

The role of clinical pathway on the outcomes of ischemic stroke patients at Bethesda Hospital Yogyakarta

Francisca Diana A^{1*}, Iwan Dwiprahasto², Rizaldy Pinzon³

¹Department of Pharmacology and Theraphy, Faculty of Medicine, Universitas Palangkaraya, Central Kalimantan, ²Department of Pharmacology and Therapy, Faculty of Medicine, Universitas Gadjah Mada, Yogyakarta, ³Department of Neurology, Bethesda Hospital, Yogyakarta, Indonesia

ABSTRACT

Stroke becomes world health problem all over the world because it is the causal factor of high mortality and disability. Good and well-organized process of healthcare service will improve the outcome of the patients with stroke. Clinical pathway may be used as clear standard to help reduce unnecessary variations of medical treatment and measure. The study aimed at finding out the correlation between the use of clinical pathway and the outcome of the patients with ischemic stroke in Bethesda Hospital Yogyakarta. It was an observational and analytic study with cohort restorative study design. The author compared the outcomes of acute ischemic stroke between the group with clinical pathway and the group without the clinical pathway. Data was collected using consecutive sampling from the electronic registry and medical record data of the patients from January 1st, 2011 to December 31st, 2011. It was conducted to 124 patients with ischemic stroke assigned to two groups (the first groups of 62 patients with clinical pathway and the second groups of 62 patients without clinical pathway). The basic characteristics of the two groups were the same. The results of the analysis showed that there was a significant decrease in the incidence of complication and a significant increase in the use of antiplatelete drugs, antidiabetic drugs and statin as secondary preventive measure of the recurrent stroke. There was not any significant difference in the duration of the hospitalized healthcare, the financing and the mortality between the two observation groups. In conclusion, the study indicated that the use of the clinical pathway in the stroke treatment improves the outcome of the patients with stroke and that it is necessary to conduct further study to evaluate the effectiveness of the clinical pathway in improving the outcome of the patients with bigger number of the subjects and longer period of time.

ABSTRAK

Stroke menjadi masalah kesehatan utama di seluruh dunia, karena menyebabkan angka kematian dan kecacatan yang tinggi. Proses pelayanan yang baik yaitu lebih terorganisir akan memperbaiki luaran pasien stroke. *Clinical pathway* dapat dimanfaatkan sebagai standar yang jelas untuk membantu mengurangi variasi yang tidak perlu dari perawatan dan tindakan medis. Tujuan dari penelitian ini adalah untuk mengetahui hubungan pemberlakuan *clinical pathway* dengan luaran pasien stroke iskemik di rumah sakit Bethesda, Yogyakarta. Penelitian ini merupakan penelitian observasional analitik dengan rancangan penelitian *cohort retrospective*. Peneliti membandingkan luaran stroke iskemik akut antara kelompok yang menggunakan *clinical pathway* dengan kelompok yang tidak. Data diambil dengan *consecutive sampling* dari data register stroke elektronik pasien dan rekam medis antara 1 Januari 2011 sampai dengan 31 Desember 2011. Penelitian diperoleh dari 124 pasien stroke iskemik (62 pasien dengan *clinical pathway* dan 62 pasien tanpa *clinical pathway*). Karakteristik dasar dari kedua kelompok sama. Hasil analisis menunjukkan bahwa ada penurunan angka kejadian komplikasi dan peningkatan penggunaan obat antiplatelet, antidiabetes dan statin sebagai tindakan pencegahan sekunder agar stroke tidak berulang. Tidak ada perbedaan bermakna dalam hal lama

* corresponding author: indrihardani@yahoo.com

rawat inap, pembiayaan dan kematian diantara dua kelompok pengamatan. Penelitian ini menunjukkan bahwa pemberlakuan *clinical pathway* pada pelayan stroke memperbaiki luaran pasien stroke. Penelitian lebih lanjut sangat diperlukan untuk menilai efektivitas *clinical pathway* terhadap luaran pasien dengan jumlah subyek yang lebih banyak dan jangka waktu yang lebih lama.

Keywords: clinical pathway - stroke - outcomes

INTRODUCTION

Stroke becomes main health problem all over the world because it is the causal factor of high mortality and disability. In Indonesia, it ranks the highest in causing death, followed by diabetes mellitus and hypertension in both rural and urban areas.¹ Good and well-organized healthcare service process such as the one in the stroke unit will improve the outcome of the patients with stroke because it decreases mortality risk in a year.² It is possible that multidisciplinary healthcare service in the stroke unit result in various medical measures prone to malpractices.

Clinical pathway may be used as clear standard to help reduce unnecessary variations. The clinical pathway or care pathway or critical pathway is a healthcare service planning concept that aims at improving the efficiency of the healthcare service organization for the patients with stroke in which the healthcare service is delivered in multidisciplinary manner on scientific evidence with medical care standard.^{3,4}

The clinical pathway to handle the patients with stroke in Bethesda Hospital, Yogyakarta has been introduced since the beginning of 2008. It was in check list form for easier use, memorizing and evaluation. An initial study by Pinzon *et al.*⁵ that have examined the effectiveness of the use of the clinical pathway in the management of 167 patients with stroke in Bethesda Hospital, Yogyakarta showed that the use of the clinical pathway significantly improved the indicators of the process of the healthcare service for the patients with stroke. Therefore, the study was conducted to find out the

effectiveness of the use of the clinical pathway in improving the outcome of the patients with ischemic stroke in Bethesda Hospital, Yogyakarta.

MATERIALS AND METHODS

Protocol of the study

It was an observational and analytic study with retrospective cohort design to compare the outcome of the patients in two observation groups. Data was collected using consecutive sampling technique from the electronic registry and medical record data from January 1st, 2001 to December 31st, 2011. The patients were classified into case group of ischemic stroke and got the first stroke used clinical pathway, had complete registry and medical record data and also complete observation. They were assigned to control group if they met the inclusion and exclusion criteria in the case group, but did not use the clinical pathway. They were excluded from the study if they experienced the variants such as forced discharge, changing hospital, cared in ICU and requiring decompression operation. The protocol of the study has been approved by the Medical and Health Research Ethics Committee, Universitas Gadjah Mada, Yogyakarta.

The outcome of the study included the use of drugs, mortality, complication incidence, functional status, hospitalization duration, and total healthcare cost. The functional status was evaluated using modified ranking scale (MRS) that was made when the patients were discharged from the hospital. The outcomes in dichotomous form were good (MRS < 2) and bad (MRS > 2).

Statistical analysis

The results of this study were analyzed using data processing software. For comparisons of dichotomous outcomes, the relative risk (RR) with their 95% confident interval (CI) was calculated. Calculated the exact p value was used Yates-corrected chi-square test and Fisher's exact test. The outcome with continuous data was first checked the data for normality of distribution. For normally distributed data, comparison of means was performed using and independent t-test; otherwise, the non parametric Mann-Whitney U test was used. For outcome

measures that could be influenced by case mix, the data was adjusted using logistic regression.

RESULTS

Based on the registry data, there were 406 patients with ischemic stroke and got the first seizure. They were assigned to 2 groups, which were control group (n=250) of those without clinical pathway in the treatment and case group (n=156) of those with clinical pathway. The study data selection process was illustrated in the FIGURE 1.

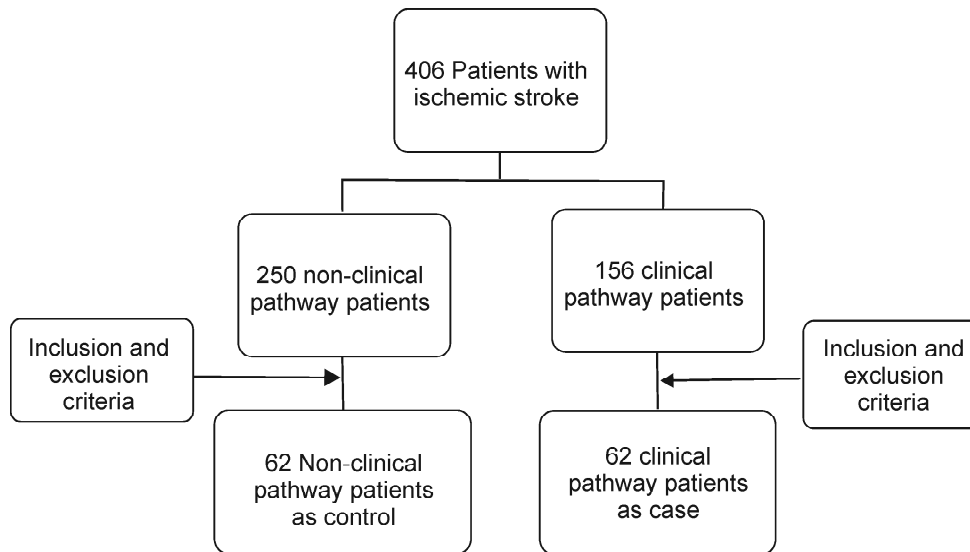


FIGURE 1. The flowchart of the study data selection process

Based on the data summarized in TABLE 1, it could be concluded that the basic characteristics as age, sex, clinical symptom, comorbid disease,

GCS score, Charlson index, and the care ward of the two cohorts were equal.

TABLE 1. Basic characteristics of study subjects

Characteristics	Total n=124	Jumlah (%)		p
		Clinical pathway (n=62) n (%)	Non Clinical pathway (n=62) n (%)	
Sex				
• Man	57(46)	24 (38.7)	33 (53.2)	0.105
• Woman	67(54)	38 (61.3)	29 (46.8)	
Age				
• ≥ 55 year	85 (68.5)	44 (71)	41 (66.1)	0.562
• < 55 year	39 (31.5)	18 (29)	21 (33.9)	
Onset				
• ≤ 3 hour	18 (14.5)	9 (14.5)	9 (14.5)	1
• > 3hour	106 (85.5)	53 (85.5)	53 (85.5)	
Decrease in consciousness				
• No	115 (92.7)	56 (90.3)	59 (95.2)	0.491
• Yes	9 (7.3)	6 (9.7)	3 (4.8)	
Afasia				
• No	112 (90.3)	55 (88.7)	57 (91.9)	0.544
• Yes	12(9.7)	7 (11.3)	5 (8.1)	
Movement disorders				
• No	20 (16.1)	8 (12.9)	12 (19.4)	0.329
• Yes	104(83.9)	54 (87.1)	50 (80.6)	
Tingling				
• No	115 (92.7)	58 (93.5)	57 (91.9)	1
• Yes	9(7.3)	4 (6.5)	5 (8.1)	
Vertigo				
• No	118 (95.2)	60 (96.8)	58 (93.5)	0.680
• Yes	6(4.8)	2 (3.2)	4 (6.5)	
Pelo				
• No	76 (61.3)	36 (58.1)	40 (64.5)	0.461
• Yes	48(38.7)	26 (41.9)	22 (35.5)	
Asymmetrical face				
• No	114 (91.9)	57 (91.9)	57 (91.9)	1
• Yes	10(8.1)	5 (8.1)	5 (8.1)	
Atrial Fibrillation				
• No	116 (93.5)	55 (88.7)	61 (98.4)	0.062
• Yes	8 (6.5)	7 (11.3)	1 (1.6)	
Hypertension				
• No	32 (25.8)	19 (59.4)	13 (40.6)	0.218
• Yes	92 (74.2)	43 (46.7)	49 (53.3)	
Diabetes Mellitus				
• No	83 (66.9)	40 (64.5)	43 (69.4)	0.567
• Yes	41(33.1)	22 (35.5)	19 (30.6)	
Dislipidemia				
• No	33 (26.6)	16 (25.8)	17 (27.4)	0.839
• Yes	91 (73.4)	46 (74.2)	45 (72.6)	
Charlson Index				
• < 2	89 (71.8)	42 (67.7)	47 (75.8)	0.318
• ≥ 2	35 (28.2)	20 (32.3)	15 (24.2)	

TABLE 1. Basic characteristics of study subjects (continued)

Characteristics	Total n=124	Jumlah (%)		p
		Clinical pathway (n=62) n (%)	Non Clinical pathway (n=62) n (%)	
GCS				
• < 8	8 (6.5)	4 (6.5)	4 (6.5)	1
• ≥ 8	116 (93.5)	58 (93.5)	58 (93.5)	
Class				
• Major	4 (3.2)	1 (1.6)	3 (4.8)	0.824
• Class I	31 (25)	13 (21)	18 (29)	
• Class II	45 (36.3)	28 (45.2)	17 (27.4)	
• Class III	44 (35.5)	20 (32.3)	24 (38.7)	

The secondary prevention of the ischemic stroke was conducted using drugs such as antiplatelete, anticoagulant, antidiabetes, statin, and antihypertension to handle the risk factor. Additionally,

the use of vitamins and neuroprotectors was also analyzed in the study because they were often used. The results of the analysis of the use of each of the drugs were summarized in TABLE 2.

TABLE 2. Bivariate analysis of factors of drug use

Characteristics	Total (%)		p	Relative risk (95% CI)
	Clinical pathway (n=62) n (%)	Non Clinical pathway (n=62) n (%)		
Antiplatelete				
• Yes	62(100)	56 (90.3)	0.028 ^b	1.11 (1.02 – 1.20) Ref
• No	0	6 (9.7)		
Anticoagulant				
• Yes	26 (41.9)	23 (37.1)	0.582 ^b	1.13 (0.73 – 1.75) Ref
• No	36 (58.1)	39 (62.9)		
Anti diabetic				
• Yes	22 (35.5)	11 (17.7)	0.025 ^a	2 (1.06 – 3.76) Ref
• No	40 (64.5)	51 (82.3)		
Statin				
• Yes	47 (75.8)	28 (45.2)	0.000 ^a	1.68 (1.23 – 2.28) Ref
• No	15 (24.2)	34 (54.8)		
Antihypertensive				
• Yes	24 (38.7)	25 (40.3)	0.854 ^a	1.68 (1.23 – 2.28) Ref
• No	38 (61.3)	37 (59.7)		
Vitamin				
• Yes	19 (30.6)	30 (48.4)	0.043 ^a	0.63 (0.40 – 0.99) Ref
• No	43 (69.4)	32 (51.6)		
Neuroprotective				
• Yes	59 (95.2)	53 (85.5)	0.068 ^a	1.11 (0.99 – 1.25) Ref
• No	3 (4.8)	9 (14.5)		

Note : Ref = Reference; ^a tested by Pearson Chi-Square; ^b tested by Fisher's Exact Test; CI = Confident Interval

The results of the analysis in TABLE 2 showed that the use of the clinical pathway increased the use of antiplatelete (100% vs. 90.3%, $p= 0.028$), antidiabetes (35.5% vs. 17.7%, $p=0.025$) and statin (75.8% vs. 45.2%, $p= 0.000$) as compared to the non-clinical pathway group, while there was not any significant difference in the use of anticoagulant and antihypertension between the two observation groups. TABLE 2 also indicated that the use of vitamins was lower in the clinical pathway group than in the non-clinical pathway, while there was not any

significant difference in the use of the neuroprotectors between the two groups.

TABLE 3 showed that the use of the clinical pathway was able to decrease the complication incidence in the patients with stroke as compared to the control group (3.2 % vs 14.5%, $p = 0.027$). However, there was not any significant difference in the mortality (6.5% vs 1.6%, $p = 0.365$), functional status (use of the clinical pathway (25.8% vs 40.3%, $p = 0.086$) between the two observation groups.

TABLE 3. Bivariate analysis of the outcome

Outcome	Total (%)		p	Relative risk (95% CI)
	Clinical pathway (n=62) n (%)	Non Clinical pathway (n=62) n (%)		
Death				
• Yes	4 (6.5)	1 (1.6)	0.365 ^a	4.00 (0.46 – 34.78) Ref
• No	58 (93.5)	61 (98.4)		
Complication				
• Yes	2(3.2)	9 (14.5)	0.027 ^a	0.22 (0.05 – 0.99) Ref
• No	60 (96.8)	53 (85.5)		
MRS Score				
• < 2	16 (25.8)	25 (40.3)	0.086 ^a	0.64 (0.38 – 1.08) Ref
• = 2	46 (74.2)	37 (59.7)		

Note : Ref = Reference; ^a tested by Pearson Chi-Square; ^b tested by Fisher's Exact Test; CI=Confident Interval

No significant difference in the hospitalization duration between the two cohorts was observed. Similarly, there was also not any significant difference in the total cost for the patients during the hospitalization between the two groups though

the mean costs of the clinical pathway was lower than the control group (i.e., the mean difference was 492.136; 95% Confident Interval -3.147.457 – 163.185).

TABLE 4. Bivariate analysis of clinical pathway implementation on length of stay

Clinical pathway	Length of stay (SD)	p	Mean difference	95% Confidence Interval
• Yes	6.08 (3.16)	0.502	-0.435	-1.176 – 0.845 Ref
• No	6.52 (3.99)			

Note : Ref = Reference

TABLE 5. Bivariate analysis to total cost the implementation of clinical pathways

Clinical pathway	Total cost mean (SD)	p	Mean difference	95% Confidence Interval
• Yes	6.576.026.45 (3.665.950.03)	0.077	-1.492.136.25	-3.147.457.78 – 163.185.28
• No	8.068.162.70 (5.469.191.53)			

Note : Ref = Reference

DISCUSSION

It was observed in the study that the use of the clinical pathway increased the use of antiplatelete, which was higher than the subjects without any clinical pathway in their treatment process. The result was similar to that of the study conducted by Wolf *et al.*⁶ However, the result is different from that of the study conducted by Tylor *et al.*⁷ The use of the clinical pathway in the treatment of the patients with stroke increased the use of antidiabetes and statin as indicated and compared to those without any clinical pathway, but the study conducted by Taylor *et al.*⁷ indicated the contrary.

Bivariate analysis of the risk factor of the use of anticoagulant in the patients with ischemic stroke and atrial fibrillation showed that the use of the clinical pathway could not increase the use of anticoagulant as compared to the group without any clinical pathway. It is consistent with the study conducted by Taylor *et al.*⁷ Also, the results of the study have not been able to proof that the use of the clinical pathway could increase the use of antihypertension. It is consistent with the study conducted by Taylor *et al.*⁷ and Kwan *et al.*⁸ though after the use of the pathway there were more patients found to use the antyhypertension drugs.

The use of the clinical pathway could increase the rationality of the use of the drugs such as antiplatelete, antidiabetes and statin in the patients with stroke because the function of the clinical pathway was as reminder and it contained the

summary of the data necessary for physicians and paramedics responsible for the treatment of the patients.^{4,9,10}

The use of vitamins and neuroprotectors in the study was analyzed because they were often used in the treatment of the patients with stroke. The results of the study indicated that the use of the vitamins in the case group was lower than the control group. The neuroprotectors used in the study were citicoline and piracetam. However, they were not analyzed separately. There was not any significant difference in the use of the neuroprotectors between the two cohorts. There was not any improvement of the functional status and not any decrease in the mortality between the two groups. It is consistent with some studies suggesting that the use of the neuroprotectors did not improve the functional status of the patients with stroke.^{11,12}

The results of the study showed that there was not any significant difference in the mortality between the two groups. It is similar to the finding of the study conducted by Taylor *et al.*⁷ and Kwan *et al.*⁸ The influencing factor of the mortality indicated in the study was the GCS score < 8. There were more patients with the GCS < 8 who died because of organ malfunction that gave them only small life expectancy.

The study showed that the use of the clinical pathway could decrease the complication incidence in the patients with stroke. It was consistent with the study conducted by Kwan *et*

*al.*⁸ indicating that there were smaller number of the patients in the group with the pathway were affected by urethra infection than the patients without the pathway. However, there were more complications resulting from the use of antiplatelet and anticoagulant that caused the hemorrhage of digestive line that mostly affected the groups of the patients without any clinical pathway as compared to the group with the clinical pathway.

The use of statin was more for the protection against complication than the subjects who did not use the statin. It protected the patients against the hemorrhage of the digestive line because it increased the production of prostacyclin and prostaglandin that function to protect the digestive line wall.¹³

The symptom of decreasing consciousness was proven to increase the risk of complication incidence. Therefore, the patients experiencing the decreasing consciousness were in need for special treatment such as the insertion of urinary catheter, the use of NGT or tracheostomy that could increase the complication incidence, prolong the hospitalization period and influence the functional status of the affected patients.^{14,15}

The use of the clinical pathway in the study did not show any effectiveness in improving the functionality of the patients when they were discharged from the hospital. The result is similar that of the study conducted by Taylor *et al.*⁷, although it is different with that of Sulch *et al.*¹⁶

Diabetes mellitus became the risk factor of the decrease in the functionality of the patients because hyperglycemia would cause the lactic acidosis, the increase in excitatory neurotransmitter concentration and the increase in intracellular calcium that caused neurocellular damage. Such hyperglycemia condition would aggravate neurological deficit and increase mortality of both the patients with diabetes mellitus and those with reactive hyperglycemia.^{17,18}

The results of the study showed that there was not any difference in the hospitalization duration between the clinical pathway group and the non-

clinical pathway group. They were similar to the study conducted by Taylor *et al.*⁷ They were different from the study conducted by Van Exel *et al.*¹⁹ suggesting that the integrated healthcare service was able to shorten the hospitalization duration of the patients with the clinical pathway as compared to the control group. The presence of the complication could prolong the hospitalization duration because the patients experiencing the complication were in need for more intensive healthcare than those without the complication that required longer hospitalization.⁸

The results of bivariate analysis of the financing in the study have not proven that the use of the clinical pathway in the healthcare of the patients with stroke was able to decrease the cost necessary to incur by the patients with the clinical pathway than the control. Although the mean cost necessary to incur by the patients with the clinical pathway was lower than that necessary to incur by the patients without any clinical pathway, there was statistically not any significant difference between the two groups during the hospitalization. This is not consistent with the study conducted by Van Exel *et al.*¹⁹ indicating that the financing of the treatment of the patients with stroke was cheaper in the group served using integrated healthcare service. It was expected that it related to the decrease in the hospitalization duration, which resulted in the significant reduction of the financing of the treatment of the patients with the stroke.

The presence of the complication could increase the financing by the patients and it was not the case of the patients without any complication. It was because the patients with the complication required more intensive healthcare and hence it increased the cost. Additionally, the patients were also in need for longer hospitalization period. Moreover, they had to consume more anticoagulant drugs and the anticoagulant drugs that were used subcutaneously were relatively expensive and it finally caused more financing by the patients.

The study has not managed to find the evidence that the use of the clinical pathway could decrease the mortality and had significant impact on the outcomes such as disabilities and the use of drugs. It might result from the small number of samples and the randomized sampling technique that could cause bias and the unavoidable presence of the confounding factors that could have significant impact on the validity of the results. Additionally, the study was conducted simultaneously by the same physicians and paramedics with the same management of the two groups of patients. Also, the important thing was that the condition of the patients with stroke was very complex and it could have significant impact on the outcome.

CONCLUSION

The study indicated that the use of the clinical pathway in the treatment of the patients with stroke was able to decrease complication. However, there was not any significant difference in the mortality, the functional status, the hospitalization duration, and the financing between the two observation groups.

The use of the clinical pathway could increase the use of antiplatelete, antidiabetes, and statin as the prevention measure of secondary stroke. However, there was not any significant difference in the use of antihypertension and anticoagulant.

ACKNOWLEDGEMENTS

This research cannot be separated from the support of many people, both directly and indirectly. Authors especially thank the Director of Bethesda Hospital Yogyakarta who has given the author confidence and permission to do research, as well as to all those who cannot be mentioned one by one, those who have helped the implementation of this research.

REFERENCES

1. Anonim. Laporan hasil riset kesehatan dasar (Riskesdas) nasional 2007. Jakarta: Badan Penelitian dan Pengembangan Kesehatan, 2008.
2. Seenan P, Long M, Longhorne L. Stroke units in their natural habitat: systematic review of observational studies. *Stroke*. 2007; 38(6):1886-92.
3. Middleton S, Barnett J, Reeves D. What is an integrated care pathway? *hayward medical communication*. 2001.
4. National Stroke Foundation. Clinical guideline for stroke management 2010. Melbourne: National Health and Medical Research Council, 2010.
5. Pinzon R, Sugianto, Asanti L, Widyo K. Peran clinical pathway dalam memperbaiki proses pelayanan stroke. *Majalah Kedokteran Damianus*. 2009; 8:79-82.
6. Wolff AM, Taylor SA, McCabe JF. Using checklists and reminders in clinical pathway to improve hospital inpatient care. *Med J Aust* 2004; 181(8):428-31.
7. Taylor WJ, Wong A, Siegert RJ, McNaughton HK. Effectiveness of a clinical pathway for acute stroke care in a district general hospital: an audit. *BMC Health Serv Res* 2006; 6:16.
8. Kwan J, Hand P, Dennis M, Sandercock P. Effect of introducing an integrated care pathway in an acute stroke unit. *Age Ageing* 2004; 33(4):362-7.
9. ElBaz N, Middel B, van Dijk JP, Oosterhof A, Boonstra PW, Reijneveld SA. Are the outcomes of clinical pathways evidence-based? a critical appraisal of clinical pathway evaluation research. *J Eval Clin Pract* 2007; 13(6):920-9.
10. Pearson SD, Goulart-Fisher D, Lee TH. Critical pathways as a strategy for improving care: problems and potential. *Ann Intern Med* 1995; 123(941):941-8.
11. Ricci S, Celani MG, Cantisani TA, Righetti E. Piracetam for acute ischaemic stroke. *Cochrane Database of Syst Rev* 2012; 12:9.
12. Davalos A, Castillo J, Alvarez-Sabin J, Secades JJ, Mercadal J, Lopez S, et al. Oral citicoline in acute ischemic stroke: an individual patient data pooling analysis of clinical trials. *Stroke* 2002; 33(12):2850-7.
13. Birnbaum Y, Ye Y, Rosanio S, Tavackoli S, Hu ZY, Schwarz ER, et al. Prostaglandins mediate the cardioprotective effects of atorvastatin against ischemia-reperfusion injury. *Cardiovasc Res* 2005; 65(2):345-55.
14. Roth EJ, Lovell L, Harvey RL, Bode RK, Heinemann AW. Stroke rehabilitation: indwelling urinary

catheters, enteral feeding tubes, and tracheostomies are associated with resource use and functional outcomes. *Stroke* 2002; 33(7):1845-50.

15. Roth EJ, Lovell L. Seven-years trends in stroke rehabilitation: patient characteristics, medical complications, and functional outcomes. *Top Stroke Rehabil* 2003; 9(4):1-9.
16. Sulch D, Evans A, Melbourn A, Kalra L. Does an integrated care pathway improve process of care in stroke rehabilitation? a randomized controlled trial. *Age Ageing* 2002; 31(3):175-9.
17. Kiers L, Davis SM, Larkins R, Hopper J, Tress B, Rossiter SC, et al. Stroke topography and outcome in relation to hyperglycaemia and diabetes. *J Neurol Neurosurg Psychiatry* 1992; 55(4):263-70.
18. Clement S, Braithwaite SS, Magee MF, Ahmann A, Smith EP, Schafer RG, et al. Management of diabetes and hyperglycemia in hospitals. *Diabetes Care* 2004; 27(2):553-91.
19. Van Exel NJ, Koopmanschap MA, Scholte op Reimer W, Niessen LW, Huijsman R. Cost-effectiveness of integrated stroke services. *QJM* 2005; 98(6):415-25.