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Effects of clinical pathways in stroke management: A meta-analysis

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Abstract

Objective: To assess the implementation effects of clinical pathways, compared with usual care, among patients with stroke. *Methods:*Two investigators independently searched PubMed, Embase, the Cochrane Library, Web of Science, Chinese Biomedical Literature Database and Wanfang Database for studies published before December 2014. Jadad methodological approach was applied to assess the quality of included studies and RevMan software (version 5.2.7) was used for meta-analysis. *Results:* A total of 11 RCTs involving 913 patients were included in this meta-analysis. The overall results showed that a shorter average length of stay [MD = -2.92; 95% CI (-4.06, -1.78); P < 0.001] and a lower inpatient expenditures [SMD = -1.64; 95% CI (-1.80, -1.48); P < 0.001] in clinical pathways group comparing with the usual care group. The higher score of patient satisfaction was also seen in clinical pathways group.
Conclusion: clinical pathways may reduce the average length of stay, reduce the inpatient expenditures, increase patient satisfaction and improve the quality of care in stroke management.

INTRODUCTION

Stroke is a global epidemic and a major public health-care concern as mortality rates are known to vary greatly between countries and geographic regions. Annually, 15 million people worldwide suffer an episode of stroke. Of these, 5 million die and another 5 million are left permanently disabled, with added burden to the family and community.[1]

Clinical pathways (CPW) originated in the United States in the 1980s; these were developed through the collaborative efforts of physicians, nurses, pharmacists, and others to improve the quality and value of patient care. CPW map a patient's journey, providing coordination of services for users and aim to have "the right people, doing the right things, in the right order, at the right time, in the right place, with the right outcome".[2] It is a tool to provide standard care with little variability.[3] Several researchers[4-7] have shown that the implementation of clinical pathways reduce the variability of clinical practice and improve outcomes. In the United States. CPW have been applied to health care management since the 1980s to improve efficiency of care and reduce hospitalization costs.

CPW is increasingly being implemented in many countries to improve the care of stroke patients, but the effects of CPW on stroke management are not clear. This meta-analysis aims to assess the effects of CPW on stroke management in the hospital, and to evaluate whether CPW improve the outcomes of patients who have a stroke.

METHODS

We used the methods described in the preferred reporting items for systematic reviews and meta-analyses (PRISMA) statement.[8]

Literature search strategy

Two investigators independently searched PubMed, Embase, the Cochrane Library, Web of Science, Chinese Biomedical Literature Database, and Wanfang Database for studies published before December 2014. We searched the electronic databases combining medical subject headings (MeSH) terms with free text terms. MeSH terms were performed based on the following search string: "clinical pathways", "critical pathways", "care pathways", "care map", and "stroke",

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"cerebral vascular accident", "apoplexy", and "randomized". Details of the search strategy used in PubMed are shown in the Appendix. There were no language restrictions during the document retrieval. In addition, the reference list of the retrieved articles was also searched and relevant studies were checked manually to identify other studies pertaining to the study topic.

Selection criteria

We identified and reviewed all studies that met the following criteria: (1) Type of study: prospective randomized controlled trials, (2) Participants: all studies that recruited patients who had been admitted to hospital with a clinical diagnosis of stroke, (3) Intervention: patients who were diagnosed as having astroke were randomized either to the clinical pathways (CPW) group or to the non-intervention (usual care) group; (4) Outcome measures: average hospital length of stay, inpatient expenditures, and patient satisfaction. Abstracts, case reports, conference presentations, editorials, and expert opinions were excluded.

Data extraction and critical appraisal

Two reviewers (Huang D and Song XP) independently screened the article titles, abstracts, and full texts to identify studies that met our inclusion criteria. Any conflicts or disagreements were adjudicated by a third reviewer (Tian JH). The following variables were extracted from all studies: first author, publication year, study design, country, participant information (sample size, mean age, percentage of men, and baseline information), and reported indicators. We contacted authors for additional data or clarification where needed. Extracted data were entered into Microsoft Office Excel 2007 (Microsoft, Seattle WA, USA) and were checked by the third reviewer (Tian JH). Discrepancies between reviewers' assessments of the publications, conceptual problems on the pathway intervention or methodological and statistical problems were solved through discussion, or advice was sought from a third reviewer (Tian JH).

Statistical analysis

This meta-analysis was performed using RevMan 5.2.7 software (available from the website for free: http://ims.cochrane.org/revman). In the meta-analysis, the Mantel-Haenszel method was used for analyses of dichotomous data and results were presented as Odds Ratios (ORs) with 95% confidence intervals (CI). The inverse variance method was used to pool continuous data, and the mean difference (MD) with 95% confidence interval (CI) was used to evaluate continuous data when all studies use the same scale to report their outcomes, while the standardized mean difference (SMD) with 95% CI was used to evaluate the studies using different scales. The heterogeneity between trials was assessed by the Chi-square test and the extent of inconsistency was evaluated by the I^2 statistic. Meta-analysis was performed using a fixed-effects model ($p>0.1$) or a randomized-effects model ($p\leq0.1$) according to the degree of heterogeneity.

Sensitivity analyses were carried out to investigate the influence of each study on the overall outcome of the meta-analysis, which were calculated using the software Meta-analyst 3.13.

RESULTS

Quantity and quality of trials

A systematic review of the six electronic database searches identified 913 potentially relevant references. After exclusion of duplicate or irrelevant references, 267 potentially relevant articles were retrieved for more detailed evaluation. After applying the selection criteria, 11 comparative studies remained eligible for quantitative assessment. A PRISMA chart summarizing the search strategy is presented in Figure 1 and characteristics of included trials are summarized in Table 1.

The risk of bias was independently assessed by two reviewers (Huang D and Song XP). The evaluation of risk of bias in included studies was assessed by the modified Jadad 7-point scale.[9] The Jadad approach is a five-point scale that assigns points to each study on the basis of the quality of the randomization generation (0–2 points), of the blinding process (0–2 points), of the description of withdrawals and dropouts (0–1 point), and of the allocation concealment (0–2 points). In general, a total score of 4 or more points was achieved only by high quality studies. Any disagreements were resolved in consultation with the third reviewer (Tian JH) who acted as an arbiter.

Characteristics of included studies

Characteristics of included trials are summarized in Table 1. These 11 RCTs[6,10-19] recruited a total of 984 patients. Eight studies had recruited their

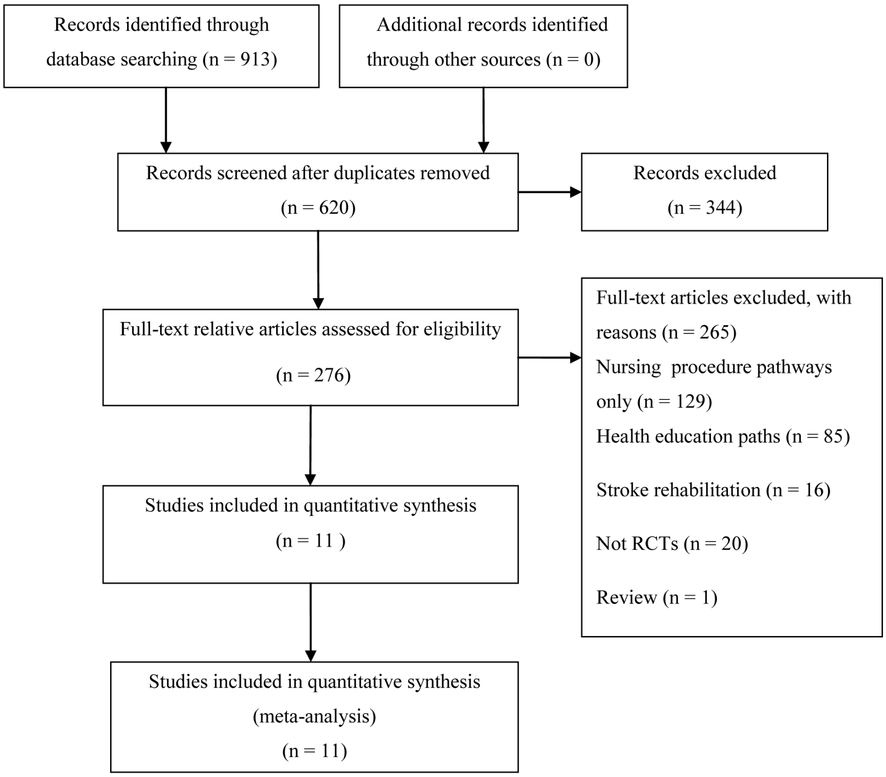

Figure 1. Flow chart of the study selection process.

Table 1: Characteristics of the included studies

Study name	Year	Age (years)		Sample Size		Staff received training	Reported indicators
		CPW	usual care	CPW	usual care		
Panella[7]	2011	74.5±10.8	74.0 ± 11.7	238	238	recevied	ALOS, Mortality, Complication rates,
Lu[11]	2013	55±72	56±74	40	40	recevied	ALOS, IE, PS,
Sun[12]	2013	47±70	48±71	25	25	recevied	ALOS, IE, PS,
Li[13]	2011	42.3±6.8	42.6±7.2	30	30	recevied	ALOS, IE, PS, GHK
Bai[14]	2011	59.9*	61.2*	100	100	Not reported	ALOS, IE, PS, FAM, BI
Qian[15]	2011	65.63±11.93	68.72±12.98	45	45	Not reported	ALOS, IE, NIHSS
Wang[16]	2010	50*	50*	43	40	Not reported	ALOS, IE, NIHSS
Guo[17]	2010	63.5±9.2	63.5±9.2	40	40	Not reported	ALOS, IE, PS, SAS
He[18]	2008	58.5*	58.5*	30	30	Not reported	ALOS, IE, PS, SAS
Wang[19]	2007	61.3±13.2	64.8±11.7	51	50	Not reported	ALOS, IE, PS, GHK
Chen[20]	2006	Not reported	Not reported	90	90	Not reported	ALOS, IE, PS, GHK

*: mean; IE: Inpatient expenditures; ALOS: Average length of stay; GHK: Grasp of health knowledge; PS: Patient satisfaction; NIHSS: the National Institutes of Health Stroke Scale; BI: Barthel index; SAS: Self-rating anxiety scale; FAM: Fugl—Meyer assessment

Table 2: Methodological quality of included studies

Study name	Randomization	Blinding	Withdrawals and dropouts	Allocation concealment	Total
Panella[6]	Not reported	Not reported	No	Not reported	4
Lu[10]	Not reported	Not reported	No	Not reported	3
Sun[11]	Not reported	Not reported	No	Not reported	3
Li[12]	Not reported	Not reported	No	Not reported	3
Bai[13]	Not reported	Not reported	No	Not reported	3
Qian[14]	Random number table	Not reported	No	Not reported	4
Wang[15]	Not reported	Not reported	No	Not reported	3
Guo[16]	Not reported	Not reported	No	Not reported	3
He[17]	Not reported	Not reported	No	Not reported	3
Wang[18]	Not reported	Not reported	No	Not reported	3
Chen[19]	Not reported	Not reported	No	Not reported	3

participants in 2010 and later[6,10-16] and three studies recruited before 2010.[17-19] Ten studies[10-19] took place in China and one[6] in Italy. Participants were between 18 to 86 years of age. Ten studies[10-19] diagnosed a stroke based on the head computed tomography scan (CT) or magnetic resolution imaging (MRI). Nine studies[10,11,13-19] showed no significant statistical difference between CPW and usual standard of care on baseline data of patient characteristics. Table 1 shows the characteristics of the studies that were included. The evaluation of the risk of bias in the studies included in this meta-analysis is showed in Table 2.

Average length of stay

Ten studies[6,10-12,14-19] reported the average length of stay (LOS), of which nine studies[6,10-12,14-16,18,19] reported this indicator with mean±standard deviation (SD), the aggregate results showed that significant heterogeneity existed in included studies (I^2 = 89%; P < 0.001). Data from these studies were pooled using a random effects model; the pooled analysis indicated that the mean length of hospital stay was significantly shorter in the CPW group, [MD= -2.92; 95% CI (-4.06, -1.78); P < 0.001](Figure2). The sensitivity analysis (leaving one out at a time) produced no statistically significantly increased or decreased summary results, although the findings from the study[6]were quite influential (Figure 3).

Only one study[17] did not report standard deviations and therefore could not be included for summary analysis. It showed a shorter mean length of hospital stay in the CPW group (the mean LOS of CPW group was 28 days vs. 34 days for the usual care group, P< 0.01).

Study or Subgroup	CPW Mean	CPW SD	CPW Total	Usual care Mean	Usual care SD	Usual care Total	Weight	Mean Difference IV, Random, 95% CI
Chen 2006	16.3	2.3	90	20.5	3.4	90	12.3%	–4.20 [–5.05, –3.35]
Guo 2010	15.61	1.6	40	20.14	3.15	40	11.8%	–4.53 [–5.62, -3.44]
Li 2011	7.01	1.06	30	11.15	2.02	30	12.4%	–4.14 [-4.96, –3.32]
Lu 2013	11.4	1.9	40	14.5	3.3	40	11.6%	–3.10 [–4.28, –1.92]
Panella 2012	11.78	6.6	238	10.88	7.9	238	11.3%	0.90 [–0.41, 2.21]
Qian 2011	14.32	2.89	45	16.75	3.25	45	11.4%	–2.43 [–3.70, –1.16]
Sun 2013	13.4	1.9	25	16.5	3.3	25	10.8%	–3.10 [–4.59, –1.61]
Wang 2011	16.3	8.1	43	21.4	8.3	40	5.8%	–5.10 [–8.63, –1.57]
Wang 2007	18.6	1.58	51	20.1	2.09	50	12.6%	–1.50 [–2.22, –0.78]
Total (95% CI)			**602**			**598**	**100.0%**	**–2.92 [–4.06, –1.78]**

Heterogeneity: $Tau^2 = 2.56$; $Chi^2 = 75.38$, df = 8 (P < 0.00001); $I^2 = 89\%$
Test for overall effect: Z = 5.02 (P < 0.00001)

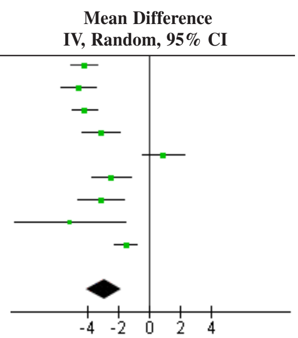

Figure 2. Forest plot of meta-analysis: ALOS (Average Length of Stay), MD (mean difference) with 95% CI.

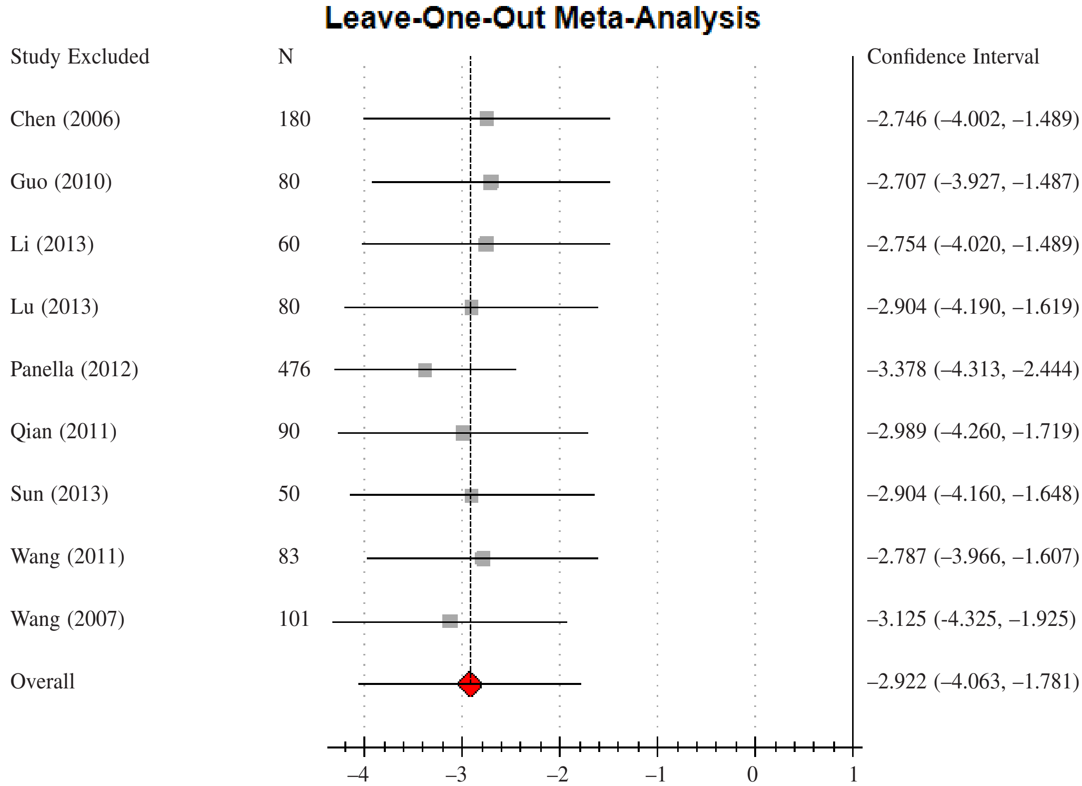

Figure 3. The results of sensitivity analysis.

Inpatient expenditures

Eight studies[10-14,17-19] reported inpatient expenditures. There was significant heterogeneity in included studies (I^2 = 89%; P < 0.001). Data from these studies were pooled with a random-effects model. The aggregate results of random-effects model showed that CPW was superior to usual care on inpatient expenditures [SMD = -1.82; 95% CI (-2.33, -1.30) (Figure 4).

Patient satisfaction

Patient satisfaction was reported by eight studies, five[10,11,13,16,17] of which reported in percentage and three[12,18,19]reported in mean ± standard deviation (SD). The aggregate results of five studies[10,11,13,16,17]reported in percentage presented higher patient satisfaction in CPW [OR = 2.04; 95% CI (1.04, 3.98); P=0.04] (Figure 5). The three[12,18,19]RCTs reported in mean ± SD showed

	CPW			Usual care				Std. Mean Difference
Study or Subgroup	**Mean**	**SD**	**Total**	**Mean**	**SD**	**Total**	**Weight**	**IV, Fixed, 95% CI**
Bai 2011	5,963.3	495.6	100	6,969.5	554.2	100	23.5%	–1.91 [–2.24, –1.57]
Chen 2006	2,790.5	158.65	90	3,042.4	160.58	90	23.5%	–1.57 [–1.91, –1.24]
He 2008	8,500	800	30	9,300	1,000	30	9.3%	–0.87 [–1.40, –0.34]
Li 2011	3,541.05	691.07	30	4,157.93	765.82	30	9.4%	–0.83 [–1.36, –0.31]
Lu 2013	7,682	375.7	40	9,725	750.3	40	5.4%	–3.41 [–4.11, –2.71]
Qian 2011	8,233.71	1,684.71	45	10,732.32	2,146.89	45	12.7%	–1.28 [–1.74, –0.83]
Sun 2013	7,648	358.7	25	9,873	758.3	25	3.0%	–3.69 [–4.63, –2.76]
Wang 2007	2,790.5	158.65	51	3,042.4	160.58	50	13.1%	–1.57 [–2.01, –1.12]
Total (95% CI)			**411**			**410**	**100.0%**	**–1.64 [–1.80, –1.48]**

Heterogeneity: Chi^2 = 65.22, df = 7 (P < 0.00001); I^2 = 89%
Test for overall effect: Z = 19.81 (P < 0.00001)

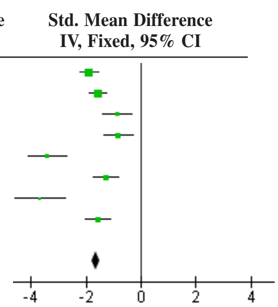

Figure 4. Forest plot of meta-analysis: inpatient expenditures, MD (mean difference) with 95% CI.

Study or Subgroup	CPW Events	CPW Total	Usual care Events	Usual care Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Bai 2011	98	100	94	100	15.0%	3.13 [0.62, 15.89]
Guo 2010	35	40	32	40	32.0%	1.75 [0.52, 5.90]
He 2008	25	30	24	30	32.0%	1.25 [0.34, 4.64]
Lu 2013	38	40	35	40	14.0%	2.71 [0.49, 14.90]
Sun 2013	24	25	22	25	7.0%	3.27 [0.32, 33.84]
Total (95% CI)		**235**		**235**	**100.0%**	**2.04 [1.04, 3.98]**
Total events	220		207			

Heterogeneity: $Chi^2 = 1.13$, df = 4 (P = 0.89); $I^2 = 0\%$
Test for overall effect: Z = 2.09 (P = 0.04)

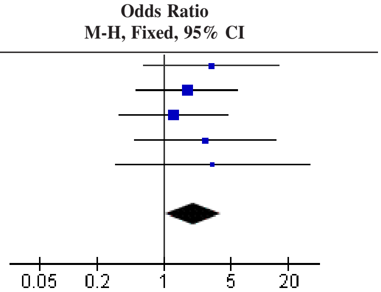

Figure 5. Forest plot of meta-analysis: patient satisfaction (%), OR with 95% CI.

Study or Subgroup	CPW Mean	CPW SD	CPW Total	Usual care Mean	Usual care SD	Usual care Total	Weight	Std. Mean Difference IV, Fixed, 95% CI
Chen 2006	29.6	5.35	90	21	4.98	90	51.7%	1.66 [1.32, 200]
Li 2011	98.24	1.65	30	95.16	3.12	30	19.4%	1.22 [0.66, 1.77]
Wang 2007	29.6	5.35	51	21	4.98	50	28.9%	1.65 [1.20, 2.10]
Total (95% CI)			**171**			**170**	**100.0%**	**1.57 [1.33, 1.81]**

Heterogeneity: $Chi^2 = 1.92$, df = 2 (P = 0.38); $I^2 = 0\%$
Test for overall effect: Z = 12.61 (P < 0.00001)

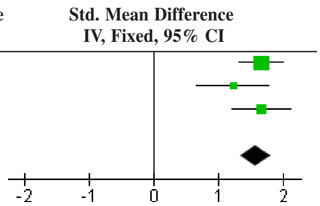

Figure 6. Forest plot of meta-analysis: patient satisfaction (Mean±SD), standardized mean difference (SMD) with 95% CI.

that patients were significantly more satisfied with their hospital care in the CPW group [SMD = 1.57; 95% CI (1.33, 1.81); P<0.0001] (Figure 6).

DISCUSSION

CPW was initially employed in 1980s in the United States. They were designed to minimize delays and resource utilization, maximize quality of care, reduce variation in care and provide continuous quality improvement.[20] The results of our meta-analysis show that CPW was effective in improving the outcomes of patients who had a stroke. CPW was associated with a significantly decreased average length of stay and reduction in inpatient expenditures compared to the usual care. One of the studies included in our analysis[6]showed that usual care was superior to CPW in the average length of stay, but the difference did not achieve statistical significance. In addition, the sensitivity analysis showed that our result was stable. The average length of stay and inpatient expenditures were measured as days and yuan (the monetary unit of China), which were the most commonly employed outcomes and from the economic perspective.

As a major indicator reflecting quality of care, evidence from eight randomized studies[10-13,16-19] reported the patient's satisfaction. The aggregate results showed that CPW had a positive effect on patient satisfaction compared with the usual care. Only one study[18] reported patient satisfaction quantitatively, with a total score 30 points, while others did not mention any quantitative score. In addition, four studies[10,11,18,19] measured this indicator by a comprehensive scale and others did not describe the questionnaires. Future research should report more quantitative details on this aspect of study.

The strength of our study is the large number of patients. In addition, many previous systematic reviews focused on investigating CPW for stroke rehabilitation or the shoulder pain after stroke[21,22]; whereas our paper aimed to study the effects of CPW in stroke management.

However, the limitations in the present meta-analysis should be acknowledged. Some factors added to the difficulty in interpreting the results of this review and high heterogeneity existed in several pooled results. First, random sequence generation was described in only one study.[14] Second, the studies included in our meta-analysis were from different countries and different hospitals, which may be the potential sources of heterogeneity. Third, the development of pathways has been described in great detail, but little information was provided on the logistics of their implementation; this may have affected the outcomes. Moreover, publication bias may have influenced the results and outcomes of the studies, as authors may prefer to write "no difference"

Appendix 1: Search strategy for PubMed

Search	Queries
#1	critical pathways [MeSH]
#2	(clinical pathway OR clinical pathways OR clinical path OR clinical paths) [Tiltle/Abstract]
#3	(critical pathway OR critical pathways OR critical path OR critical paths) [Tiltle/Abstract]
#4	(care pathway OR care pathways OR care path OR care paths) [Tiltle/Abstract]
#5	(care map OR care maps) [Tiltle/Abstract]
#6	(care protocol OR care protocols) [Tiltle/Abstract]
#7	#1 OR #2 OR #3 OR #4 OR #5 OR #6
#8	Stroke [MeSH]
#9	apoplexy [MeSH]
#10	(stroke* OR cerebrovascular* OR cerebral vascular OR cva*) [Tiltle/Abstract]
#11	(cerebral OR cerebellar OR brainstem OR vertebrobasilar) [Tiltle/Abstract]
#12	(infarct* OR isch?emi* OR thrombo* OR apoplexy OR emboli*) [Tiltle/Abstract]
#13	#11 AND #12
#14	(cerebral OR intracerebral OR intracranial OR parenchymal) [Tiltle/Abstract]
#15	(brain or intraventricular or brainstem or cerebellar) [Tiltle/Abstract]
#16	(infratentorial or supratentorial or subarachnoid) [Tiltle/Abstract]
#17	#14 OR #15 OR #16
#18	(haemorrhage or hemorrhage or haematoma or hematoma) [Tiltle/Abstract]
#19	(bleeding or aneurysm) [Tiltle/Abstract]
#20	#18 OR #19
#21	#17 AND #20
#22	#8 OR #9 OR #10 OR #13 OR #21
#23	#7 AND #22

rather than report the actual data or they may omit publication of studies with negative results. Finally, methods were not clearly described in some of the studies and this may resulted in confounding factors, and sources of contamination that have not been identified.

In conclusion, the results of this meta-analysis demonstrate that CPW improves the quality of care in patients with stroke. Theoretical advantages of such methods are clear. However the benefits may be less than expected because of variations in patients' characteristics, pre-existing practices, and/or dependence on external factors. Further RCTs are needed before implementation of the CPW in stroke patients. We should also pay attention to the following aspects: the authors of CPW should receive training in quality improvement and in the development of CPW before implementation. Establishing an evidence based CPW should be a focus for the future. Moreover, there is currently limited research on the formulation of CPW; additional studies may provide evidence based medicine and a beneficial direction for formulating CPW.

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