Research

Costs of stroke and stroke services: Determinants of patient costs and a comparison of costs of regular care and care organised in stroke services

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Abstract

Background: Stroke is a major cause of death and long-term disability in Western societies and constitutes a major claim on health care budgets. Organising stroke care in a stroke service has recently been demonstrated to result in better health effects for patients. This paper discusses patient costs after stroke and compares costs between regular and stroke service care.

Methods: Costs were calculated within the framework of the evaluation of three experiments with stroke services in the Netherlands. Cost calculations are base on medical consumption data and actual costs.

Results: 598 patients were consecutively admitted to hospital after stroke. The average total costs of care per patient for the 6 month follow-up are estimated at €16,000. Costs are dominated by institutional and accommodation costs. Patients who die after stroke incur less costs. For patients that survive the acute phase, the most important determinants of costs are disability status and having a partner – as they influence patients' stroke careers. These determinants also interact. The most efficient stroke service experiment was most successful in co-ordinating patient flow from hospital to (nursing) home, through capacity planning and efficient discharge procedures. In this region the costs of stroke service care are the same as for regular stroke care. The other experiments suffered from waiting lists for nursing homes and home care, leading to "blocked beds" in hospitals and nursing homes and higher costs of care. Costs of co-ordination are estimated at about 3% of total costs of care.

Conclusion: This paper demonstrates that by organising care for stroke patients in a stroke service, better health effects can be achieved with the same budget. In addition, it provides insight in need, predisposing and enabling factors that determine costs of care after stroke.

Background

Stroke is a major cause of long-term disability in Western societies [1]. At present about 27,000 Dutch citizens (i.e.,

about 0.2% of the total population) suffer from a stroke each year and with the ageing of the population this number is expected to increase to 36,000 in 2015 [2]. One

third of this group dies within 36 months and about 60% survives with moderate or severe disability [3]. In 1999 12,409 people died from a stroke, making stroke the third cause of death in the Netherlands [4]. Stroke was estimated to be responsible for 3.2% of total health care costs in the Netherlands in 1994, and 7.3% for the population aged 75 and over. Therewith stroke ranked second on the list of most costly diseases for the elderly, after dementia [5], while these costs are expected to increase with about 40% till 2015 [6].

The treatment of stroke in the Netherlands is often not optimal: many patients stay in hospital too long without medical necessity, waiting to be discharged to a nursing home (which in the Netherlands is an old people's home with a medical doctor and therapists), a rehabilitation centre or for home care. The number of such "waiting days" is quite substantial. About 10 of the average 28 days of stay in hospital after stroke are estimated to have no medical reason [7]. Moreover, as a result of this delay in discharge patients occupy beds (so-called "blocked beds") that cannot be used for other patients needing (acute) treatment, leading to waiting lists for hospital admission, additional effort of GPs trying to place acute patients, and possible risk to these patients' lives and recovery.

In recent years, stroke services are increasingly initiated to improve the management of stroke patients. A stroke service can be defined as a regional chain of caregivers – i.e., medical, nursing and therapy staff – who together, as a network, warrant integrated, expert and coherent treatment and care for stroke patients in all phases – i.e., acute, rehabilitation and chronic – of the ailment [8,9]. A stroke service thus seeks to promote regional co-operation between the disciplines and institutions involved in the care of stroke patients so that patients would receive the right care at the right time in the right place from the right professional. Though there are different models of organised care, some common elements of a stroke service are: a hospital stroke unit, a specialist multi-disciplinary team of caregivers, protocol-based care, special staff training, and agreements about transfers from one institution to another to reduce hospital discharge delay. In the EDISSE study (Evaluation of Dutch Integrated Stroke Service Experiments) three experimental stroke services were analysed in depth with respect to costs, health effects, quality and organisation of care, and compared to three reference regions representing current standard care for stroke in the Netherlands [8]. It is not known which specific elements of a stroke service exert a beneficial effect. The need to compare different models of organized care has therefore been emphasized [10,11]. In the present study we evaluated the extent to which three different stroke services succeeded in reducing discharge delay. In this study we demonstrated that organising stroke care in a stroke service potentially reduces the length of hospital stay for non-medical reasons considerably [8,12], and may lead to improved health outcomes 6 months after stroke in terms of functional limitations, handicap and quality of life [8,13]. These results are supported in recent international studies of the effectiveness of stroke services [10,11,14–16]. In this paper we present patient costs, relate costs to need, predisposing and enabling factors (i.e., severity of stroke, age, gender, place of residence before stroke, waiting lists) [17], different care pathways and analyse whether costs differ between regular care for stroke patients and care organised in stroke services.

Methods
The EDISSE study is an observational, non randomised study, comparing the costs, patient outcomes and quality of care for three experimental stroke regions versus three reference regions that together represent current standard stroke care. Although the study is observational, data on case mix variables were collected, enabling us to control for differences in case-mix, see the results.

The stroke service experiments
In all stroke service experiments evaluated, hospitals, nursing homes, rehabilitation centres, general practitioners and home care worked together in order to provide co-ordinated care. The practical design of the stroke service experiments however varied considerably. The Delft stroke service experiment consisted of one hospital with a stroke unit, a major nursing home which made additional capacity available on a special stroke unit, specialised nurses in home care and a transmural stroke nurse to accompany patients and their files in and between institutions. The focus of the Nijmegen experiment was on monitoring and supporting recovery after discharge to home. Two hospitals, that did not have stroke units during the project, were each linked to a nursing home with a stroke unit. A special outpatient follow-up care facility was created to support patients in their rehabilitation, and part of the district nurses received specialised training. The Haarlem experiment was primarily directed at nursing home and home rehabilitation. Three hospitals, none of them having a stroke unit during the project, were linked to a single nursing home with a stroke unit, and a specialised rehabilitation team was set up for intensive home care. The reference regions were chosen as a proxy for average current stroke care in the Netherlands, based on previous research [18]. The study was approved by the medical ethics committees of the participating centres, and informed consent was given by all participants.

Cost calculation
We analysed the direct health care costs during the first 6 months after hospital admission. All costs concern the year 1999. Health care utilisation in hospitals, nursing
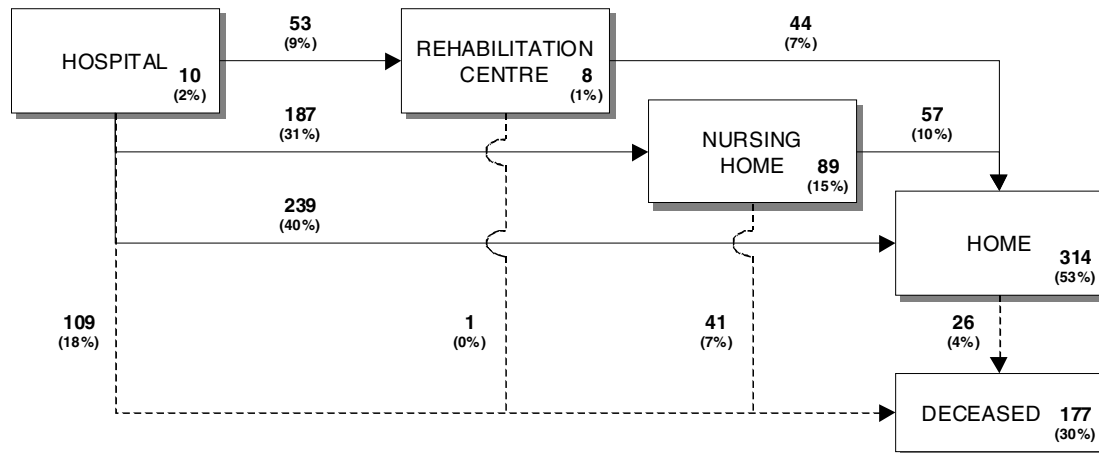
Figure 1
Patients' stroke careers during the 6 month follow-up (N = 598). Note: (i) patient flows along arrows; (ii) patients' place of stay after 6 months in boxes.

homes and rehabilitation centres was registered by inspecting medical patient files on inpatient days, assessment, medication, physician consultations and consultations of various paramedical personnel. Patient interviews at 2 and 6 months after hospital admission produced information on non institutional care, like GP visits, medication, home care, paramedical care, home adaptations and assistive devices. With respect to inpatient days and rehabilitation treatment full costs (including capital costs and overhead) per unit were estimated in each facility in all 6 regions, using the direct allocation method [19]. For a limited number of care facilities no information on costs per unit was determined due to the small number or patients or lack of co-operation. For patients staying in these care facilities, the average costs of other care facilities of the same type were imputed. For special stroke units in hospitals and nursing homes the additional treatment costs per day were estimated and additional costs for co-ordination specific to the stroke service experiments were taken into account. For paramedical care (i.e., physical, speech and occupational therapy, and

social work) the costs per consultation were based on time registration and salary costs of the relevant paramedical disciplines [20]. For diagnostic procedures, medication and surgery the current tariffs charged were used, as these services only represent a small proportion of total costs. For home care the costs per hour for several types of home care correspond closely to the national tariffs, hence the latter were applied. For home adaptations and assistive devices common market prices, as published by providers of these services, were used. The costs of re-admissions were not considered as the number was negligible (note: 15 patients were re-admitted during the follow-up period, i.e., 5 in Delft, 2 in Haarlem, 2 in Nijmegen, and 6 in the reference regions; these numbers are too low to relate them to stroke management strategy).

Statistical analysis
In non-randomised comparing studies such as the one presented here, correcting for differences in case-mix is very important [21]. We used the Barthel Index (BI) to detect possible differences in case-mix between regions [22].

Table 1: Average hospital, nursing home and total costs per patient (in € of 1999; n = 598)

	Delft	Haarlem	Nijmegen	Reference regions
Hospital costs (per hospital patient)	4,170	7,880	8,650	6,620
(number of patients, average length of stay in days)	(151, 13)	(111, 33)	(149, 32)	(187, 29)
- accommodation costs	3,450	7,240	7,900	6,010
- diagnostics, therapy en medication	630	520	670	460
- paramedic care	90	110	80	140
Nursing home costs (per nursing home patient)	13,710	16,700	19,620	15,350
(number of patients, average length of stay in days)	(55, 82)	(34, 110)	(44, 110)	(54, 99)
- accommodation costs	11,030	14,300	15,500	13,650
- diagnostics, therapy en medication	260	670	300	590
- paramedic care	2,420	1,730	3,810	1,110
Total costs (per patient)	13,160	16,790	20,230	13,810
(number of patients)	(151)	(111)	(149)	(187)
- hospital	4,170	7,880	8,650	6,620
- nursing home	4,990	5,120	5,790	4,430
- rehabilitation centre	1,110	2,120	4,170	890
- at home	2,890	1,680	1,620	1,880

BI is a recommended measure for disability after stroke that is widely used in hospitals [23,24]. BI was registered for all (surviving) patients at hospital admission, hospital discharge, and 2 and 6 months after stroke during patient interviews. A patient can receive a score between 0 (deceased) and 20 (no disabilities). To investigate the relationship between costs and disability we classified the BI scores into 5 disability categories: a BI of 20 stands for independent; 15–19 mild; 10–14 moderate; 5–9 severe; 0–4 very severe. Univariate statistics and multivariate regression analysis are presented in the tables.

Results
Study population
The EDISSE study included a total of 598 stroke patients: 411 in the three stroke service experiments (151 in Delft, 149 in Nijmegen and 111 in Haarlem respectively) and 187 in the reference regions together. A small majority (54%) of the total population was female, the average age was 73.5 years (56% aged 75 or older), and one third of the patients lived single before stroke. On average women were somewhat older and more often single [8]. Starting point for the cost analysis is hospital admission after stroke. During the 6 months follow-up patients followed different paths through the health care system (see Figure 1). About 18% of the patients died in hospital, 40% was discharged back to home, 31% to a nursing home, 9% to a rehabilitation centre, and 10 patients (2%) were hospitalised for the full 6 months period. After 6 months about 30% (i.e., 177) of the patients had died, 15% stayed in a nursing home, and over 50% had returned home. There was no difference in mortality between the regions in the 6 months follow-up. However, 6 months after stroke, the average health related quality of life of patients (measured by the EuroQol EQ-5D and the SA-SIP 30) treated in the stroke service in Delft was significantly better than in the reference regions [13]. With respect to quality of care the Delft region also showed superior results. Compared to all other regions, the fraction of observed care deficiencies with a (potential) negative impact on patients health was 50% lower [8].

Mann-Whitney and υ^2-tests were applied to detect potential differences in case-mix between regions. We found traces of a case-mix difference between Haarlem and the joint reference regions (p = 0.03), whereas no differences in disability at hospital admission were found for Delft and Nijmegen versus the joint reference regions [8,12].

Hospital costs
Average length of stay in hospital was 13 days in Delft, 33 days in Haarlem, 32 days in Nijmegen, and 29 days in the reference regions (table 1) [12]. Length of stay in hospital was mainly dependent upon severity of stroke, death from stroke in the acute phase and waiting lists for nursing home care (table 2 [a]). Average hospital costs per patient amount to €6,740 (95% CI: €6,090 – €7,390). About 90% of these costs concern accommodation costs. The costs of medication, assessment, medical and paramedical treatment are limited. Hospital costs were lower for patients who died in hospital (€4,430 vs. €7,260; p < 0.001), patients under the age of 75 (€5,860 vs. €7,490; p < 0.05), men (€5,970 vs. €7,400; p < 0.05) and are higher for regions with waiting lists for nursing home care (table 2 [c]). For stroke service Delft the hospital costs are by far the lowest: €4,170 per patient; the other two experiments are much more expensive, whereas the reference regions have intermediate hospital costs.

Table 2: Linear regression results (n = 575)

Variable	[a] Length of stay in hospital		[b] Length of stay in nursing home[a]		[c] Hospital costs		[d] Nursing home costs[a]		[e] Total costs	
	B	95% CI	B	95% CI	B	95% CI	B	95% CI	B	95% CI
Constant	3.2	-4.6; 10.9	114.7***	76.1; 153.3	1,011	-901; 2,924	20,780***	14,179; 27,380	-8,246***	-11,464; -5,027
Age[b]	3.7	-1.4; 8.8	7.1	-8.3; 22.5	744	-500; 1,987	658	-1,975; 3,291	1,140	-343; 2,623
Gender[c]	2.4	-2.6; 7.4	-2.4	-17.4; 12.7	477	-748; 1,703	-705	-3,282; 1,872	-312	-1,730; 1,105
Living single[d]	3.2	-2.1; 8.4	1.8	-12.9; 16.5	609	-680; 1,898	-656	-3,169; 1,857	1.357*	-152; 2,867
BI hospital admission	2.9*	-0.3; 6.1	-1.0	-14.8; 12.8	627	-154; 1,409	-357	-2,720; 2,006	1,359**	433; 2,286
BI hospital discharge	7.2***	4.2; 10.3	6.8	-2.9; 16.4	1,823***	1,075; 2,570	1,053	-599; 2,704	2,630***	1,679; 3,582
Waiting list nursing home[e]	8.1**	2.4; 13.9			2,216**	809; 3,624			3,930***	2,306; 5,554
Delft region[f]	-13.0***	-19.6; -6.3	-43.7***	-61.9; -25.6	-2,216**	-3,855; -577	-6,860***	-9,965; -3,755	-651	-2,546; 1,243
Died in hospital[g]	-38.6***	-48.3; -29.0			-9,482***	-11,859; -7,105			-8,343***	-12,381; -4,304
Died within 6 months[d]									10,919***	8,617; 13,220
Length of stay in hospital			-0.6***	-0.9; -0.4			-109***	-150; -68		
Stayed in nursing home[d]									11,325***	9,088; 13,563
Stayed in rehab centre[d]									18,457***	15,684; 21,229
R[2]	0.23		0.17		0.21		0.17		0.66	

[a] Selecting only patients that stayed in nursing home (n = 182). [b] 1 if 75 years or older; else 0. [c] 1 if female; else 0. [d] 1 if yes; else 0. [e] proxy based on whether an agreement was made between hospital and nursing home for efficient stroke patient discharge: 1 if no; else 0. [f] 1 if patient was admitted to hospital in Delft region; else 0. [g] 1 if patient died in hospital; else 0. *** significant at p < 0.001 level. ** significant at p < 0.01 level. * significant at p < 0.1 level.

Only in Delft a hospital stroke unit was fully operational during the study period: 75% of the patients was admitted to this unit and stayed on average for 13 days. Although the additional costs of the unit were €35 per day, hospital costs in Delft were comparable to the reference regions as a result of the substantial reduction in length of stay. The substantial reduction in hospital length of stay in Delft was caused by the fact that in Delft 82% of hospital days had a "hard" medical reason, whereas this percentage was only 43% in Haarlem, 46% in Nijmegen and 49% in the reference regions [12]. A patient's day of stay in hospital has a "hard" medical reason in case treatment or assessment is performed that cannot be performed outside the hospital; a "soft" medical reason in case treatment or assessment is performed that could also have been performed in an other care facility; non-medical reason in case the patient is not undergoing any treatment or assessment and is only waiting to be discharged to another care facility [7]. Reason of stay has been recorded for all patients and all days of stay in hospital. In most regions the main reason for patients occupying a hospital bed without medical reason were waiting lists for nursing homes and home care, "enabling" factors [17]. The hospital costs for days of stay with a hard medical reason were however highly comparable between regions, indicating that the additional nursing home capacity made available in Delft is an important determinant of the lower costs.

Nursing home costs

For the 187 patients discharged to a nursing home average length of stay was 99 days. The total nursing home costs were on average €16,120 (95% CI: €14,840 - €17,390) per patient (table 1). Again the lion's share of costs (83%) concerns accommodation. Stroke units were operational in 3 experiment and 2 reference regions during the study period. About half of the patients (n = 95) stayed in a nursing home stroke unit.

Nursing home costs are lower for patients who die during their stay in a nursing home (€8,550 vs. €18,240; p < 0.001) due to shorter length of stay. Costs are comparable for men and women as well as for younger and older patients. Those who stayed in a nursing home stroke unit were more expensive (€17,900 vs. €14,270; p < 0.001), mainly due to additional expenditures and protocols for intensified paramedical care. Average costs per region vary significantly, predominantly as a result of differences in length of stay. Patients in Delft were discharged from hospital after a relatively short stay (13 days, see table 1). Hence, part of the short term mortality "shifted" to the nursing home and the mortality of patients admitted to a nursing home increased significantly, i.e., 40% in Delft vs. 14% in the other regions (note: no differences in mortality for the 6 month follow-up or timing of death (i.e., average number of days alive of those who die) were found

Table 3: Total average costs per patient by stroke career (in € of 1999; n = 598)

	Hospital	Hospital ↓ home	Hospital ↓ rehab centre	Hospital ↓ rehab centre ↓ home	Hospital ↓ nursing home	Hospital ↓ nursing home ↓ home
	(n = 119)	(n = 239)	(n = 9)	(n = 44)	(n = 130)	(n = 57)
Total costs	7,790	7,580	49,230	29,930	28,200	22,520
- institutional	7,790	3,840	49,230	27,100	28,200	19,070
- non institutional	-	3,740	-	2,830	-	3,450

between experiment and reference regions. The higher mortality in Delft nursing homes therefore is not related to the change in service setting, but simply due to the natural course of stroke). Therefore, as patients who die have shorter length of stay in nursing home, the average length of stay in Delft is much lower (table 1) and consequently also the average nursing home costs (see also table 2 [b] and 1 [d]). Patients that do not die during their stay in the nursing home in Delft have average lengths of stay comparable to the other regions (i.e., about 110 days).

Other costs
For the 53 patients who stayed in a rehabilitation centre during the follow-up period the average costs were €22,440 per patient. Accommodation costs accounted for 82% of total costs. The costs are lower for patients discharged from hospital with only mild disabilities (€17,040 vs. €23,700; P < 0.05). The rehabilitation costs vary considerably between regions, but the small number of patients per region does not allow us to draw conclusions on this issue.

The costs of care for patients who stayed at home during part of the follow-up period amount to €3,580 per patient. The main costs are for home care, paramedical care and GP visits. The costs of medication, home adaptations and assistive devices together were only 13% of total costs. The costs are markedly higher for patients aged 75 and older (€4,120 vs. €3,160; p < 0.05), and for patients living single before stroke (€4,260 vs. €3,290; n.s.). Patients living single (often women) can less often fall back on informal care and therefore need more professional home care [25]. The costs at home vary considerably among regions, with Delft as highest (€4,500) mainly due to earlier discharge back home.

Total costs
The total costs of care per patient for the 6 month follow-up after stroke amount to almost €16,000 on average (95% CI: €14,670 – €16,930). Although many patients spent a considerable share of the 6 months at home, insti-

tutional care is responsible for 87% of the costs (table 1). The costs vary markedly between regions: care organised in stroke services in Delft is the least expensive, slightly cheaper than the reference regions (non significant difference). The stroke service in Haarlem is slightly more expensive than the reference regions (n.s.) and Delft (n.s.). The stroke service in Nijmegen is more significantly expensive than the reference regions (p < 0.001) and Delft (p < 0.001), especially for the hospital and rehabilitation phases. A small part of the higher hospital costs in Nijmegen may be attributed to the participation of an academic hospital in the experiment, with obviously higher costs per day. But also after correction the hospital (and total) costs in Nijmegen remain significantly higher. The substantial reduction of hospital costs in Delft is partly compensated by increased costs in the other subsectors, especially home care.

Table 3 shows the relationship between costs and the patients' stroke career, the path patients have followed through the health care system during the follow-up period. By far the most expensive path is a hospital stay and subsequent rehabilitation care for the full six months period. All paths that include nursing home or rehabilitation care (after hospital care) are relatively expensive. Not surprisingly, patients directly discharged to home are the least expensive. The costs for patients who only stayed in hospital are also quite low, because most of them died after a short hospital stay. The average costs for the 10 patients that stayed in hospital for the full 6 month period amount to €44,480.

Total costs versus disability after stroke and patient characteristics
To get better insight into the variation of costs among stroke patients, we analysed the relationship with disability after stroke and patient characteristics as age, gender, and place of residence before stroke.

The last column of table 4 clearly shows that patients who died within the first 6 months after stroke were less expen-

Table 4: average total costs per patient; by disability at hospital admission and by mortality status after 6 months (in € of 1999; n = 595)

Died within 6 months?		Disability[a]					Average
		Independent (n = 31)	Mild (n = 81)	Moderate (n = 98)	Severe (n = 126)	Very severe (n = 259)	
Yes	Total costs	4,510	5,630	10,020	10,240	7,500	7,870
	- institutional	3,720	4,300	9,200	9,310	7,440	7,630
	- non institutional	790	1,330	820	920	60	240
No	Total costs	6,610	6,860	13,170	23,810	30,610	19,160
	- institutional	4,350	3,810	9,290	20,840	28,860	16,380
	- non institutional	2,260	3,050	3,880	2,960	1,750	2,780
Total	Total costs	6,470	6,800	12,950	21,440	18,210	15,860
	- institutional	4,310	3,830	9,290	18,830	17,360	13,820
	- non institutional	2,160	2,970	3,660	2,610	840	2,040

[a] Based on Barthel Index. Categorisation: BI of 20 independent; BI of 15–19 mild; BI of 10–14 moderate; BI of 5–9 severe; BI of 0–4 very severe

sive than average, obviously because their stay in institutional care is on average relatively short and their medical consumption therefore low. Disability at hospital admission seems to be a good indicator of total care costs: the more severe the disability, the higher total costs, especially for stroke survivors. A closer look shows that only the costs of institutional care increase with the degree of disability. For ambulatory care the peak in costs can be found for patients with mild and moderate disabilities, as a result of the combination of a fair probability of returning home and being partly dependent after stroke. Only for independent patients and those with mild disability the fraction of non-institutional costs in total costs is substantial. Our finding that surviving patients with very severe disability cost about 5 times as much as independent patients corresponds to findings in previous research [26].

Viewing patient characteristics, the costs for patients older than 75 years are slightly higher and women who survive the first 6 months incur about 10% more costs than men (table 5). The most important cost determinant seems to be the place of residence before stroke: living single results in substantially higher costs, because the probability of being admitted to a nursing home is elevated substantially, even with limited disabilities. In our sample the probability of being discharged to a nursing home increases with the disability at hospital discharge (p < 0.001), is higher for patients of 75 years of age or older (p < 0.001), patients living single before stroke (p < 0.001), and female patients (p < 0.01). This corresponds with findings from previous research [27,28]. Determinants for higher costs also seem to interact: single living women (€20,080), single elderly (€19,500) and especially single living elderly

women (€21,790) are the most expensive patients (see also table 2 [e]).

Costs of co-ordinating stroke services
Setting up and maintaining a stroke service requires considerable co-ordination efforts between disciplines and facilities involved in organising co-ordinated care for stroke patients. Analysis of the organisation of stroke services showed that especially in the very early phase of the stroke service experiments the developments most of the times took place during regular management, department and discipline meetings [8]. Therefore, most of the times it was impossible to reconstruct the actual start of the experiment and all time and material effort dedicated to stroke service development. As a result, we focussed on the bulk of costs, i.e. frequency, duration and number/type of staff involved in meetings, workshops, development teams and training. Based on organisation schedules, minutes of staff meetings, and interviews with staff members and stroke service co-ordinators we estimated the costs of co-ordination, making a distinction between one time start up costs and yearly structural costs of a stroke service.

Start up costs consisted of: development of uniform transfer of patient information, setting up communication and treatment protocols between care facilities and treatment disciplines, dedicated training (neurology and stroke), developing dossiers, producing news letters, organising working conferences etc. The range of costs per region is between €66,000 and €134,000, the average costs being €96,000 per region. The implementation of stroke services took between 2 and 3 years.

Table 5: Average total costs per patient by age, gender and place of residence (in € of 1999; n = 598)

Died within 6 months?	Age		Gender		Place of residence[a]	
	Under 75 (n = 265)	75 and older (n = 333)	Female (n = 323)	Male (n = 275)	Single (n = 193)	Other (n = 387)
Yes	7,330	8,050	7,650	7,960	9,400	7,780
No	17,760	20,630	20,090	18,040	21,800	17,790
Total	15,430	16,120	16,550	14,920	18,650	14,890

[a] Of 18 respondents the place of residence before stroke could not be retrieved.

Table 6: average cost of stroke care for Delft versus reference regions, decomposed into price and utilisation component (in € of 1999)

	Delft (n = 151)	Reference regions (n = 187)	Total cost difference	Price-component	Utilisation-component
Total costs	13,160	13,810	-650	2,410	-3,060
- hospital	4,170	6,620	-2,450	1,100	-3,540
- nursing home	4,990	4,430	560	400	160
- rehabilitation	1,110	880	220	250	-20
- care at home	2,890	1,880	1,020	670	350

Structural costs comprise costs of additional co-ordination between institutes, interdisciplinary meetings, fortnightly patient discussions, training of new personnel, refresh training of old personnel, communication and monitoring. The annual structural co-ordination costs ranged from €51,000 to €98,000 per region and averaged €71,000 per region per year. The costs of co-ordination have not been included in the patient costs, as these could not be attributed to individual patients (note: by simply estimating the number of stroke patients per year per region based on the number of patients included in each region during the inclusion period of the study, the structural co-ordination costs per patient range between €175 and €260, i.e., about 3% (2.7–3.4%) of total costs).

Cost differences between regular care and stroke service
The substantial differences between regional costs as presented above were analysed further. We focused on the most notable region – in terms of (comparable) costs and (better) health effects, i.e., the stroke service in Delft. The difference in costs per patient between Delft and the reference regions was decomposed into a price component and a utilisation component. The price component indicates the costs difference due to differences in costs per unit of medical services and includes costs of intensified care. The utilisation component reflects differences in the amount of medical consumption. As table 6 shows, the substantial reduction in hospital length of stay in Delft causes a saving in hospital costs of €2,450 per patient. The higher cost per day of stay for the hospital stroke unit is

thus more than compensated by this shorter stay. But, as a consequence, the patients in Delft are treated in a nursing home and/or stay at home longer, causing additional costs for care in those subsectors. For care at home, both cost components are positive, indicating that in Delft the cost per day is higher and the number of days care provided at home is larger. On balance, the total health care costs per patient during the 6 month follow-up are €650 lower in Delft as compared to the reference regions (non significant difference; excluding the co-ordination costs).

Discussion
Total costs of care per patient for the 6 month follow-up after stroke are estimated at €16,000. This is comparable to what was found in other studies [26,29–31]. Patient costs after stroke are dominated by institutional costs, which is again similar to what other studies found [26,30–32]. The most important determinant of costs is death. Patients that die from a stroke bring about significantly less costs. That is, total costs. The costs per day alive are significantly higher for those who die from stroke (€275 vs. €105; p < 0.001). For patients that survive the acute phase, disability after stroke and place of residence before stroke – people living single most likely do not to have a partner and therefore no informal caregivers – are important determinants of costs as these factors have great influence on patients' stroke careers. Previous research has demonstrated that these "need" and "predisposing" factors are important determinants of costs of care after stroke and therefore potential building blocks for the de-

velopment of Diagnosis Related Groups (DRGs) for stroke [26,33,34]. Informal care also plays a crucial role, as the support provided by informal caregivers is a key variable in determining whether and for how long the chronically ill will be institutionalised [35].

We found considerable differences in costs between the regions participating in the study, but no significant difference between the best functioning stroke service – in the Delft region – and regular care in the reference regions. One of the main reasons why the stroke service experiment in Delft was more efficient than the other two experiments appears to be the additional capacity that was made available in the nursing home, probably reinforced by the transfer co-ordination efforts of the transmural stroke nurse. This effects has been demonstrated elsewhere [36]. As a result of the successful co-ordination of patient flow, patients could be discharged from hospital soon after finishing of medical treatment. This is emphasised by the high percentage in Delft of days of stay in hospital with a hard medical reason. In Haarlem nursing home capacity was insufficient to deal with the requests from the three participating hospitals and in Nijmegen the focus of the experiment was on after care. As a result patients stayed in hospital much longer, leading to "blocked beds" and higher costs. The hospital costs for days of stay with a hard medical reason are however highly comparable between the experiments, therefore the key success factor of stroke services, at least concerning cost control, may be the co-ordination of patient flow. Delft is thus well ahead of Haarlem and Nijmegen in the development of an integrated and fully operational stroke service, and the cost estimate for Delft may be considered as a good first approximation of a DRG for stroke service care – preferably differentiated for patient life status and disability after stroke. Note, however, that we found a significant shift of costs between subsectors of care in Delft – mainly from institutional to home -and that integration of care for stroke patients may therefore have an impact on the financing of care. In addition, costs of co-ordination for setting up and maintaining a stroke service may be substantial. There are some critical comments to our study. First of all, EDISSE is a non-randomised non-controlled observational study and consequently we have to be cautious in comparing the results between regions. Though we found traces of a case-mix difference between Haarlem and the reference regions, this was not the case for the experiment in Delft which we used as benchmark of a fully operational stroke service. Second, not all nursing homes and revalidation centres made registrations of paramedical therapy available. Consequently, we used available volumes from other centres weighted for patient disability status. As a result, the presented variations in costs of paramedical therapy between regions may be an underestimation of actual differences between patients and regions.

We assert to have taken a societal perspective in calculating the costs of stroke. This is true. Still, one may argue that taking a societal perspective also implies that we should have taken in to account the effect (i.e., the opportunity costs) of dedicating additional scarce health care funds to co-ordinating and intensifying care for stroke patients. Perhaps creating additional nursing home capacity for stroke patients has lead to waiting lists for other groups of patients, especially considering the current shortage of capacity – mainly staff – in the Dutch health care system. And even if this were not the case, one could question whether stroke patients are the most deserving of patients to be allocated this additional capacity. Nonetheless, our analysis shows that a well-operating stroke service need not require additional funds – and will lead to better health outcomes [8].

It is worth mentioning that recently the Central Agency Tariffs for Health Care (CTG) in the Netherlands proposed to allocate a bonus €86 per inpatient day to nursing homes for intensive stroke care (e.g., on a nursing home stroke unit) [37]. This tariff is higher than the additional daily stroke unit costs we have estimated, but maximised to 8 weeks per patient. Because the patients in our study stay in the nursing home for an average of about 100 days, the total sum for intensive stroke unit care from CTG and from our costs study are comparable (€4,830 vs. €5,220).

Conclusions
Concluding, in this paper we have shown that patient costs after stroke depend on need (disability after stroke), predisposing (age, gender, place of residence/having a partner) and enabling (waiting days and waiting lists) factors. The need and predisposing (demand-side) factors may be important building-blocks for DRGs for stroke. Having a partner (or other relatives) that provides informal care may prevent, shorten or postpone (costly) institutionalisation. We also demonstrated that enabling (supply-side) factors, i.e., those related to the organisation of care, may be an important source for improving cost-efficiency of care for stroke patients. Through sound capacity planning on supra-institutional level and efficient, well co-ordinated discharge procedures the stroke service in Delft was able to reduce waiting lists for nursing homes and home care and, consequently, to discharge patients from expensive hospital beds as soon as there was no longer a hard medical reason for them to stay. Finally, and most important, our study [8] shows that a well-operating stroke service will lead to better health outcomes for patients and need not require additional health care funds. Evidence from other disease groups support the statement
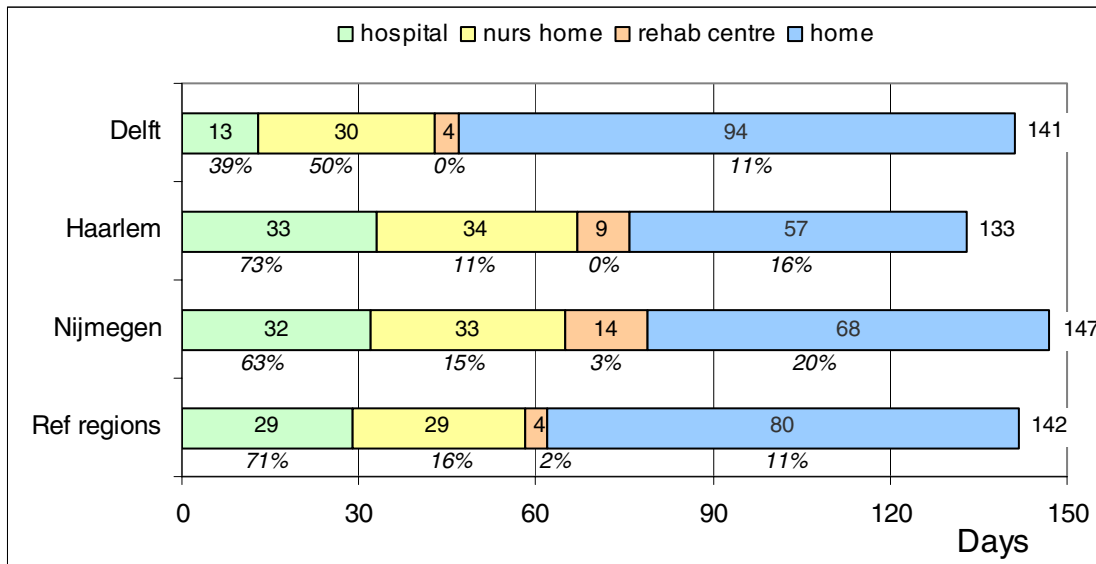
Figure 2
Average length of stay and mortality per region during the 6 month follow-up (N = 598). Note: (i) average length of stay in bars; (ii) mortality per sector as percentage of total deceased in region.

that this result is not exclusive for stroke care [e.g., [38,39]].

Competing interests
At the time of the study Wilma Scholte op Reimer was employed at the Department of Health Policy and Management of Erasmus MC, Rotterdam, The Netherlands.

Authors' contributions
JE, MK, WS and JW participated in the design of the study. MK and WS participated in the co-ordination of the study. JE, WS and JW carried out the data collection. JE and MK performed the statistical analysis and prepared the manuscript. All authors read and approved the final manuscript.

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