Home-Time is a feasible and valid stroke outcome measure in national datasets

McDermid Iain MSc[1], Barber Mark MD[2], Dennis Martin MD [3,] Langhorne Peter PhD[4], Macleod Mary J PhD[5], McAlpine Christine H MBChB[6], Quinn Terence J MD[4]

1.NHS National Services Scotland, Edinburgh, UK

2.NHS Lanarkshire Stroke MCN, Monklands Hospital, Airdrie, UK

3.Centre for Clinical Brain Sciences, University of Edinburgh, Edinburgh, UK

4.Institute of Cardiovascular and Medical Sciences, University of Glasgow, Glasgow, UK

5.Division of Applied Medicine, Department of Medicine and Therapeutics, University of Aberdeen, Aberdeen, UK

6.NHS Greater Glasgow and Clyde, Glasgow, UK

Corresponding author: Dr Terry Quinn

Room 2.44 Institute of Cardiovascular and Medical Sciences, University of Glasgow

New Lister Building Campus, Glasgow Royal Infirmary, Glasgow, G4 0SF

Tel:+44(0)141 201 8510

Email:terry.quinn@glasgow.ac.uk

Twitter:@DrTerryQuinn

Cover title: Validity & feasibility of Home-Time

Total Figures:1

Total Tables:2

Word count:2000

Keywords:database, stroke, outcome assessment, home-time

Background and Purpose: Home-Time is a stroke outcome measure based on time spent at home following stroke. We hypothesised that Home-Time assessment would be feasible and valid using national data.

Methods: We linked the Scottish Stroke Care Audit to routine healthcare data and calculated 90-day Home-Time for all strokes:2005-2017. We described prognostic validity (Spearman rank correlation) of Home-Time to baseline factors.

Results: We were able to calculate Home-Time for 101,969 strokes (99.3% of total Scottish strokes). Mean Home-Time was 46 days (95%CI:45.8 to 46.2; range:0-90). Home-Time showed consistent correlation with our pre-specified prognostic factors, :age:rho-0.35 (95%CI:-0.35 to -0.36);NIHSS:-0.54 (95%CI:-0.52 to -0.55);Six Simple Variables (ordinal):-0.61 (95%CI:-0.61 to -0.62).

Conclusions: Home-Time can be derived at scale using routine clinical data and appears to be a valid proxy measure of functional recovery. Other national databases could use Home-Time as a time and cost efficient measure of medium and longer term outcomes.

Introduction

Robust measures of stroke functional outcome are required for clinical trials; observational epidemiology and quality improvement programs.[1] The ideal measure should be relevant to patients/carers, responsive to change and widely available at low cost. In person, detailed assessment may not be possible for large or geographically dispersed populations. In trials we use modified Rankin Scale (mRS). However, in large studies with limited resource, low response rate risks substantial attrition bias. Thus, we need outcomes which approximate to mRS but which are available without direct follow up.

Home-Time (HT) is a measure of the time spent back at the person's home during a predefined period following a stroke. It accounts for survival, time spent in hospital or rehabilitation settings; re-admission and institutionalisation.[2] HT has been shown to be a valid marker of functional outcomes and is valued by people living with stroke.[3] HT is an attractive measure for population studies, but to date validation has been limited to trials, quality improvement or insurance datasets.[2,4]

We sought to describe the feasibility and prognostic validity of using HT at scale in a national dataset.

Methods

Datasets: The datasets used in this project are managed by Information Services Division, NHS Scotland. Access to these data is made through the Information Request Service.

Stroke data were from the Scottish Stroke Care Audit (SSCA). SSCA has been described previously[5], in brief, this resource collects patient level data from all Scottish hospitals providing stroke care. Participation in the SSCA is mandatory as data are used to improve stroke care.

We performed individual patient level linkage of SSCA to national health and social care datasets using Scottish Morbidity Records[6] and Mortality data. These datasets all have robust quality control processes.[6] A unique patient identifier, the Community Health Index, was used to facilitate the linkage. We quantified length of initial stay (even if across hospitals), readmission (and length of subsequent stays), institutionalisation and death. Using SSCA data for research has been approved by Scotland A REC:10/MRE00/76; Privacy Advisory Committee Ref:76/11.

Analyses: We attempted to describe HT for all strokes contained in SSCA, censoring at the standard time of 90 days.[2] HT follow-up period started on admission date (or onset date for in-hospital cases). HT was the number of full days not in hospital and where discharge destination was same as at admission (including where care-home was the pre-stroke residence).

To assess feasibility we described the proportion of stroke events held in SSCA that could have HT calculated. We described prognostic validity by comparing HT to predefined variables known to be associated with outcome:age (years); NIHSS (baseline and post thrombolysis); stroke type (ischaemic/haemorrhagic) and Six Simple Variables scale (SSV). SSV is a prognostic scale that includes pre-stroke living arrangements and independence, and post stroke orientation, arm movement, mobility and verbal response.[7] We assessed SSV as an ordinal scale, in aggregate and individual components, and as a quasi-continuous measure including age.[8] SSV is used as a case-mix adjuster in trials and has been shown to have excellent prognostic utility.[7] Age and NIHSS were combined to

calculate SPAN score, another validated prognostic scale.[9] We described association for the complete group and subgroups of 90-day survivors and those admitted from home. We correlated HT with survival and length of stay. We used Spearman's rank correlation with strength of association described using conventional categorisations.[10] Analyses were performed using SPSS software version:21(IBM Corp. Armonk,NY).

Results

We accessed SSCA data from 2005-2017 inclusive. Of 102,642 patients, we were able to calculate HT for 101,969 (99.3%). Median age:71 years (IQR:65-83); 51674 (50.7%) female; 81,771 (80.2%) ischaemic stroke; 70130 (68.8%) from urban areas; 25,071 (24.6%) from areas of socioeconomic deprivation.

Mean HT was 46 days (95%CI:45.8-46.2; range:0-90). There was significant correlation with all prognostic factors. Correlations ranged from medium to large, with strongest correlation for post-thrombolysis NIHSS (rho:-0.72[95%CI:-0.77 to -0.70]). Correlations remained significant in subgroup analyses.(Table 1,Figure 1) HT was associated with individual SSV factors.(Table 2) Correlations with NIHSS after adjusting for age and sex were similar to unadjusted values: Pre-thrombolysis NIHSS, rho:-0.51 (-0.53 to -0.49); post-thrombolysis NIHSS, rho:-0.71 (-0.73 to -0.69).

Discussion

We have demonstrated that in a national dataset of over a hundred thousand stroke admissions, it is feasible to calculate HT using routinely recorded data. HT derived in this way correlates with factors that predict recovery and should be a reasonable proxy of functional outcome.

Although our study was limited to Scotland, our findings will be relevant to any healthcare system that collects stroke and healthcare utilisation data. Countries with national stroke registries that lack resource for post-discharge follow-up may be particularly interested in our findings. HT offers an inexpensive, time efficient method of outcome assessment that can be used for research, audit and service planning. In Scotland we have already started using HT for outcome comparisons across stroke centres.(Supplementary material I)

The strengths of our approach include the size of our dataset, giving unparalleled precision in analyses. Our inclusive sampling frame included all patients with stroke treated in a Scottish hospital and covers all rural and urban settings and socioeconomic strata. Our inclusive approach is reflected in the range of outcomes demonstrated. Previous work has suggested that a mean HT of around 50 days is equivalent to a modified Rankin Scale (mRS) of 3[2,4]. Thus, our SSCA data suggest a broader range of stroke outcomes than usually seen in a clinical trial. Our findings were robust across a series of subgroups, while correlation with length of stay and mortality shows that HT offers something more than if using these values alone.

There are limitations to our work. Assessments of prognosis were limited to baseline factors only, albeit baseline factors known to have excellent predictive accuracy. We did not have full data for all

factors of interest, but this further emphasises the difficulty of outcome assessment at scale and the potential utility of our HT approach. However, the consistency of association between HT and all prognostic factors is reassuring. We recognise that comparisons with mRS would be a useful assessment of concurrent validity. Such validations, using trial and registry data, have been described and consistently report strong association of HT with mRS.[2,4,11] There is no reason to think the relationship would differ in larger scale, real-world data.

Granularity of information at the individual patient level was limited and there are plausible situations where our derived HT may be erroneous. For example, our data capture would miss a person who is a temporary resident or emigrates following stroke. We believe such occurrences are unusual, only 700 (0.7%) SSCA patients did not have a Scottish postcode. Admission to care-home following discharge may also be missed and methods for capturing care-home admission from routine sources are being developed.[12]

We have demonstrated feasibility and validity of 90 day HT for stroke. The approach could be easily applied to other diseases and other time points. Use of HT following subarachnoid haemorrhage is described[13], but the HT concept could be used beyond cerebrovascular disease allowing a 'big data' approach to other chronic conditions.[14]

Acknowledgements: We thank all SSCA audit coordinators and teams.

Sources of Funding:SSCA is funded by NHS Scotland. Dr Quinn is supported by a CSO/Stroke Association Senior Lectureship.

Disclosure(s): Nil

References

1.Quinn TJ,Dawson J,Walters MR Lees KR.Functional outcome measures in contemporary stroke trials.Int J Stroke.2009;4:200–205.

2.Quinn TJ,Dawson J,Lees JS,Chang TP,Walters MR,Lees KR.Time spent at home post stroke:"home-time"a meaningful and robust outcome measure for stroke trials.Stroke.2008;39:231–233.

3.Hannah D,Lindholm B,Maisch L.Certain uncertainty:life after stroke from the patient's perspective.Circ Cardiovasc Qual Outcomes.2014;7:968–969.

4.Fonarrow GC,Lianmg Li,Thomas L,Xian Y,SaverJL,Smith EE et al.Assessment of Home-Time after acute ischaemic stroke in Medicare beneficiaries.Stroke.2016;47:836-842.

5.Turner M,Barber M,Dodds H,Murphy D,Dennis M,Langhorne P et al.Implementing a simple care bundle is associated with improved outcomes in a national cohort of patients with ischemic stroke.Stroke.2015;46:1065-70.

6.Public Health Information Scotland Report: https://www.scotpho.org.uk/publications/overview-of-key-data-sources/scottish-national-data-schemes/hospital-discharges Accessed December 2018.

7.Teale E,Young J,Dennis M,Sheldon T.Predicting patient reported stroke outcomes a validation of the Six Simple Variable prognostic model.Cerebrovasc Dis Extra.2013;3:97-102.

8.Lewis SC, Dennis MS, Sandercock PA.Predicting outcome in hyper-acute stroke-validation of a prognostic model in the Third International Stroke Trial.JNNP.2000,79:397-400.

9.Saposnik G,GuzikAK,Reeves M,Ovbiagele B,Johnston SC.Stroke prognostication using Age And NIH Stroke Scale.Neurology.2013;80:21-8.

10.Altman DG,Bland JM.Measurement in Medicine.The Statistician.1983;32:307–317.

11.Mishra NK,Shuaib A,Lyden P,Diener HC,Grotta J,Davis S et al.Home time is extended in patients with ischemic stroke who receive thrombolytic therapy.Stroke.2011;42:1046–1050.

12.Burton JK,Papworth R,Haig C,McCowan C,Ford I,Stott DJ.Statin use is not associated with future long-term care admission.Drugs Ageing.2018;35:657-663.

13.Stienen M,Smoll N, Fung C, Goldberg J, Bervini D, Maduri R et al.Home-time as surrogate marker of functional outcome after aneurysmal subarachnoid haemorrhage.Stroke 2018;49:3081-3084.

14.Doubal F,Ali M,Batty DG,Charidimou A,Eriksdotter M,Hofmann-Apitus M et al.Big data and data repurposing-using existing data to answer new questions in vascular dementia research.BMC Neurology.2017;17:72.

Figure and Table Legends

Table 1: Correlation of Home-Time with prognostic factors

Table 2: Home-time for components of Six Simple Variable score

Figure 1: Home-time versus SPAN (age plus NIHSS)9

Table 1: Correlation of Home-Time with prognostic factors

	Rank correlation with HT		
Prognostic factor	**Total population**	**Survivors only**	**Excluding care-home residents**
Age (years)	-0.35 (-0.36 to -0.34) N=101,969	-0.28 (-0.28 to -0.27) N=82,045	-0.34 (-0.35 to -0.34) N=92,324
SSV (ordinal score)	-0.61 (-0.62 to-0.61) N=92,231	-0.53 (-0.54 to -0.53) N=74,812	-0.61 (-0.61 to-0.60) N=84,047
SSV (quasi-continuous)	-0.63 (-0.62 to -0.63) N=92,231	-0.55 (-0.56 to -0.55) N=74,887	-0.63 (-0.63 to -0.62) N=84,138
NIHSS	-0.54 (-0.56 to -0.52) N=5,546	-0.48 (-0.50 to -0.46) N=4,445	-0.54 (-0.60 to -052) N=5,252
NIHSS (post-thrombolysis)	-0.72 (-0.74 to -0.70) N=2,877	-0.70 (-0.72 to -0.68) N=2,360	-0.72 (-0.74 to -0.71) N=2,734
SPAN (age + NIHSS)	-0.48 (-0.50 to-0.46) N=5,546	-0.38 (-0.40 to -0.35) N=4,445	-0.47 (-0.49 to -0.45) N=5,252
Length of stay (days)	-0.64 (-0.64 to -0.64) N=101,858	-0.90 (-0.90 to -0.90) N=81,959	-0.68 (-0.68 to -0.67) N=92,223
Survival at one year	0.56 (0.55 to 0.56) N=95,013	0.25 (0.24 to 0.26) N=76,424	0.54(0.54 to 0.55) N=85,805
Stroke type Ischaemic (N=81,771) Haemorrhage(N=11,640)	**Mean HT** 49.3 (49.1 to 49.6) 26.6 (25.9 to 27.2)		

All significant:p<0.001; analyses are rho (95% confidence interval) unless otherwise stated

HT:Home-Time; SSV:Six Simple Variables

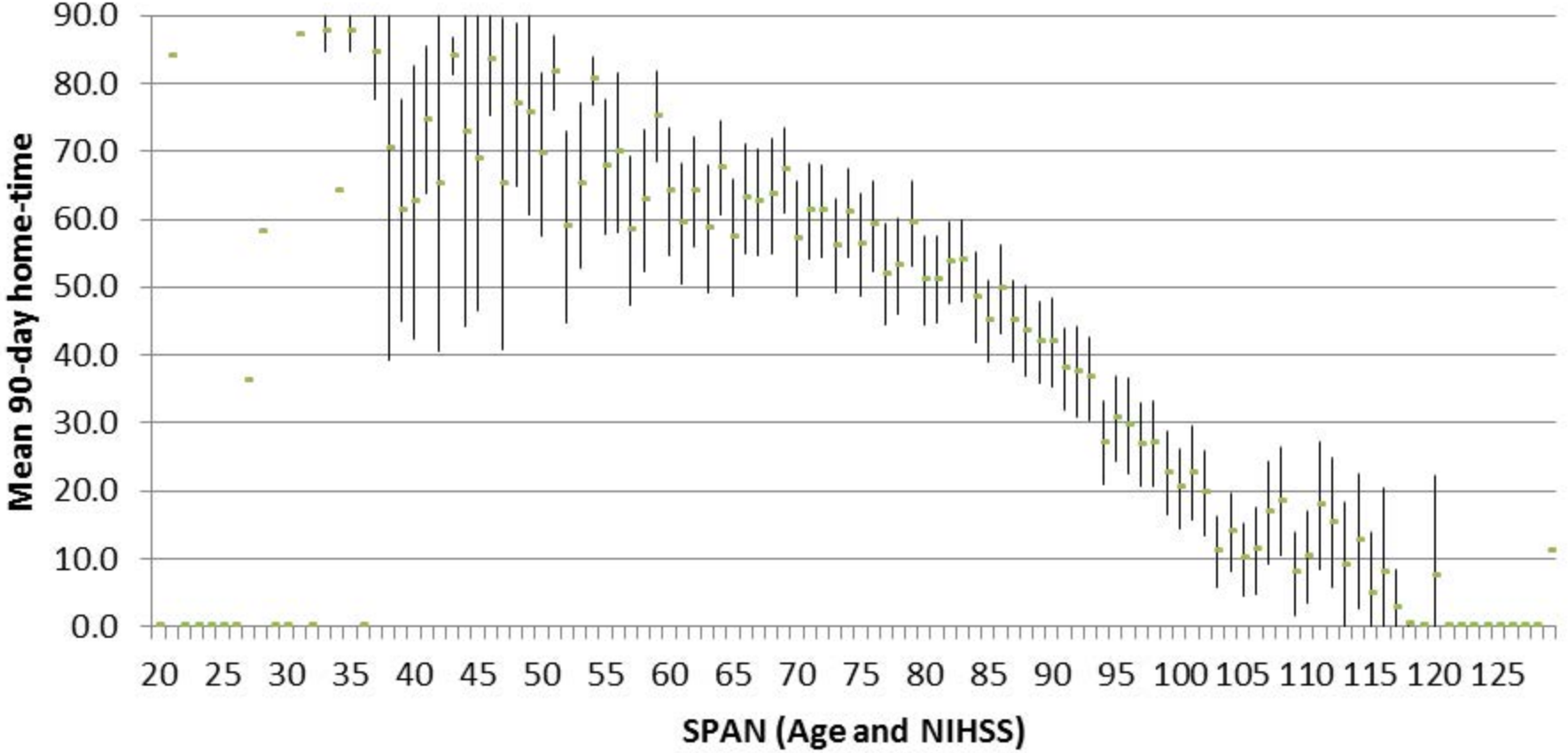
Table 2: Home-time for components of Six Simple Variable score

Prognostic variable	Present (n) Mean HT (95%CI)	Absent (n) Mean HT (95%CI)	Mean difference HT (95%CI)
Lives alone	38,152 41.1 (40.7-41.5)	60,883 49.3 (49.0-49.6)	-8.2 (-8.7 to -7.7)
Independent pre-stroke	81,312 50.6 (50.3-50.8)	16,968 26.0 (25.5-26.5)	24.6 (24.0-25.2)
Orientated	62,873 58.8 (58.6-59.1)	34,884 24.7 (24.3-25.0)	34.1 (33.7-34.6)
Lift arms	62,196 60.5 (60.2-60.8)	36,512 22.2 (21.9-22.5)	38.3 (37.9-38.7)
Walking	43,457 66.4 (66.1-66.7)	54,007 30.0 (29.7-30.3)	36.4 (36.0-36.9)
Talking	74,488 54.8 (54.5-55.1)	25,556 21.2 (20.8-21.6)	33.6 (33.1-34.0)

All significant:p<0.001

HT:Home-Time

Figure 1: Home-time versus SPAN (age plus NIHSS)[9]


Mean 90-day home-time
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125
SPAN (Age and NIHSS)

SUPPLEMENTAL MATERIAL

Supplemental Material I

Comparison of 90 day home-time and annual stroke admissions across all hospitals providing acute stroke care in Scotland

SE=Standard Error