A modelling tool for capacity planning in acute and community stroke services

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Supplementary Methods

Methodology for partial bed pooling

In order to conduct an analysis of partial bed pooling we used concepts from standard probability theory. For example, consider a scenario where there are 14 acute stroke unit beds and 12 rehabilitation beds. Two of the acute unit beds are pooled, i.e. they can be used by either acute or rehab patients. Under these circumstances we can say that:

- *Only acute patients will be delayed* if the current number of acute patients is >=14 and the current number of rehab patients is <12;

- *Only rehab patients will be delayed* if the current number of rehab patients is >=14 and the current number of acute patients is <12

- *Both acute and rehab patients will be delayed* if
  the current number of acute patients is >=14 and the current number of rehab patients is >=12;

  or the current number of acute patients is =13 and the current number of rehab patients is >=13;

  or the current number of acute patients is =12 and the current number of rehab patients is >=14.

Continuing to use the approximation that the ward occupancies are independent, standard probability rules give us that:

P(*acute delayed*) = P*(only acute delayed*)+P(*both acute and rehab delayed*)

=P(acute>=14) x P(rehab<12) + P(acute>=14) x P(rehab>=12) + P(acute=13) x P(rehab>=13) + P(acute=12) x P(rehab>=14)

And

P(*rehab delayed*) = P(*only rehab delayed*)+P(*both acute and rehab delayed*)

=P(acute<14) x P(rehab>=12) + P(acute>=14) x P(rehab>=12) + P(acute=13) x P(rehab>=13) + P(acute=12) x P(rehab>=14)

All of these individual probabilities are provided by the simulation model.

Supplementary Model parameters

This supplementary appendix provides the details of model parameters. These parameters replicate the base scenario, i.e. with current levels of demand. Scenarios investigating increased demand multiply the mean arrivals rates (supplied in main text) by the appropriate factor. To exclude a particular patient group the mean inter-arrival time for that group is multiplied by a large number such that no arrivals will occur in the modelled time horizon.

Table S2: Acute Length of stay parameters

				Percentiles			
	Mean	**Stdev**	**Median**	**5th**	**95th**	**25th**	**75th**
Strokes – No ESD	7.4	8.6	4.0	1.0	23.0	2.0	9.0
Strokes – ESD	4.6	4.8	3.0	1.0	11.0	2.0	6.0
Stroke – Mortality	7.0	8.7	4.0	0.5	22.0	2.0	8.0
TIA	1.8	2.3	1.0	0.5	4.0	1.0	2.0
Complex-neurological	4.0	5.0	2.0	0.5	13.6	1.0	5.0
Other	3.8	5.2	2.0	0.5	12.1	1.0	5.0

All distributions modelled as lognormal.

Table S2: Rehabilitation length of stay parameters

				Percentiles			
	Mean	**Stdev**	**Median**	**5th**	**95th**	**25th**	**75th**
Strokes - No ESD	28.4	27.2	20.0	3.0	86.9	9.0	38.0
Strokes - ESD	30.3	23.1	22.0	6.0	78.0	13.8	44.0
Complex-neurological	27.6	28.4	18.0	2.5	88.5	8.0	36.0
Other	16.1	14.1	11.5	1.0	43.0	5.8	24.3
TIA	18.7	23.5	11.0	1.1	41.6	5.5	28.0

All distributions modelled as lognormal.

Table S3: Patient transfer matrix from acute stroke unit

Destination	**Stroke**	**TIA**	**Complex-neurological**	**Other**
Rehab	24%	1%	11%	5%
ESD	13%	1%	5%	10%
Other*	63%	98%	84%	85%

*Other includes any destination other than rehab or ESD. For example own home, care home or mortality.

Table S4: Patient transfer matrix from inpatient rehabilitation ward

	Stroke	**TIA**	**Complex-neurological**	**Other**
ESD	40%	0%	9%	13%
Other	60%	100%	91%	88%

*Other includes any destination other than ESD. This will include the small proportion of patients that 'bounce back' to the acute ward.

Supplementary Results

Effect of complex neurological patients on flow

Table 1: Likelihood of delay. Current admissions versus No Complex neurological patients

	Current admissions		No Complex neurological	
No. acute beds	**p(delay)***	**1 in every n patients delayed**	**p(delay)***	**1 in every n patients delayed**
10	0.14	7	0.09	11
11	0.09	11	0.05	18
12	0.06	16	0.03	32
13	0.04	28	0.02	55
14	0.02	50	0.01	100
15	0.01	90	0.01	95
No. rehab beds				
12	0.11	9	0.03	17
13	0.08	13	0.02	30
14	0.05	20	0.01	56
15	0.03	33	0.01	110
16	0.02	50	0.00	214

*shown to 2 decimal places

Effect of ring fencing stroke beds on flow

Table 3: Likelihood of delay. Current admissions versus ring fenced acute stroke beds

	Current admissions		Ring fenced acute beds	
No. acute beds	**p(delay)***	**1 in every n patients delayed**	**p(delay)***	**1 in every n patients delayed**
10	0.14	7	0.08	12
11	0.09	11	0.05	19
12	0.06	16	0.03	32
13	0.04	28	0.02	57
14	0.02	50	0.01	113
15	0.01	90	0.00	240

*shown to 2 decimal places