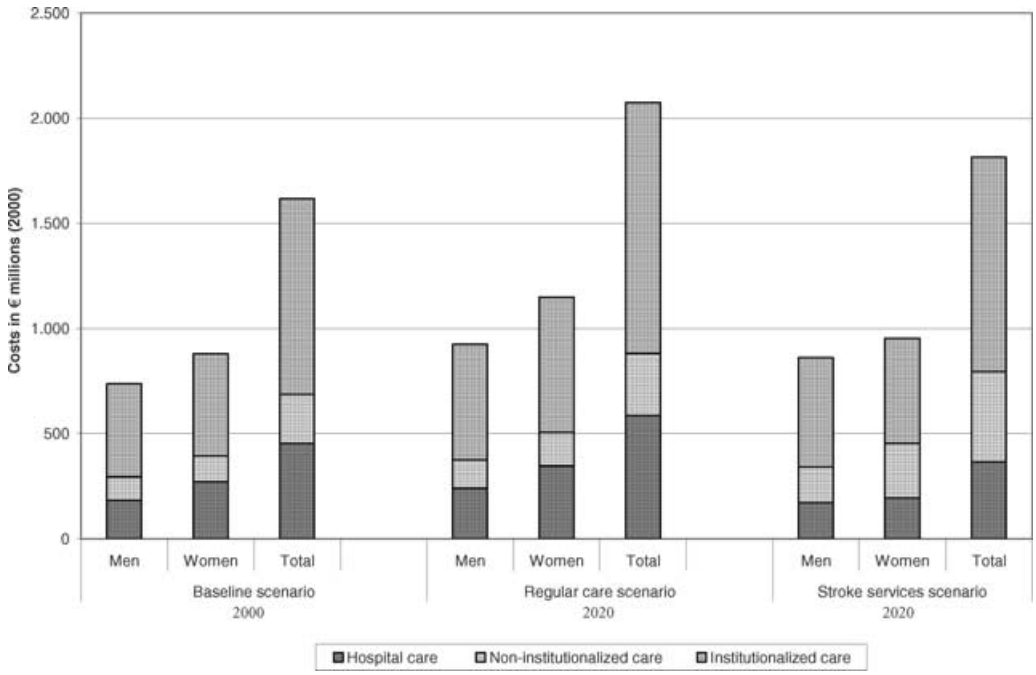


**Figure 1.** Projections of the total healthcare costs of stroke in the Netherlands in 2020 compared with the costs of stroke in the Netherlands in 2000.

approximately € 260 million cost reduction). Stroke services will lead to a sharp 38 percent decline in total hospital care costs (approximately € 220 million cost reduction).

Figure 2 shows the healthcare costs of the *regular care scenario* and the *stroke services scenario*, specified for age and healthcare sector. Stroke services are estimated to lead to considerably lower hospital costs compared with the regular care scenario. The differences in hospital costs increase by age group, which can be explained by the small number of stroke patients in the younger age groups.

Conversely, the costs of noninstitutional care are estimated to be higher in all age groups in the stroke services scenario compared with the regular care scenario (an increase of 45 percent). The costs of noninstitutional care in the oldest age group (over 85 years of age) appeared to be substantially higher in the stroke services scenario (€75 million) compared with the regular care scenario (€33 million).

Furthermore, when stroke services are widely implemented, the costs for institutional care will decrease compared with the regular care scenario. This finding is caused by the lower cost estimates of institutional care of stroke patients in the stroke services compared with the cost estimates of stroke patients in the regular care setting. However, this decrease in institutional care costs does not apply for the youngest age group (under 65 years of age). Apart from the overall lower healthcare costs, a nationwide implementation of stroke services also results in a substitution of costs from hospital care and institutional care toward noninstitutional care of approximately €133 million, which is more than 7 percent of the total costs of stroke.

### Sensitivity Analysis

To test the effects of changes in relevant variables on the outcomes of the model, a sensitivity analysis was performed. The model appeared not to be particularly sensitive to variations in case fatality rates, transition rates, and the input prevalence data of hypertension and smoking. For all these variables, the total healthcare costs in 2020 changed with a maximum of 8 percent. The estimates of the future healthcare costs were more sensitive to variations in the input data of stroke incidence and prevalence. When applying the lowest and highest incidence and prevalence stroke rates from the five Dutch GP registrations (7;17) included in the regular care scenario, the total healthcare costs by the year 2020 will decrease with 20 percent and increase with 19 percent, respectively. Furthermore, the model appeared to be highly sensitive to variations in healthcare costs, with a maximum of 47 percent when the lower bound of the 95 percent confidence interval of the stroke costs per incident and prevalent case was applied.

## DISCUSSION

The purpose of the present study was to predict the future healthcare costs of stroke in 2020 in the Netherlands, in particular focusing on a nationwide implementation of stroke services. We estimated future healthcare costs based on



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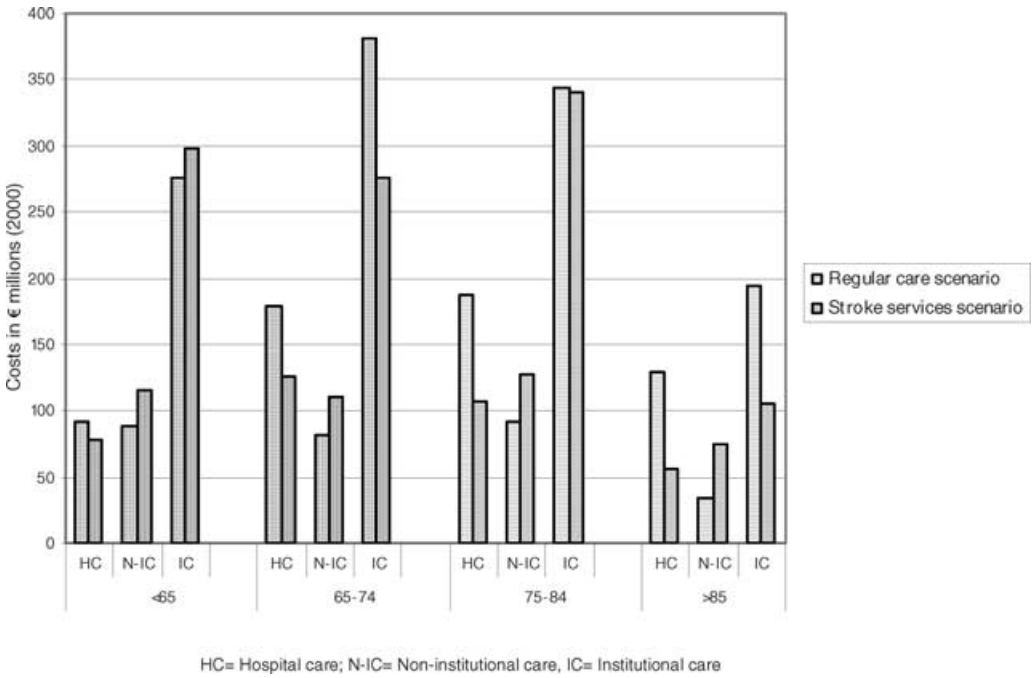


**Figure 2.** Comparison of the total healthcare costs of stroke in the regular care scenario versus the stroke services scenario, specified for age and healthcare sector. HC, hospital care; N-IC, noninstitutional care; IC, institutional care.

regular care, taking into account the effects of demographic changes and trends in major risk factors for stroke, that is, hypertension and smoking. In addition, we estimated the effects of the nationwide implementation of stroke services on future stroke costs.

The total healthcare costs of stroke in the baseline scenario are estimated at approximately €1.62 billion (2000). This value amounts to approximately 4.4 percent of the total national healthcare budget for 2000 in the Netherlands, which is somewhat higher than the estimations in other stroke cost studies (2;10). Costs differences between the studies can be explained partly by the different cost calculations approaches (top-down versus bottom-up) (10).

Our model demonstrates that a nationwide implementation of stroke services results in a considerable decrease of the total healthcare costs of approximately 13 percent compared with the total healthcare costs in the regular care scenario (1.81 billion versus 2.08 billion in the year 2020). Our projections show the potentials of a nationwide implementation of stroke services for cost containment of national healthcare expenditures. Until now, the participation in stroke services by healthcare providers have been on a voluntary basis (18). By creating new (financial) incentives, the desired organizational changes in stroke care management at a nationwide level may be achieved earlier than by the current facilitating approach on a voluntary basis.

Our calculations also show that a nationwide implementation of stroke services causes significant substitutions of costs between different healthcare sectors, in particular from hospital care and institutional care to noninstitutional care. Although this substitution will result in economic gains at the societal level, this substitution could have considerable side effects, such as pressure on the home care capacity and informal caregivers and financial consequences for individual stroke patients because of the current policy of increasing copayments.

Some remarks need to be made on the interpretation of the results. First, in our model, assumptions have been made to fill gaps in knowledge. For most variables, the model appeared to be quite robust. However, changes in the input data of stroke incidence and prevalence rates and changes in the costs estimates resulted in considerable changes in the estimated outcomes. However, we varied the input data for stroke incidence and prevalence and the cost estimates by using the upper and lower bound of the 95 percent confidence interval, which has a very broad range because the number of patients on which the cost estimates were based is small. This finding explains the sensitiveness of the model for changes in healthcare costs and for changes in the input data of stroke incidence and prevalence.

Second, the costs estimates were not comprehensively assessed within one particular study, because data on long-term healthcare utilization were lacking in the EDISSE study. We assumed that the proportion of costs made after the first 6 months in the ROSA study are similar to the proportion of costs made after 6 months in the EDISSE study. This strategy may have introduced some bias, because the treatment patterns of stroke patients will change over time. However,



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the assumption is in line with what we found in an earlier systematic review of stroke costs studies, in which the proportion of costs made after the first year after stroke was quite comparable between stroke cost studies (2).

Third, we assumed a constant treatment pattern and, therefore, constant costs estimates for both the regular care and the stroke services care in the next 20 years. In reality, this assumption does not hold. However, because this is assumed in both cost estimates (regular and stroke services care), the estimated potential economic gain due to the implementation of stroke services in the medium term is not influenced by this assumption. In addition, when stroke services further improve compared with regular stroke treatment over the coming years, the potential economic gain may even be higher. The effects on healthcare utilization and related healthcare costs are probably in the same direction as presented in our study, resulting in a larger decrease of the hospital care costs (due to a further decrease in the average length of stay), no large substitution of costs toward the institutional care facilities (rehabilitation and nursing home care), and an even larger increase in the costs of noninstitutional and informal care.

To conclude, the total healthcare costs of stroke in the Netherlands will rise sizably from €1.62 billion in 2000 to €2.08 billion in 2020, when regular care costs estimates are used. A nationwide implementation of stroke services will lead to a substantial cost reduction (€260 million: 13 percent cost reduction) compared with the costs estimates based on regular care. Our calculations show that a nationwide implementation of stroke services is a strong policy tool for cost containment of health care.

The implementation of stroke services will cause a substitution of costs from hospital care and institutional care to noninstitutional care. To ensure that noninstitutional healthcare providers are capable of delivering and managing the growing demand for noninstitutional care, additional policy measures are necessary. New (financial) incentives are needed to realize a nationwide implementation of stroke services in the year 2020. More than now, policy makers should be keen to optimize the organization of stroke care.

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