Appendix

Figure A1. Structure of the health economic model

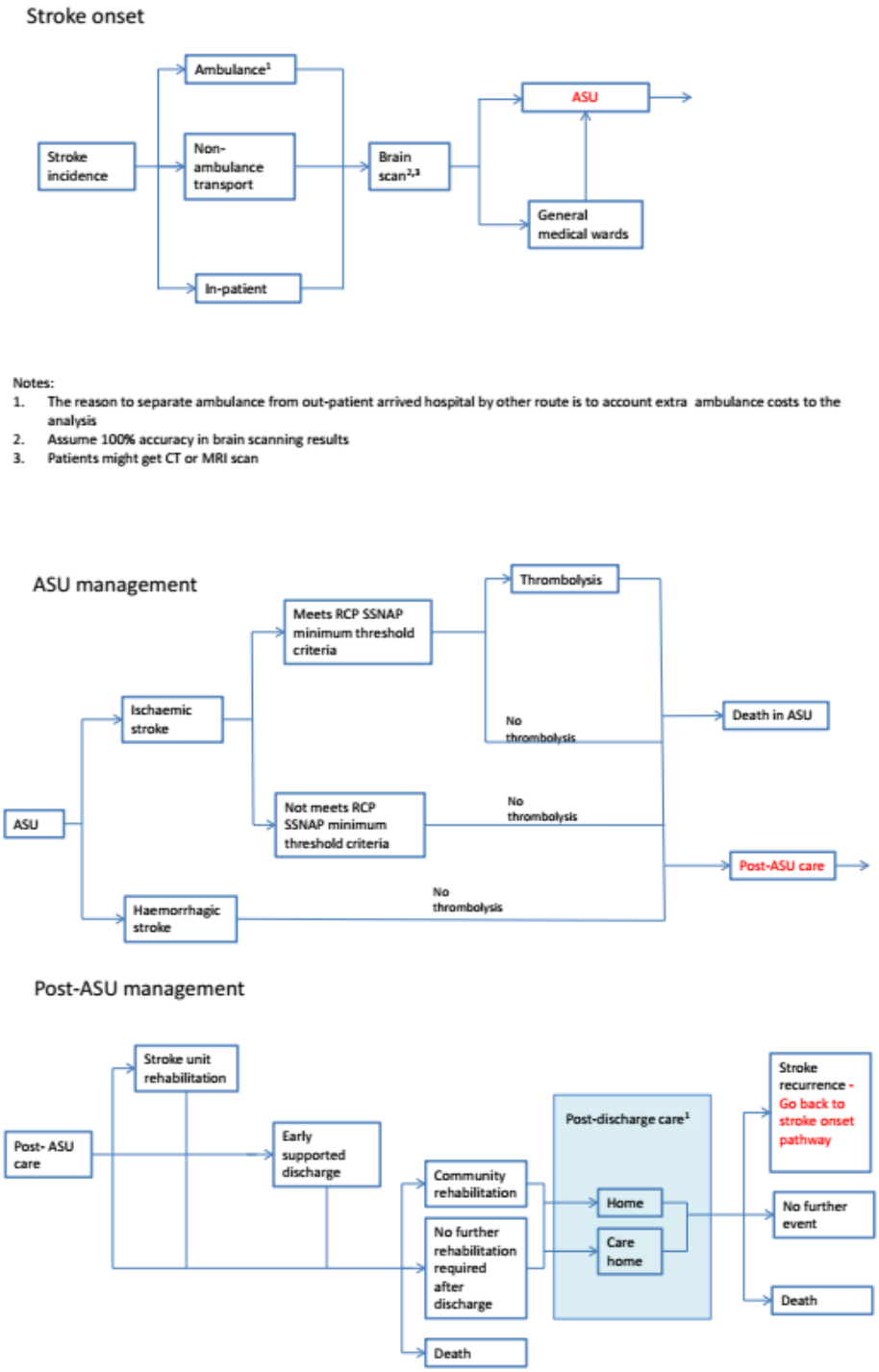


Table A1. Resource use and assumptions

Treatment unit	Resource use	Other inputs	Assumptions
Acute stroke unit (ASU) and thrombolysis	Thrombolytic therapy for those patients who were thrombolysed Acute stroke unit stay	Proportion of patient that was eligible for thrombolysis	100% of the patients get scanned 100% accuracy of scan Thrombolysis treatment affects mRS and mortality in ASU. Patients were not distinguished by their thrombolysis status after they were discharged from ASU. Ischaemic stroke and haemorrhage stroke treatment differs in terms of thrombolysis and length of stay. An average per day cost was used. We assumed the same per day cost for patients with different levels of severity but older patients and those with more severe strokes stay in ASU for longer and therefore incur more cost.
General medical wards (GMW)	General medical ward stay	Proportion that were admitted to GMW (rather than ASU) after brain scan	No mortality in the model. No severity change in GMW No thrombolysis available in GMW All patients will be transferred to ASU after GMW Fixed length of stay on GMW (before transfer to ASU).
Stroke unit (SU) - inpatient rehabilitation	Stroke unit stay		We assumed the first team/hospital the patient was treated with provided acute care and classified as ASU when analysed the SSNAP data, and all the rest inpatient treatments were classified as SU rehabilitation (or inpatient rehabilitation)
Early supported discharge (ESD)	Mean number of days of Physiotherapy, occupational therapy, speech and language therapy per Early Supported Discharge (ESD) treatment package on an average patient by age and mRS. Mean number of hours of psychological therapy time per ESD treatment package by age and modified Rankin		Patients will have a maximum of one occupational therapy, physiotherapy and speech therapist visit per day All patients in Early Supported Discharge programs are living at home 23% of staff cost added to cover overhead costs in sensitivity analysis

	Score.		
Community rehabilitation team (CRT)	Community rehabilitation treatment cost episode General Practitioner (GP) visits Usage by age and mRS of: Care home cost (if newly admitted), Home help, Meals on wheels, Social service day centre	Proportion that stayed at own home/care home while doing community rehabilitation treatment	Due to the lack of data of patients' location (own home or care home) during community rehabilitation Cost was from the Persoanl Social Services Research Unit (PSSRU) Unit Costs Of Health and Social care 2014 section 1.8
Discharged to own home or care home	<u>NHS resource use</u> GP visits <u>Social care resource use</u> Care home – proportion of patient discharged to care home by age group and mRS at discharge Home help – mean number of visits per patient by age groups and mRS Meals on wheels– 3% of patients. Social service day centre visits – 1.5 visits per patient per year Usage by age and mRS	Proportion of patients discharged to own home or care home	It was assumed that health state (mRS) does not change after the patient is discharged (unless they have a stroke recurrence) People discharged to their own home or care home will stay at the same place until death or stroke recurrence if patients were in a care home then they would not use the home help, meals on wheels and social day centre services

Stroke recurrence	Same pathway as first stroke	Recurrence rate and severity from South London Stroke Register	Patient pathway is assumed to be the same for recurrent and first- stroke Recurrence rate is not dependent on age or previous stroke severity Maximum of 3 non-fatal stroke recurrences per person

Table A2 Calibration results

Item	Odds ratio before calibration	Odds ratio after calibration	Odds ratio in Cochrane review
Total number died in ASU	1.12	1.76	1.69(1.44,1.98)
Died in 90 days	1.02	1.28	1.18(1.06,1.30)
mRS 2-6 in 90 days	1.06	0.82	0.76(0.70,0.84)
mRS 3-6 in 90 days	1.05	0.88	0.85(0.78,0.93)
mRS 3-5 in 90 days	1.04	0.72	0.75(0.69,0.82)
Number of deaths within 1st year comparing ESD patients with non-ESD patients	0.91	NA	Co-ordinated and delivered by an ESD team, all ESD patients: 0.69 [0.44,1.07] Odds ratio in Cochrane review (all teams, all patients): 0.91[0.67, 1.25]
Number of deaths or dependency (mRS 3-6) within 1st year comparing ESD patients with non-ESD patients	0.67	NA	Co-ordinated and delivered by an ESD team, all ESD patients: 0.71 [0.55, 0.91] Odds ratio in Cochrane review (all teams, all patients): 0.80 [0.67, 0.97]

Table A3 Unit costs used in the analysis

Cost Item	Unit cost (£)	Data Sources
Ambulance	233	Personal Social Services Research Unit [A1](PSSRU 2014 7.1)
MRI scan	143	National Health Service reference costs (2013-2014 RA01A)
CT scan	91	National Health Service reference costs (2013-2014 RA08A)
Thrombolysis	875	National Health Service reference costs (2013-2014 YR23A-B ;day-case)
Acute stroke unit per day	649	National Health Service reference costs (2013-2014 AA35A-F ; average cost per day of

Cost Item	Unit cost (£)	Data Sources
		short-stay)
General medical ward per day	210	National Audit Office, Progress in improving stroke care (2010) [A2]. inflated to 2015 prices
Stroke unit per day	233	National Health Service reference costs (2013-2014 AA35A-F ; average per day cost in non-elective long-stay stroke patient)
ESD Occupational therapy per visit	74	National Health Service reference costs (2013-2014 A06A1)
ESD Physiotherapy per visit	52	National Health Service reference costs (2013-2014 WF01B)
ESD Speech and language therapy per visit	84	National Health Service reference costs

Cost Item	Unit cost (£)	Data Sources
		(2013-2014 A13A1)
ESD Psychologist per hour	61	Community therapist are collected from PSSRU 2014, 9.5
Community rehabilitation per patient referred	2808	Personal Social Services Research Unit (PSSRU 2014, 1.8)
GP visit –23.4 minutes service + 12 minutes travel time	103	Personal Social Services Research Unit (PSSRU 2014, 10.8b&B.1)
Care home per day	157	Personal Social Services Research Unit (PSSRU 2014 1.3 ; not including personal expenses)

Cost Item	Unit cost (£)	Data Sources
Home help – community care package per week mRS=1	37	Personal Social Services Research Unit (PSSRU 2014 8.1 ; older person very low cost)
Home help – community care package per week mRS=2	148	Personal Social Services Research Unit (PSSRU 2014 8.1 ; older person low cost)
Home help – community care package per week mRS=3-5	370	Personal Social Services Research Unit (PSSRU 2014 8.1 ;older person medium-high cost)
Meals on wheels per week	46	Personal Social Services Research Unit (PSSRU 2014 8.1)
Social service day centre visit	56	Personal Social Services Research Unit

Cost Item	Unit cost (£)	Data Sources
		(PSSRU 2014 1.6)

Thrombolysis Scenario Analysis

To examine the impact of potential scenarios of improved stroke care, two alternatives were considered in our model: increased thrombolysis probabilities and increased ESD rate. For thrombolysis, two possibilities were evaluated:

1) 10%-100% of patients who met SSNAP minimum criteria receive thrombolysis treatment with intervals of 10%. These patients are the patients that should be thrombolysed but were not. This scenario is more realistic and conservative, the purpose is to see how much the outcomes could be improved without implementation of complicated improvement of healthcare services provided such as how patients were delivered to hospitals or further education.
2) 50% of patients who did not get thrombolysis due to the following reasons, now meet the criteria by age and initial severity:
    a. Not arriving within thrombolysis time window
    b. Wake-up time unknown
    c. Too mild/severe
    d. One or more of criteria above

These scenarios in section 2) were conducted to demonstrate the effect of improved healthcare service delivery. These patients might get thrombolysed with improved healthcare services. Patients who were not thrombolysed due to other reasons such as medical conditions that were not suitable for thrombolysis or patient refused thrombolysis was not considered in our model.

Early Supported Discharge Scenario Analysis

The purpose of these analyses was to examine the effect of changing the proportion of people receiving ESD. Similar to thrombolysis, not all patients are suitable to be discharged to ESD. In practice, patients will usually be considered suitable to be discharged to ESD if they are:

- Independent or have a carer at home after stroke &...
- Not severely disabled before stroke &...
- No major language and speech problem

We did not have data on the patients' carer or whether the patient has language or speech problem, therefore the only standard we could use to examine whether a patient is suitable to be discharged to ESD is whether the patient could walk independently or not, which was assumed to be mRS 3 or less.

The following analyses were conducted:

1) Increasing the proportion of patients discharged to ESD regardless of age and severity:

- 20% of patients who were not discharged to ESD now discharged to ESD
- 35% of patients who were not discharged to ESD now discharged to ESD
- 50% of patients who were not discharged to ESD now discharged to ESD

• 80% of patients who were not discharged to ESD now discharged to ESD

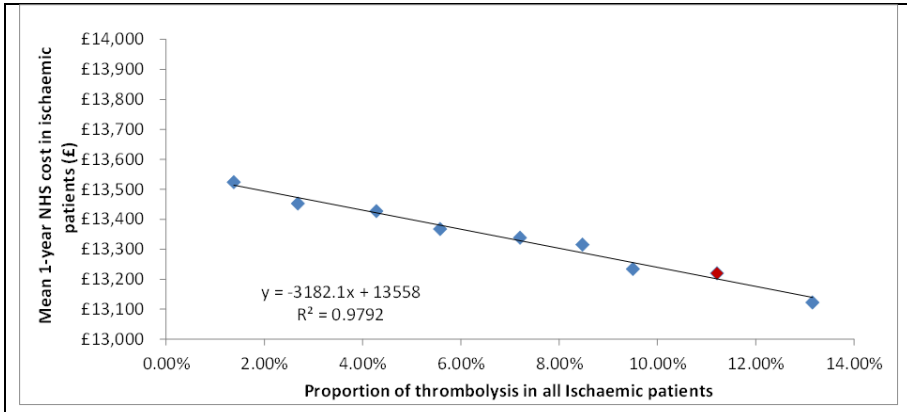
2) Increase the proportion of patients discharged to ESD in less severe patients:

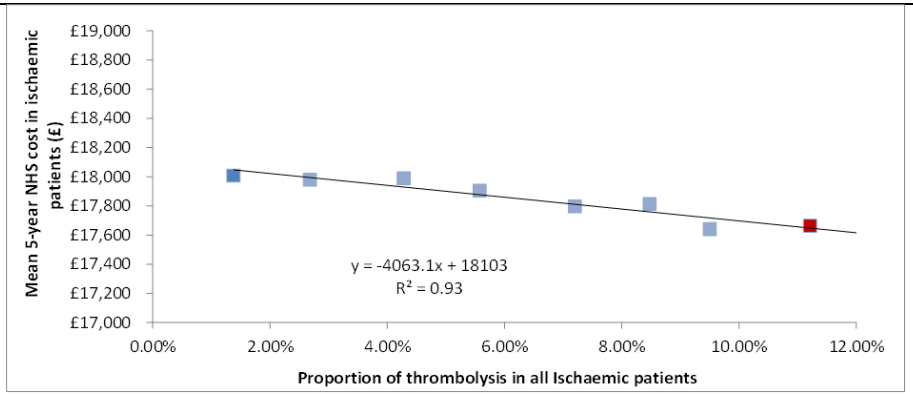
- 20% of mRS 0-2 patients who were not discharged to ESD now discharged to ESD
- 35% of mRS 0-2 patients who were not discharged to ESD now discharged to ESD
- 50% of mRS 0-2 patients who were not discharged to ESD now discharged to ESD
- 80% of mRS 0-2 patients who were not discharged to ESD now discharged to ESD

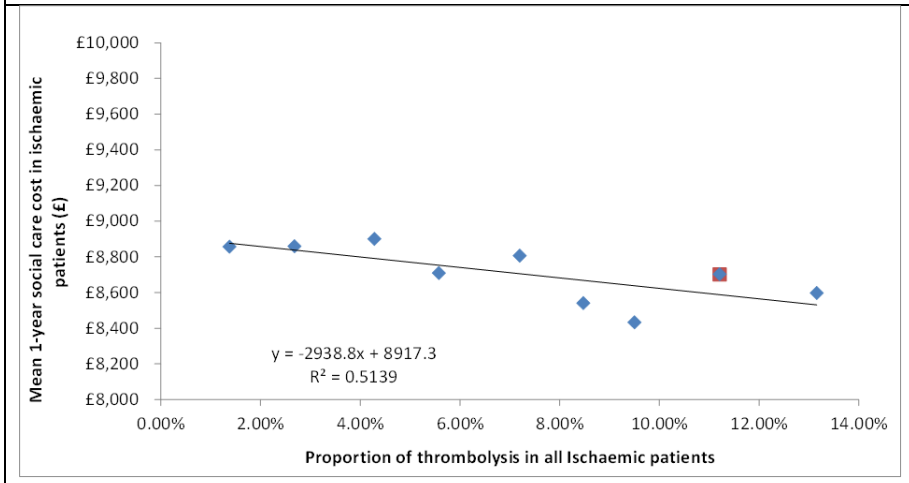
For both analyses, patients were switched as follows:

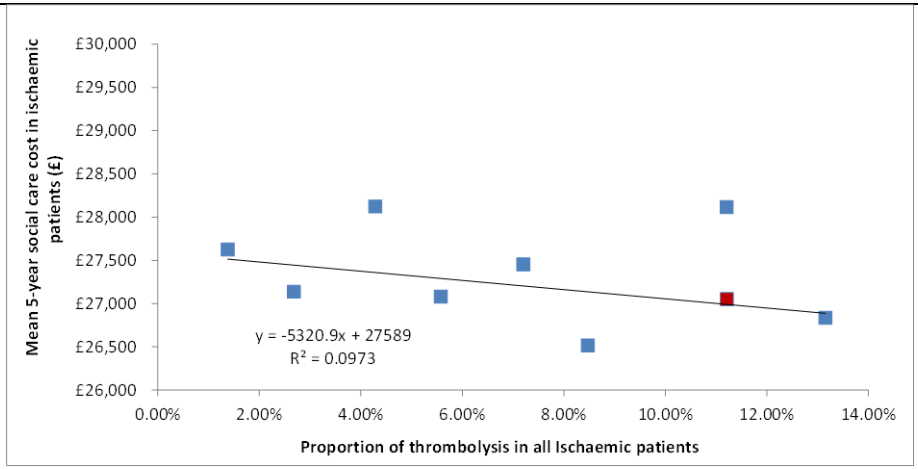
- ASU->CRT to ASU->ESD,
- ASU->SU to ASU->ESD, and
- ASU->SU->CRT to ASU->SU->ESD

Patients who were discharged from ASU with no rehabilitation requirement were not switched on the assumption that they did not need rehabilitation.


Mean 1-year NHS cost in ischaemic patients (£)
£14,000
£13,900
£13,800
£13,700
£13,600
£13,500
£13,400
£13,300
£13,200
£13,100
£13,000
y = -3182.1x + 13558
R² = 0.9792
0.00%
2.00%
4.00%
6.00%
8.00%
10.00%
12.00%
14.00%
Proportion of thrombolysis in all Ischaemic patients


Mean 5-year NHS cost in ischaemic patients (£)
£19,000
£18,800
£18,600
£18,400
£18,200
£18,000
£17,800
£17,600
£17,400
£17,200
£17,000
y = -4063.1x + 18103
R² = 0.93
0.00%
2.00%
4.00%
6.00%
8.00%
10.00%
12.00%
Proportion of thrombolysis in all Ischaemic patients


Mean 1-year social care cost in ischaemic patients (£)
£10,000
£9,800
£9,600
£9,400
£9,200
£9,000
£8,800
£8,600
£8,400
£8,200
£8,000
y = -2938.8x + 8917.3
R² = 0.5139
0.00%
2.00%
4.00%
6.00%
8.00%
10.00%
12.00%
14.00%
Proportion of thrombolysis in all Ischaemic patients


Mean 5-year social care cost in ischaemic patients (£)
£30,000
£29,500
£29,000
£28,500
£28,000
£27,500
£27,000
£26,500
£26,000
y = -5320.9x + 27589
R² = 0.0973
0.00%
2.00%
4.00%
6.00%
8.00%
10.00%
12.00%
14.00%
Proportion of thrombolysis in all Ischaemic patients

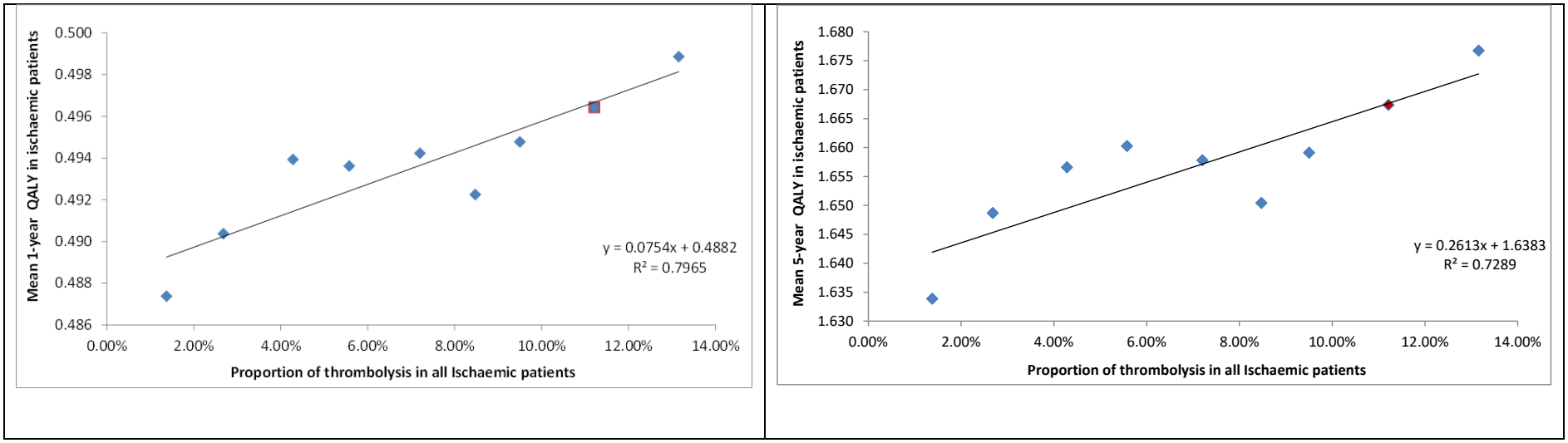
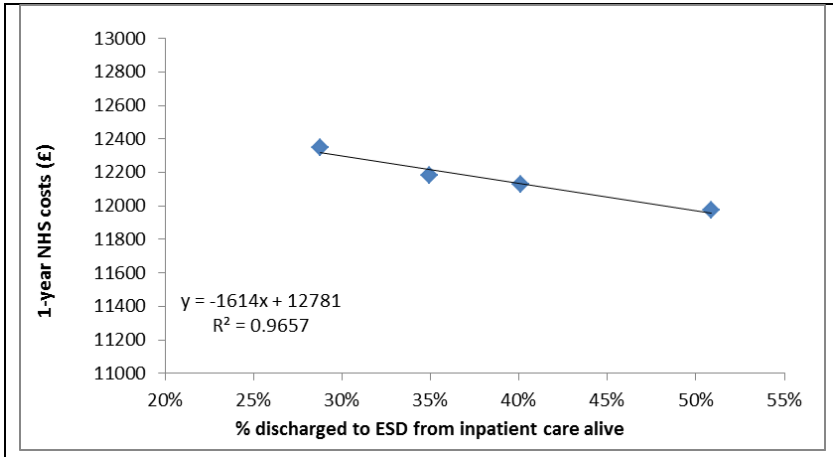
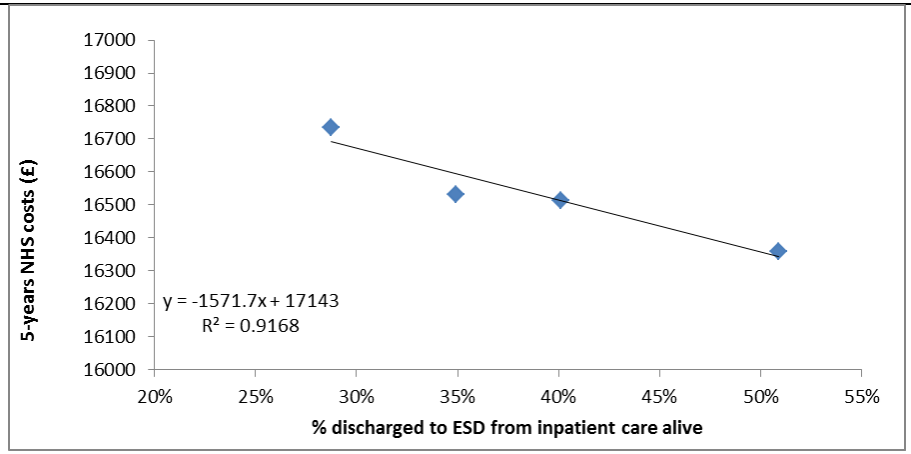
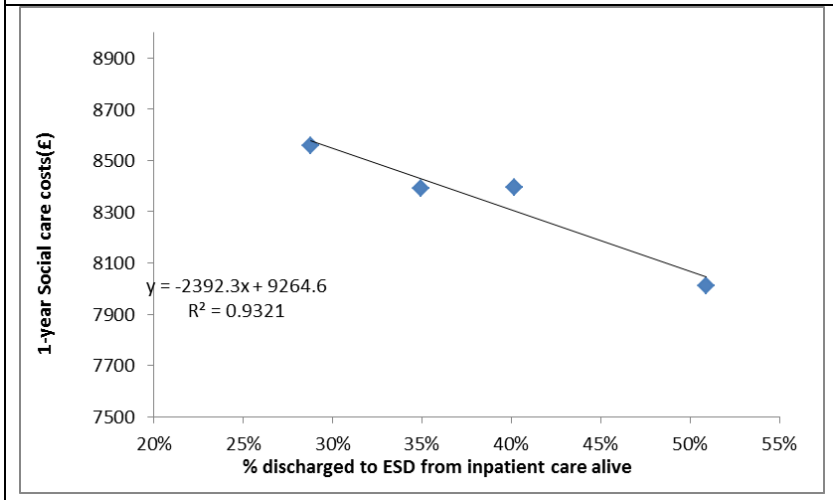
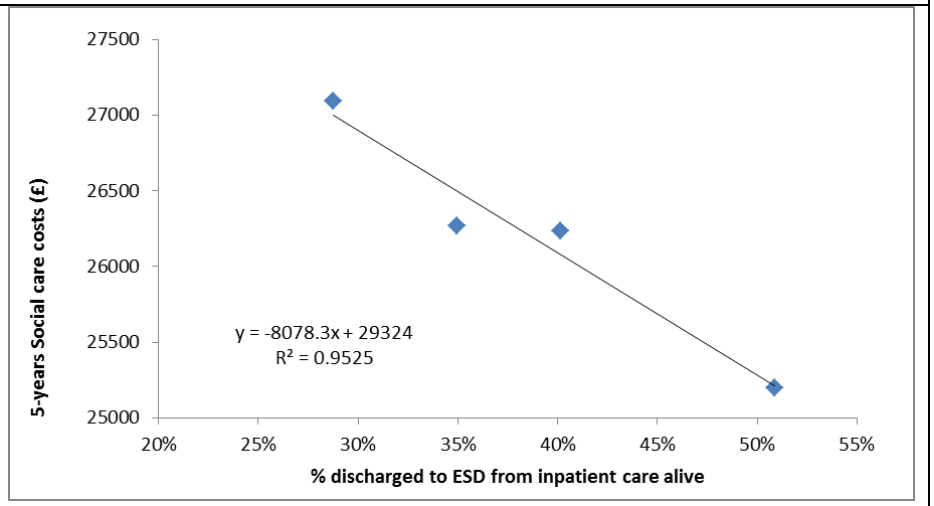


Figure A2 Results of thrombolysis scenarios with different proportions of patients who met the SSNAP minimum criteria get thrombolysed.


1-year NHS costs (£)
13000
12800
12600
12400
12200
12000
11800
11600
11400
11200
11000
y = -1614x + 12781
R² = 0.9657
20%
25%
30%
35%
40%
45%
50%
55%
% discharged to ESD from inpatient care alive


5-years NHS costs (£)
17000
16900
16800
16700
16600
16500
16400
16300
16200
16100
16000
y = -1571.7x + 17143
R² = 0.9168
20%
25%
30%
35%
40%
45%
50%
55%
% discharged to ESD from inpatient care alive


1-year Social care costs(£)
8900
8700
8500
8300
8100
7900
7700
7500
y = -2392.3x + 9264.6
R² = 0.9321
20%
25%
30%
35%
40%
45%
50%
55%
% discharged to ESD from inpatient care alive


5-years Social care costs (£)
27500
27000
26500
26000
25500
25000
y = -8078.3x + 29324
R² = 0.9525
20%
25%
30%
35%
40%
45%
50%
55%
% discharged to ESD from inpatient care alive

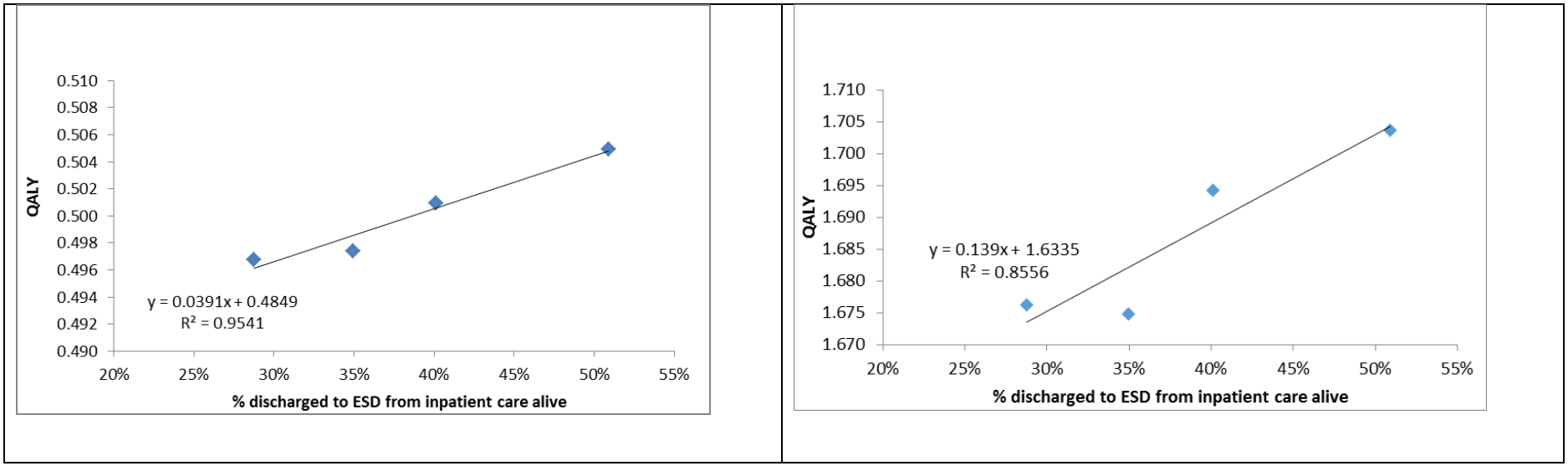


Figure A3 Results of ESD scenarios with different proportions of patients discharged to ESD.

Table A4. Scenario analysis results

		1-year			5-years		
		Mean NHS cost (£)	**Mean social cost (£)**	**Mean QALYs**	**Mean NHS cost (£)**	**Mean social cost (£)**	**Mean QALYs**
Base case	Baseline result	£13,452	£8,977	0.483	£17,963	£28,076	1.627
	PSA Mean	£13,528	£8,992	0.486	£18,009	£28,283	1.636
	SEM	£462	£244	0.007	£538	£871	0.025
	Upper 95% CL	£14,434	£9,470	0.500	£19,063	£29,990	1.685
	Lower 95% CL	£12,622	£8,514	0.472	£16,955	£26,576	1.587

		1-year			5-years		
		Mean NHS cost (£)	**Mean social cost (£)**	**Mean QALYs**	**Mean NHS cost (£)**	**Mean social cost (£)**	**Mean QALYs**
95% of patients meet SSNAP minimum criteria get thrombolysed	Baseline result	£13,278	£8,799	0.493	£17,729	£27,670	1.665
	PSA Mean	£13,379	£8,948	0.496	£17,918	£28,300	1.661
	SEM	£491	£348	0.011	£742	£2,839	0.108

		1-year			5-years		
		Mean NHS cost (£)	**Mean social cost (£)**	**Mean QALYs**	**Mean NHS cost (£)**	**Mean social cost (£)**	**Mean QALYs**
	Upper 95% CL	£14,342	£9,631	0.517	£19,371	£33,864	1.872
	Lower 95% CL	£12,416	£8,265	0.475	£16,464	£22,736	1.450
35% of patients discharged to ESD	Baseline result	£12,783	£8,444	0.498	£17,220	£26,429	1.678
	Mean	£12,859	£8,656	0.501	£17,346	£27,236	1.682
	SEM	£479	£367	0.011	£747	£2,847	0.115

		1-year			5-years		
		Mean NHS cost (£)	**Mean social cost (£)**	**Mean QALYs**	**Mean NHS cost (£)**	**Mean social cost (£)**	**Mean QALYs**
	Upper 95% CL	£13,798	£9,375	0.523	£18,810	£32,816	1.907
	Lower 95% CL	£11,920	£7,937	0.479	£15,882	£21,656	1.457

Table A5: Characteristics of the SSNAP cohort (01 April 2015 – 31 March 2016)

n	84184
Stroke type (n, %) Ischaemic Primary intracerebral haemorrhage Undetermined	 73318 10267
Female sex (n, %)	41451 (49%)
Pre-stroke modified Rankin score (n,%) 0 1 2 3 4 5	 70508 (55%) 12683(15%) 8970 (11%) 9974 (12%) 5158 (6%) 1485 (2%)
NIHSS on admission (Median, IQR)	5 (2-11)

Level of consciousness on admission (n,%)	
Alert	70508 (84%)
Responds to voice	8020 (10%)
Responds to pain	3375 (4%)
Unconscious	2281 (3%)

Additional References

A1. Personal Social Services Research Unit. URL accessed 25th September 2017 http://www.pssru.ac.uk/project-pages/unit-costs/

A2. National Audit Office, Progress in improving stroke care (2010). Report on the findings from our modelling of stroke care provision. URL accessed 23rd May 2017 https://www.nao.org.uk/report/department-of-health-progress-in-improving-stroke-care