Hub and Spoke stroke network in the Veneto Region: a retrospective study investigating the effectiveness of the stroke pathway and trends over time

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Stroke Unit admission has a pivotal role in reducing mortality and dependency in stroke patients: the need to organize and monitor stroke networks has become an increasingly essential aspect of stroke care. The **purpose** of this study was to evaluate the characteristics of the stroke pathway adopted in the Veneto region in order to assess how effectively the system reduces mortality and hospital stay and to analyse trends over time.

Methods: a retrospective study of stroke patients admitted to hospitals in the Veneto region from 2007 to 2015 (regional archive of hospital discharge records at public and private hospitals, diagnoses coded according to the ICD9-CM, codes 433x1 (occlusion and stenosis of precerebral arteries with cerebral infarction) and 434x1 (occlusion of cerebral arteries with cerebral infarction).

RESULTS (see tables): 61,062 stroke patients, more frequently female, females older than males, had higher intrahospital mortality and lower probability undergoing of systemic thrombolysis. Patients admitted to facilities with a level 2 SU were twice as likely to undergo thrombolytic treatment compared to those admitted to facilities with a level 1, and had a lower intrahospital mortality rate. 2007-2015 thrombolytic treatments increased in both level 1 and 2 SUs, as did number of patients admitted to Neurology wards and to facilities with an SU.

DISCUSSION AND CONCLUSIONS: in the Veneto region, the percenytage of stroke patients admitted to a Neurology ward has increased over years and so has the number of patients admitted to hospitals with an SU. The increase in the proportion of both SU admissions and thrombolytic treatments demonstrates the effectiveness of the regional hub and spoke organization model.

The implementation of highly specialized facilities seems an efficient strategy in improving stroke care.

The role of the observed sex bias in stroke treatment and outcome needs to be explored.

Table 1 Veneto region hospitals from 2007 to 2015: stroke distribution by sex and ICD9-CM classification (direct age-adjusted; reference population: discharged stroke patients 2011). LOS length of stay, 433x1 occlusion and stenosis of precerebral arteries, 434x1 occlusion of cerebral arteries

	ICD9-CM	No.	Percent	LOS (mean \pm SD)	Age (mean \pm SD)	Death %	OR	95% CI	p
Strokes	433.x1	6905	11.3	12.1 ± 15.8	73.1 ± 11.8	5.1	1		
	434.x1	54,157	88.7	13.4 ± 11.9	76.8 ± 12.9	11.4	2.38	2.13-2.66	< 0.05
	Total	61,062	100.0	13.2 ± 12.4	76.3 ± 12.8	10.7		_	
Sex	Male	29,648	48.6	12.6 ± 12.7	72.5 ± 12.7	8.2	1		
	Female	31,414	51.4	13.8 ± 12.2	79.9 ± 11.9	12.9	1.46	1.40-1.59	< 0.05
	Total	61,062	100.0	13.2 ± 12.4	76.3 ± 12.8	10.7		_	
Male patients	433.x1	4467	15.1	11.6 ± 14.3	71.4 ± 11.4	3.9	1		
	434.x1	25,181	84.9	12.8 ± 12.4	72.7 ± 12.9	9.0	2.41	2.02-2.84	< 0.05
Female patients	433.x1	2438	7.8	12.9 ± 18.2	76.2 ± 11.9	7.3	1		
	434.x1	28,976	92.2	13.9 ± 11.5	80.2 ± 11.8	13.4	1.86	1.58-2.15	< 0.05

Table 2 Veneto region hospitals from 2007 to 2015: stroke distribution by sex and thrombolytic treatment (direct age-adjusted; reference population: discharged stroke patients 2011). *LOS* length of stay

	Thrombolytic treatment	No.	Percent	LOS (mean \pm SD)	Age (mean \pm SD)	Death %	OR	95% CI	p
Strokes	Yes	3684	6.0	12.5 ± 9.9	70.5 ± 12.7	6.9	0.61	0.53-0.69	< 0.05
	Non	57,378	94	13.3 ± 12.6	76.7 ± 12.7	10.9	1		
	Total	61,062	100	13.2 ± 12.4	76.3 ± 12.8	10.7	_		
Male patients	Yes	2012	6.8	12.3 ± 9.8	68.4 ± 12.4	5.9	0.68	0.56-0.83	< 0.05
	Non	27,636	93	12.7 ± 12.9	72.8 ± 12.6	8.4	1		
Female patients	Yes	1672	5.3	12.9 ± 10.1	73.1 ± 12.4	8.1	0.58	0.48-0.69	< 0.05
	Non	29,742	95	13.8 ± 12.3	80.3 ± 11.7	13.2	1		

Table 4 Veneto region hospitals from 2007 to 2015: trend in thrombolytic treatment from 2007 to 2015 by healthcare service characteristics; change in healthcare access route taken by stroke patients and the care type to which they are admitted

	Thromb	oolysis		Healthcare access and services						
	N %		Age (mean ± SD)	Death %	Level 1 SU (%)	Level 2 SU (%)	ER access (%)	SU hospital (%)	Neurology ward (%)	
2007	59	0.9	67.5 ± 14.2	5.1	0.4	2.4	61	70	58	
2008	107	1.7	71.2 ± 12.9	8.4	0.9	4.2	62	72	65	
2009	174	2.6	69.8 ± 11.6	6.3	1.7	6.2	62	71	60	
2010	247	3.6	67.5 ± 12.1	7.3	2.7	7.9	59	75	60	
2011	338	5.1	68.3 ± 12.0	6.8	4.4	10.1	60	77	61	
2012	452	6.7	69.6 ± 12.0	6.9	6.0	12.3	63	78	61	
2013	579	8.4	69.3 ± 12.4	6.7	7.3	15.7	64	79	62	
2014	846	12.0	70.0 ± 12.6	5.7	12.7	18.3	66	80	64	
2015	882	12.2	72.7 ± 12.8	8.2	11.9	18.8	63	82	66	
Total	3684	6.0	70.5 ± 12.7	6.9	5.7	11.0	62	76	62	

Table 3 Veneto region hospitals from 2007 to 2015: thrombolysis distribution by healthcare access route and characteristics of healthcare service (direct age-adjusted; reference population: 2011). LOS length of stay, referral direct referral from primary care, transfer transfer from other hospital, ER emergency room access, SU stroke unit

		No.	Percent	LOS (mean \pm SD)	Age (mean \pm SD)	Thrombolytic treatment	Percent	OR	95% CI	p	Death %	OR	95% CI	p
Neurology ward	Yes	37,904	62	12.5 ± 9.6	73.8 ± 12.9	3684	9.7	_	_	_	7.9	0.5	0.44-0.56	< 0.05
Other	Non	23,158	38	14.5 ± 16	80.5 ± 11.5	_	_	_	_	_	14.7	1		
Access	referral	19,958	33	12.9 ± 14.2	76.2 ± 13	705	3.5	0.45	0.41 - 0.49	< 0.05	9.2	0.82	0.77-0.87	< 0.05
	transfer	3035	5	20.5 ± 23.2	76.1 ± 14.2	106	3.5	0.44	0.36-0.54	< 0.05	16.1	1.56	1.40-1.72	< 0.05
	ER	38,069	62	12.9 ± 9.8	76.4 ± 12.6	2873	7.5	1			11.0	1		
					H	Healthcare services								
Level 2 SU	2	19,216	31	12.8 ± 10.9	74.1 ± 13.9	2122	11.0	2.05	1.91-2.19	< 0.05	10.0	0.75	0.68-0.84	< 0.05
Level 1 SU	1	27,304	45	12.4 ± 9.8	75.8 ± 12.5	1562	5.7	1			12.8	1		
Non SU	0	14,542	24	15.3 ± 17.5	80.3 ± 10.9		0	_	_	_	15.0	1.72	1.61-1.82	< 0.05

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