Disability and Rehabilitation

ISSN: 0963-8288 (Print) 1464-5165 (Online) Journal homepage: http://www.tandfonline.com/loi/idre20

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To cite this article: Sarah Dewilde, Lieven Annemans, Andrew Lloyd, Andre Peeters, Dimitri Hemelsoet, Yves Vandermeeren, Philippe Desfontaines, Raf Brouns, Geert Vanhooren, Patrick Cras, Boudewijn Michielsens, Patricia Redondo & Vincent Thijs (2018): The relationship between Home-time, quality of life and costs after ischemic stroke: the impact of the need for mobility aids, home and car modifications on Home-time, Disability and Rehabilitation, DOI: 10.1080/09638288.2018.1501438

To link to this article: https://doi.org/10.1080/09638288.2018.1501438

Published online: 02 Oct 2018.

DISABILITY AND REHABILITATION
https://doi.org/10.1080/09638288.2018.1501438

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ORIGINAL ARTICLE

The relationship between Home-time, quality of life and costs after ischemic stroke: the impact of the need for mobility aids, home and car modifications on Home-time

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ABSTRACT

Purpose: Home-time (the number of days spent at home during the first 3 months after stroke) shows a strong association with the modified Rankin scale (mRS). We studied whether Home-time was also a determinant of quality-of-life and medical care costs after ischemic stroke, and assessed factors delaying discharge home.

Materials and methods: Five hundred and sixty nine patients participated in a retrospective study when returning for an in-person visit after an ischemic stroke. Home-time, mRS, EQ-5D-3L, inpatient and outpatient resource utilization, use of mobility aids, changes to home and car, comorbidities were recorded.

Results: Each additional Home-time day was significantly associated with an increase in utility of 0.0056 ($p < 0.0001$) and an in- and outpatient cost saving of $99 ($p = 0.0158$). Requiring extra material support significantly decreased Home-time by 76 days (including: requiring home changes: -68 days, car alterations: -49 days, needing a wheelchair: -80 days or walker: -71 days, needing bed or bath rails: -79 days). This univariable effect was confirmed in multivariable analysis when comparing with patients having the same disability level without requiring material support.

Conclusions: Home-time is a stroke outcome associated with disease severity, healthcare costs and patient wellbeing. Streamlining the discharge process for those requiring extra material support may lead to cost savings and higher quality-of-life.

➤ IMPLICATIONS FOR REHABILITATION

- Delays in discharge from the acute hospital or rehabilitation facility are incurred when patients need extra material support in order to return home.
- Staff from the discharging facility should assist families by giving timely information on the availability and the cost of wheel chairs and walkers; and explaining and planning the need of a stair lift, bed and bath rails as well as car modifications.
- Planning the discharge process with the families will lead to a more rapid return home and will result in reduced overall health care costs and higher quality of life for the patients.

ARTICLE HISTORY
Received 18 January 2018
Revised 11 June 2018
Accepted 13 July 2018

KEYWORDS
Home-time; stroke; disability; mRS; resource use; quality of life

Introduction

Stroke is one of the leading causes of disability: for every 15 million strokes worldwide occurring every year, 5 million patients are surviving with permanent sequelae needing daily help from caregivers [1,2]. This dependency on others results in families having to arrange for or become a caregiver, or alternatively having to relocate patients to a nursing or rehabilitation home. The patient's place of residence after ischemic stroke is known to be associated with 90-day clinical outcomes: patients with lower degrees of disability are less likely to be living in institutions than patients with higher degrees of disability [3]. In addition, it was found that for the same level of disability, patients living at home after stroke incur fewer complications (contractures, bed sores, shoulder pain, falls and depression) than patients in institutions [4].

Several patient characteristics can affect the return home after a hospitalization besides disability, including older age, female sex, lower education, the pre-stroke place of residence and the patient's geographic preferences [5–7]. From the health care provider's side, the factors impeding a swift return home include awaiting decisions of social service funding, waiting for a nursing

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home or rehabilitation home placement, mobility issues (needing walking aids or wheelchairs), and the need of domiciliary care and the resultant necessity of carrying out home modifications (such as installing rails or lifts) for patients returning home [8–10]. Addressing some of these obstacles may help the discharge process and lead to reduced acute in-patient costs.

Returning to a home situation after stroke is important for many patients, as is the timing of this return. A new outcome measure is being advocated as complimentary outcome in stroke trials reflecting this aspect of timing: "Home-time" which is the number of days a patient spends at home (away from acute hospital and inpatient rehabilitation) during the 90 days after ischemic stroke [11,12]. Home-time has been used as secondary stroke outcome next to the modified Rankin Scale (mRS) in several studies in acute stroke [13–16]. It correlates well with the mRS, the National Institute of Health Stroke Scale (NIHSS) and the Barthel index (BI) [11,12,16,17]. This outcome measure is preferred by patients based on focus group interviews [18]. Some studies have extended the time horizon of the measure up to 1 and 2 years finding it still sensitive to changes in health state [14,17]. Home-time can be easily collected from patients, from the medical file or from administrative datasets. Furthermore, the measure is also applicable to other disease areas [11]. Home-time is therefore a relevant and reproducible outcome measure that is transferable to other disease contexts. One of the drawbacks is its sensitivity to geographic region, to the health care system and to culture. However, previous analyses have shown that significant differences in Home-time were found between mRS categories, even in countries with health care systems exhibiting particularly high or low average length of inpatient stays [12,16]. This demonstrates that the Home-time outcome is able to capture the effect of a changed health care policy in different contexts. The literature on outcome parameters highlights the importance of outcome measures to be associated with clinical severity as well as reflecting patient preferences and social and health care needs. The relationship with quality of life and health care costs has not been documented yet for the Home-time outcome.

We therefore set out to study the association between Home-time and patient's quality of life (EQ-5D) and with 3-monthly direct medical costs (in hospital and in the community). We investigated the use of this alternative outcome measure in a real-world ischemic stroke setting, and confirmed its relationship with the mRS. We moreover investigated whether Home-time was influenced by the need for extra material supports such as walking aids and modifications to home or car, pointing to potentially modifiable processes in the discharge process.

Materials and methods

Study design

From 10 hospitals distributed throughout Belgium, including teaching and regional hospitals, 569 patients with ischemic stroke were recruited between September 2010 and May 2014 into an observational, retrospective, non-interventional study called the Burden of Illness in stroke (BOI) study. Participants were recruited into the study when returning to the hospital for an in-person visit after their index stroke; no other selection criteria applied other than having had an ischemic stroke and being scheduled for a check-up ("all comers"). Some patients with a major disability (mRS value 4 or 5) were recruited and interviewed (with their caregivers) by phone or at their residence when not being able to attend the outpatient clinic. Depending on the hospital's stroke follow-up policy, the time of the check-up visit ranged from 3 to 36 months after stroke; this analysis is limited to patients ($N = 464$) whose stroke was less than 24 months ago. Early supported discharge care for stroke patients is not adopted by the Belgian Health care system. The study was approved by each hospital's ethics committee and informed consent was obtained from all patients or their caregivers.

Outcome measures

Place of residence was collected from the patient for two time points: before stroke (measured retrospectively) and after stroke (measured at the time of the interview), and was categorized into living at home without help, living at home with help, with a family member, in a nursing home, in a long-term rehabilitation facility. Home-time was collected from the neurologist and was defined as the time spent at home during the first 90 days after stroke. It was equal to "90 days – length of stay in acute hospital – length of stay in inpatient medical rehabilitation facilities". Home was referred to in the patient questionnaire as being the patient's "usual place of living"; this could therefore be the patients' own home, the home of a family member, or a non-skilled nursing home. As a check we also collected Home-time and the length of stay in different facilities during the first 90 days after stroke from the patient as well and used this information when the data supplied by the neurologist were insufficient. Two mRS measurements were collected: one assessment made by the neurologist at the time of the patient's check-up visit to the hospital (the day of the interview), and the other measurement was transcribed from the patient's medical file and was usually measured 3–6 months after discharge from hospital. The neurologist also provided details on patient characteristics (age, gender), comorbidities (previous stroke, TIA, heart failure, PAD, CHD, diabetes), and risk factors (hypertension, hypercholesterolemia, atrial fibrillation, smoking) at baseline. The patient provided information on changes to home (y/n) and car (y/n), and the need for mobility aids (walker, wheelchair) after stroke. Quality of life was collected from the patient with the EQ-5D-3L at the time of the check-up visit, assessing problems with mobility, self-care, usual activities, anxiety/depression, and pain. Anxiety/depression was self-reported as one of the dimensions of the EQ-5D and flagged for all patients indicating "I'm extremely anxious or depressed". Hospital characteristics were collected including whether the hospital is a regional/teaching hospital and where it was situated (Brussels Capital region, Flanders or Wallonia). Detailed inpatient and outpatient health care resource use (number of visits or length of stay) was collected from the patient during 90 days after stroke, including inpatient days (acute, general, stroke or rehabilitation ward), residency in rehabilitation facilities and nursing homes, and outpatient visits to the emergency ward, neurologist, cardiologist, geriatrician, rehabilitation doctor, general practitioner, nurse, physiotherapist, occupational therapist, speech therapist, and neuropsychologist. Detailed data on resource utilization in the short, medium, and long term are published in a related article [19].

Statistical analysis

Home-time was analysed as a continuous measure (0–90 days) and its distribution was displayed with a Kernel density. The mRS was analysed respecting its ordinal nature with scores ranging from 0 (no symptoms at all) to 6 (death). The EQ-5D-3L utility index was calculated as a weighted sum of the scores on five domains (mobility, self-care, usual activities, anxiety/depression

and pain), with the published European tariffs [20] used as weights. This utility value takes "1" for perfect health and "0" for death, and can also be negative for health states considered worse than death. The total 3-monthly medical care cost was calculated by multiplying the number of visits or length of stays with their National Tariff unit costs [19,21], summing up the costs for each care provider and exchanging the total cost into US dollars using the Purchasing Power Parity ($1=€0.800978) [22]. A variable was created indicating "needing material support" (y/n), signalling when patients needed either a wheelchair or a walker after stroke; or when patients needed to make changes to their home (chair lift, bed or bath rails, etc.) or modifications to their car.

Variables are presented as proportions for categorical variables; and median with interquartile range (IQR) for non-normally distributed continuous variables. A boxplot shows the relationship between Home-time and the mRS. Differences in time until returning home between subgroups were displayed with Kaplan–Meier's curves (truncated at 90 days). Determinants of Home-time were investigated with a lognormal survival model. Multivariable analysis was conducted with the mRS, anxiety/depression, needing material support, co-morbidities, age, and gender as independent variables, in order to disentangle the different effects of each factor on the Home-time outcome. The aim was also to estimate whether there was an additional delaying effect of needing material support in time to returning home, over and above the expected delay due to disability. All regression models were estimated with a random effect for geographic region (multilevel models). Relationships with health economic variables (costs and utility) were investigated with a Gamma model with log link, based on patients in whom cost, utility and outcome assessments were $\leq$4 weeks apart. All analyses were conducted in SAS version 9.4 (SAS, Cary, NC), and no adjustment was made for multiple testing.

Results

Patient characteristics

The BOI study included 464 patients whose stroke was less than 24 months ago and who contributed data to this analysis. Patients had an average age of 75.0 (SD 13.1), 40.8% were female and 13.2% had a previous stroke. Patient characteristics are presented in Table 1. The majority of patients from this study (98%) were living at home before their stroke, and 10.7% moved to an institution (nursing or rehabilitation home) after stroke. In the first 6 months after stroke, some changes in residency were observed: 1.5% patients returned home initially but moved on to a residential home, and 9% patients continued their inpatient rehabilitation beyond 90 days but were able to return home at 6 months after stroke. In the long term (more than 6 months after stroke), the total proportion of patients living in institutions did not change significantly over time ($p = 0.38$) and was 12.2%, 11.8%, and 11.%, at 9, 12, and 18 months after stroke, respectively.

As expected, patients who were more disabled after their stroke were less likely to be living at home, irrespective of whether disability was defined as an mRS scores $\geq$3 (odds ratio for living in an institution: OR =65.15), or defined as needing a wheelchair (OR =11.43) or a walker (OR =6.67). Other factors significantly associated with living in an institution after stroke were female sex (OR =3.90), and living in the capital (as proxy for a larger city) compared to other regions (OR =3.13–7.69).

Table 1. Patient baseline characteristics.Table LayoutTable Layout

	All patients with stroke $\leq$24 months ago ($N = 464$)
Population distribution by age category	
$\leq$65	23.4%
66–75	22.1%
$\geq$76	54.6%
Population distribution by gender	
Male	57.3%
Female	42.7%
Time since stroke (months)	5.27 IQR (3.48–9.17)
Before stroke	
% of population with following risk factors	
Hypertension	73.9%
Diabetes	19.9%
Atrial fibrillation	24.7%
Heart Failure	9.1%
CHD	19.7%
PAD	8.5%
Previous stroke	10.7%
TIA	10.1%
Hypercholesterolaemia	64.1%
Current Smoker	21.1%
Stopped smoking	28.9%
Place of residence before stroke	
At home without help	86.3%
At home with help	11.7%
With a family member	1.3%
In a nursing home	0.7%
Population distribution in each region	
Brussels	22.9%
Flanders	55.6%
Wallonia	21.4%
Population distribution by hospital type	
Regional hospital	14.7%
Teaching hospital	85.4%
After stroke	
Population distribution per mRS	
0	22.5%
1	21.4%
2	21.6%
3	15.3%
4	14.9%
5	4.3%
Place of residence after stroke	
At home without help	58.7%
At home with help	29.2%
With a family member	1.4%
In a nursing home	6.0%
In a rehabilitation home	4.8%
Needing material support	
Needing a wheelchair	16.8%
Needing a walker	7.7%
Needing bed or bath rails	4.1%
Needing a changes to the car	2.3%
Needing a changes to the home	14.4%
Needing any of these types of material support	18.5%
Depression	32.3%

Availability and distribution of Home-time

The majority (96.6%) of the available Home-time data was based on the information reported by the neurologist, supplemented in 3.4% of these cases by calculations based on the break-down of inpatient care by type of residence provided by the patient. Few discrepancies in Home-time were identified between these two respondents, with a mean difference in Home-time of 0.23 days (IQR: 0–1 day). In total, 3% of patients had missing Home-time values that could not be recovered with the information provided by the neurologist or the patient. During the first 90 days after stroke, patients spent on average 60.9 days at home (median 79, IQR 41–84 days). Figure 1 presents the distribution of Home-time.

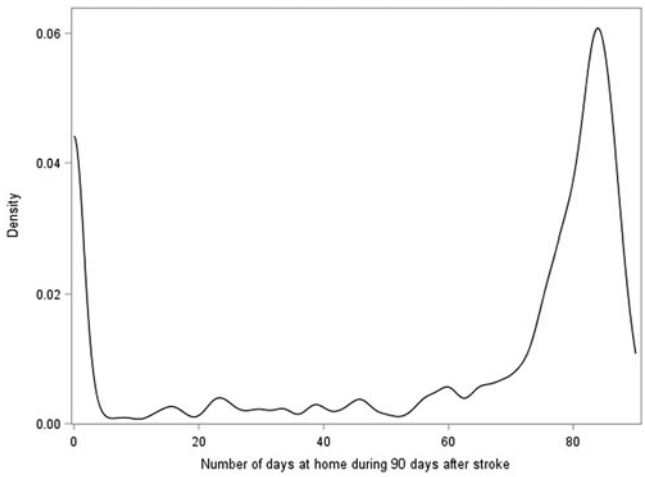

Figure 1. Kernel density of Home-time.

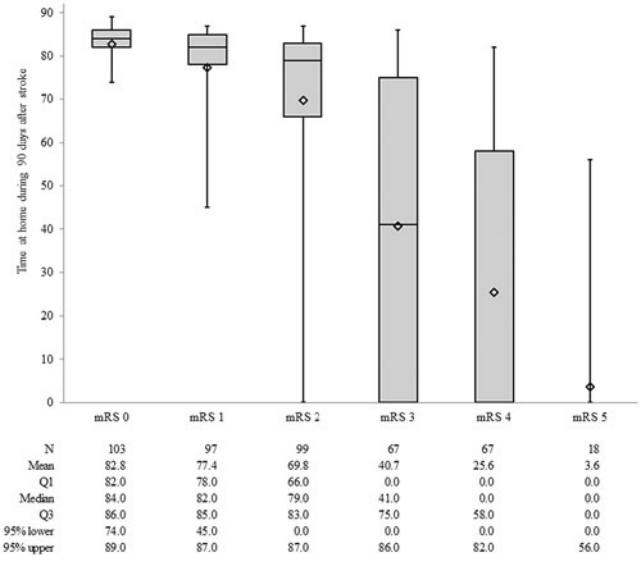

Figure 2. Associations between the mRS and Home-time.

Univariable determinants of Home-time

The relationship between Home-time and mRS was confirmed ($p > 0.001$), with reductions of 2, 5, 43, 84, and 84 median Home-time days for mRS 1–5 compared to mRS 0 (Figure 2, adjacent mRS categories compared to each other: all $p < 0.01$). Patients *needing special material support* experienced a median reduction in Home-time of 76 days ($p < 0.0001$). The delay in returning home was observed in all components of the "needing material support" variable: needing changes to the patient's home resulted in -68 Home-time days ($p < 0.0001$), needing changes to the car: -49 days ($p < 0.0001$), needing a wheelchair: -80 days ($p < 0.0001$), needing a walker: -71 days ($p < 0.0001$), and needing bed or bath rails: -79 days ($p = 0.0006$). *Females* tended to experience a delay in the time to returning home compared to males, but this was borderline significant ($p = 0.060$). *Depressed/anxious* patients had a median reduction in Home-time of 10 days ($p = 0.0412$). None of the other factors (co-morbidities, patient characteristics, hospital characteristics, location) had any impact on Home-time.

Figure 3 displays Kaplan–Meier's curves indicating the proportion remaining in hospital or institutions at every time point between the day of the stroke and 90 days after stroke. Lower curves imply increased Home-time. A clear separation of curves with non-overlapping confidence intervals, indicate that the time to returning home is significantly different between subgroups.

Multivariable determinants of Home-time

Multivariable analysis was conducted with Home-time as dependent variable, and the mRS, anxiety/depression, needing material support, co-morbidities, age, and gender as independent variables. Both the mRS ($p < 0.0001$) and needing material support ($p = 0.0011$) were significantly negatively associated with Home-time. Female sex, anxiety/depression, co-morbidities, and region were no longer significant in this multivariable analysis. The delay in returning home associated with needing material support, over and above the expected delay in returning home due to disability (mRS), was most noticeable in patients with mild-to-moderate disability. These patients experienced additional delays in returning home in comparison to patients with the same level of disability but who did not need material changes or mobility aids: 10.5 days of delay for patients with mRS 1, 7.5 days for patients with mRS 2 and 30.5 days for patients with mRS 3. The effect of "needing material support" was difficult to measure in patients at both ends of the disability spectrum, as fully abled patients (mRS 0) did not need any material support, whereas all patients with severe disability did need some form of material support (mRS 4–5).

Associations with health economic outcomes

Spending fewer days at home was also associated with health economic variables such as quality of life and costs. Significant differences in 3-monthly health care costs and EQ-5D utility were found by the duration of Home-time (based on Gamma log regression models). The regression models in Figure 4 demonstrate that the average estimated utility value for patients not able to return home during the first 90 days after stroke is 0.24, increasing to 0.74 for patients who can be discharged immediately. Averaging across the 90-day time horizon, the marginal utility gain per additional day that the patient returns home sooner is 0.0056 (95% CI 0.0050–0.0057, $p < 0.0001$). This utility gain per additional day at home is highest for patients who are staying in an inpatient facility for the majority of the 90-day period after stroke (+0.0086 utility gain per extra day spent at home), whereas the marginal utility gain is lowest for patients who are able to return home within a few days after their stroke (+0.0033 per Home-time day).

Home-time was also significantly negatively associated with medical care costs (including cost from in-patient facilities as well as medical costs in the community) incurred during the first 90 days after ischemic stroke ($p = 0.0158$): the costs were around €8500 ($10,600) for patients who spent at least 75 out of 90 days in hospital in this period, going down to an average of €1600 ($2000) for patients who spent maximum 14 days in inpatient facilities in this period. Across the 90-day time horizon, every additional day spent at home during 90 days after stroke was significantly associated with an average 90-day medical care cost saving of €79 ($99, 95% CI $68–$131).

Discussion

Strengths of the Home-time outcome

In this study, we found that Home-time was associated with patient wellbeing (EQ-5D utility) and medical care costs. This adds

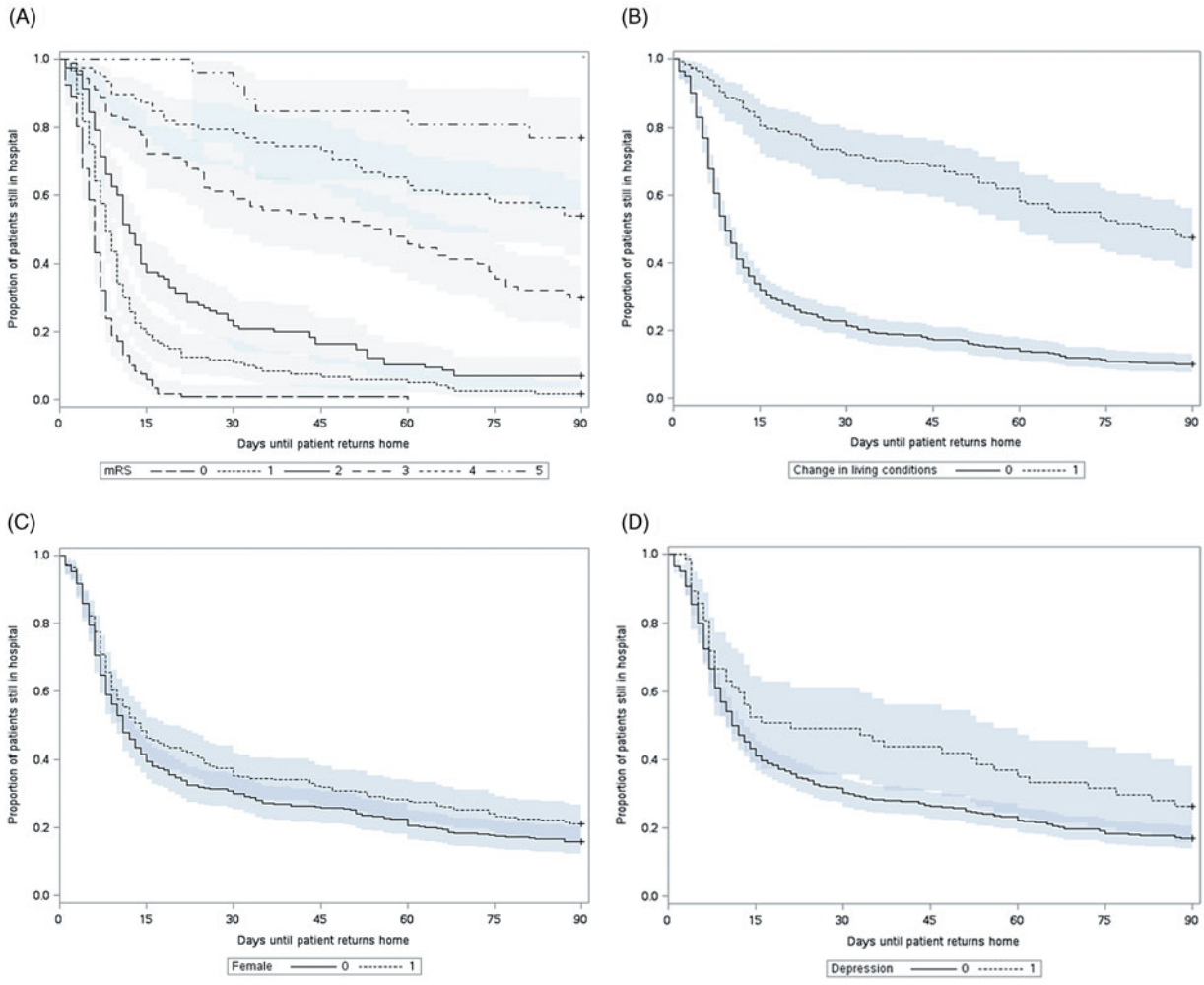

Figure 3. Kaplan–Meier curves for time to returning home: (A) by mRS, (B) by needing material support due to stroke, (C) by sex, and (D) by depression.

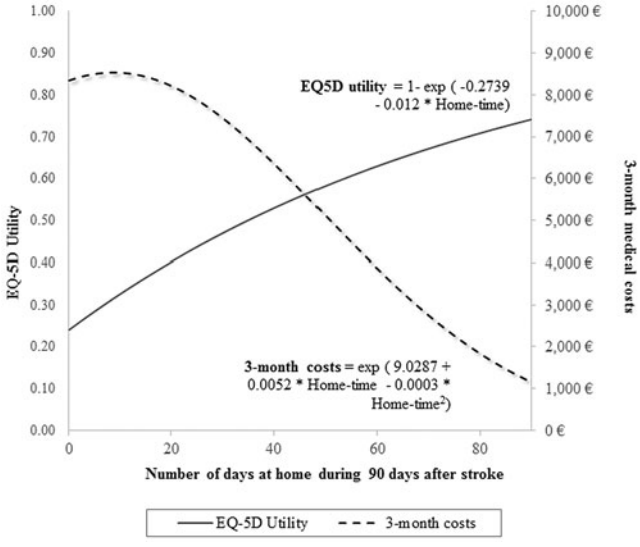

Figure 4. Association between Home-time and EQ-5D utility and 3-month medical care costs.

to previous work that associated Home-time with disability as measured with the mRS. Significant cost savings were associated with every day a patient can return home sooner. Important differences in utility were found by the timing of the patient's return home that were larger than any minimally important differences for the EQ-5D utility index [23]. The *direct* impact of Home-time on utility lies in the fact that most patients prefer to be living at home and patients generally experience a decrease in utility if they have to stay in hospital or move to a rehabilitation facility. This direct impact was also found in other published studies [24–26] where patients' EQ-5D utility values were found to be significantly higher in patients who could return home sooner and follow rehabilitation programmes from home, compared to usual rehabilitation in an inpatient facility. The *indirect* impact of Home-time on utility is through its association with other factors that have a negative impact on utility: being disabled, female sex, requiring material support, and depression. It would be cautious to say that whilst there is a proven association between QoL and Home-time, the direction of causality cannot be inferred from this study: do patients have a higher quality of life because they can return home sooner, or are patients with a higher quality of life (men, not disabled, no need for material support, not depressed) discharged from hospital sooner than others?

Policy implications

We found that delays in returning home were incurred when patients needed extra material support beyond the delays expected by their disability. This is important as streamlining these processes may lead to a more rapid discharge home and potentially reduced costs. When examining the subgroup of patients needing a wheelchair or a walker after stroke in our

study, we found that 80% of these patients had disability levels corresponding to mRS 3–4, corresponding to a mean additional delay in returning home of 21.6 days compared to mRS patients 3–4 who did not need any material support (19.3 versus 40.9 Home-time days). Translating these additional inpatient days related to needing material support into health care costs, this is equal to a medical care cost of €7251 ($9053), based on the assumption that 40% of these days were spent in an acute hospital and 60% in a rehabilitation facility (with per diem costs of €605/$755 or €246/$307) [19,27]. These inpatient costs should be compared to the cost of returning home, which is estimated at €3000 ($3750) for 4 h of paid household help per day and twice daily nursing care at home during these 22 days (per diem costs estimated at €91/$114 [28] and €45.49/$57 [29]). Note that these costs are marginal costs, exclusive of the investment costs for a chair lift (€3000–€10,000; $3750–$12,500) and a wheelchair (€150–€900, $190–$1100). These back-of-the-envelope calculations demonstrate that returning home sooner may lead to cost savings, even in severely disabled patients.

We therefore underline the importance of providing assistance to stroke patients' families in their planning of the return home, by giving information on the availability and the cost of mobility aids (wheel chairs and walkers); and explaining and planning the need of home (chair lift, bed, and bath rails) and car modifications. The organizational aspect of returning home for mild-to-moderately disabled patients is costing the health care system money whilst not reducing costs to patients. Streamlining this process will unblock beds in inpatient facilities and lead to reduced health care costs.

Statistical analysis recommendations

The Kaplan–Meier survival curves were particularly suited for analyzing the Home-time, and were able to show that differences in Home-time can be observed throughout the whole 90-day period at all levels of disability. Many patients with severe disability did not return home during this period, but using survival analysis we were able to demonstrate that for the few severe patients who did return home, the Home-time outcome was able to pick up significant differences in the timing of their return. We evaluated the Home-time outcome to be responsive and sensitive to differences in disability across the whole mRS range and we would therefore not recommend dichotomizing this variable, as is frequently done in stroke studies.

We found that the patient's ability to returning home after stroke was partly influenced by location, which is an undesirable effect limiting comparisons between regions [11,12]. The geographical effect in our study was related to the hospitals in the capital region discharging a higher proportion of patients to institutions, which could be due to the higher availability of residential care in the capital, or to more patients living alone, or more often in apartments that cannot be easily modified to accommodate wheelchairs or walkers. In other studies, this geographical effect could have a different expression and relate to for example country (health care system, culture) or study centre (different discharge policy). Therefore, any Home-time analysis should take the geographical variation into account, by stratifying analysis by region (if sample size is large) or by utilizing multilevel statistical modelling with random regional effects.

Weaknesses of the study

Several factors that are known to have an influence on the Home-time outcome, such as the hospital's discharge policy, the local availability of different types of residential care, relationships between care providers, residential care cost [6], and whether patients have a family member who could become their caregiver, were not included in our study. These factors could have influenced the strength of the relationships that we found in this study. We did not use a validated scale for measuring anxiety/depression which is also a limitation of this study, and this could have modified the results obtained for this variable.

Conclusions

We confirm Home-time as an outcome measure that is responsive to changes in patient's health. Any change in Home-time will also be apparent to health care payers through health care cost savings during the three months after stroke, and to patients through gains in quality of life. We highlight the importance of early, detailed discharge care planning, especially for those patients who will need extra material support. Early home modification and assistance with the purchase of mobility aids may unblock beds in acute care hospitals or rehabilitation facilities, which may in turn lead to reduced costs and improved quality of life.

We conclude that Home-time is a suitable measure to be used as a complimentary outcome next to the mRS, and that it may be used regardless of the hospital's discharge and rehabilitation policy, provided appropriate statistical techniques are used to filter out any geographical effects.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

The manuscript was supported by the Belgian Stroke Council, a non-profit association promoting stroke prevention and stroke care (http://belgianstrokecouncil.be): all co-authors from the Belgian Stroke Council contributed data towards this project.

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