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COMPREHENSIVE STROKE UNITS: A REVIEW OF COMPARATIVE EVIDENCE AND EXPERIENCE

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Abstract

Background: Stroke unit care offers significant benefits in survival and dependency when compared to general medical ward. Most stroke units are either acute or rehabilitation, but comprehensive (combined acute and rehabilitation) model (comprehensive stroke unit) is less common.

Aim: To examine different levels of evidence of comprehensive stroke unit compared to other organized inpatient stroke care and share local experience of comprehensive stroke units.

Methods: Cochrane Library and Medline (1980 to December 2010) review of English language articles comparing stroke units to alternative forms of stroke care delivery, different types of stroke unit models and differences in processes of care within different stroke unit models. Different levels of comparative evidence of comprehensive stroke units to other models of stroke units are collected.

Results: There are no randomized controlled trials directly comparing comprehensive stroke units to other stroke unit models (either acute or rehabilitation). Comprehensive stroke units are associated with reduced length of stay and greatest reduction in combined death and dependency in a meta-analysis study when compared to other stroke unit models. Comprehensive stroke units also have better length of stay and functional outcome when compared to acute or rehabilitation stroke unit models in a cross-sectional study, and better length of stay in a “before-and-after” comparative study. Components of stroke unit care that improve outcome are multi-

factorial and most probably include early mobilization. A comprehensive stroke unit model has been successfully implemented in metropolitan and rural hospital settings.

Conclusions: Comprehensive stroke units are associated with reductions in length of stay and combined death and dependency and improved functional outcomes compared to other stroke unit models. A comprehensive stroke unit model is worth considering as the preferred model of stroke unit care in the planning and delivery of metropolitan and rural stroke services.

Introduction

Stroke is the second commonest cause of death affecting 15 million people worldwide.[1] Of the stroke sufferers, 5 million die and another 5 million are permanently disabled each year, making it the fourth leading cause of disease burden as measured by disability-adjusted life-years.[2]

Older stroke patients are more likely to present with more severe strokes and have significantly increased mortality, rate of subsequent disability and nursing home placement.[3-7] With ageing populations, this has significant implications for future health-care spending.

A Cochrane Library and Medline (1980 to December 2010) review of English language articles comparing stroke units to alternative forms of stroke care delivery, different types of stroke unit models and differences in processes of care within different stroke unit models was performed. Different levels of comparative evidence of comprehensive stroke units (CSUs) to other models of stroke units were appraised.

The following review will focus on the evidence of CSUs when compared to other inpatient stroke unit models. The experience of local CSUs – in metropolitan and rural settings of New South Wales (NSW), Australia - will also be given. CSUs will be defined as stroke units which accept patients acutely and also provide rehabilitation for several weeks if necessary.

Evidence from randomised controlled trials (RCTs) for Stroke Units

The Cochrane reviews have provided evidence that stroke units including CSU model have better outcome when compared to alternative non-dedicated model of stroke care in the initial database review from 2002 of 23 RCTs[3] and an updated Cochrane database review from 2007 of 31 RCTs.[4] In the 2007 Cochrane review, after a median one-year follow-up, reductions are seen for death (odds ratio (OR) 0.86, 95% confidence intervals (CI) 0.76 - 0.98; P = 0.02), death or institutionalized care (OR 0.82, 95% CI 0.73 - 0.92; p < 0.001) and death or dependency (OR 0.82, 95% CI 0.73 - 0.92; P = 0.001). The benefits for those who have received stroke unit care, as opposed to alternative care, are maintained after 10 years with the risk of death lower (76% versus 87%, P = 0.008) and more than double still living at home (19% versus 8%, P = 0.018).[5-6] These outcomes are independent of age, gender or stroke severity.

The Cochrane reviews have included data from patients cared for in three different types of organized stroke unit models: a) *acute (intensive) stroke units* that discharge patients early, (usually within seven days); b) *rehabilitation stroke units* which accept patients after seven days and focus on rehabilitation; and c) *comprehensive stroke units** (CSU) which accept patients acutely, and also provide rehabilitation for several weeks if necessary (*this definition will be used throughout this review*).[7] However, the Cochrane reviews only compared the dedicated stroke units mentioned (including CSU) to alternative non-dedicated model of stroke care such as general medical ward. There was no direct comparison between the different stroke unit models. With the available evidence of heterogeneous models of stroke unit care included in the Cochrane reviews, it is not possible to determine if any single model is superior.[3] In our review, there are also no RCTs found that directly compare a CSU to other

models of dedicated “in-patient” stroke unit care. Hence, there is no Level 1 evidence to answer the salient question of which type of stroke unit provides better care.

Other Levels of Evidence that Compare CSU to other In-patient Stroke Units

a) Meta-analysis

A meta-analysis of 14 RCTs [8] using an “indirect comparison” of three different models of stroke care (acute, rehabilitation and CSUs) found that stroke units were associated with significant reductions in mortality, combined death, and dependency, as well as length of stay (LOS), but not every model of care was associated with equal benefit (Table 1). Acute stroke units were associated with significant reductions in combined death and dependency but not mortality alone. In contrast, rehabilitation stroke units were associated with the greatest reduction in mortality although this may be related to selection bias of patients with better prognosis being referred for rehabilitation.[8] CSUs appeared to demonstrate the greatest overall benefit, being the only model to achieve a significant reduction in LOS (weighted mean difference of -14 days; 95% CI: -27 to -2) and the greatest reduction in combined death and dependency (0.5; CI 0.39 - 0.65).

The following sections will review non-randomized controlled studies as well as share local experience.

b) Evidence from a cross-sectional comparison of CSU to other models of "in-patient" stroke unit

Non-randomised studies[9-12] have demonstrated potential benefits for CSUs compared to alternative models of care in relation to LOS and functional outcomes. In this section, we describe a case-control study comparing CSU and traditional stroke units (separate acute and rehabilitation locations).

Using a cross-sectional study design, the case-control study compared stroke outcome data between CSU and other models of stroke care (acute or rehabilitation) from case-mix data collected.[12] The study found an average improvement in change of Functional Independence Measure (FIM) score of 10.3 ($P < 0.001$) and an improvement in discharge FIM score of 6.7 ($P = 0.02$) when CSU was compared to other models of stroke care (see Table 2).[12] It also found a reduction in LOS for all classes of stroke patients requiring rehabilitation (difference range from -13.1 to -2.8 days).[12] Patients with moderately severe stroke requiring rehabilitation (AN-SNAP[13] class 206, 207 and 208), who represent 60-65% of all stroke patients requiring rehabilitation appeared to benefit most from the CSU model (Table 2). The in-hospital mortality in CSU was 12% compared to 15.5% in the control arm.

In the study, the conversion from providing post-acute stroke rehabilitation care to combined acute stroke and rehabilitation care was achieved in the CSU without financial enhancement. There were no additional resources (doctors, nurses or allied health) when the CSU model was established although nursing staff were given additional training in acute stroke care.

The strength of this type of cross-sectional study is its ability to analyse different outcome measures in a sizeable number of stroke patients using a statewide case-mix database. The limitations include its retrospective nature and a lack of certainty of data quality. Furthermore, despite adjustment for confounding factors including patient age, stroke severity and functional impairment in the study, certain data such as premorbid level of independence, comorbidities and intensity of rehabilitation were not known.

c) Evidence from a "before-and-after" study in a metropolitan hospital

The results "before-and-after" the establishment of a CSU in a metropolitan hospital were compared.[14] In-hospital acute stroke mortality was significantly reduced, from 18% to 9% (P = 0.007) and the combined hospital LOS (acute and rehabilitation) was reduced by seven-days in the post-CSU period (mean ± SD: 46±19 vs. 39±19, P=0.01). Patient functional outcomes, as measured by improvement of FIM scores at discharge (discharge FIM score minus admission FIM score), were similar between the two time periods (24±18 versus 24±17, P=0.98). [14]

The strength of the study is its prospective nature for which some confounding factors were collected and adjusted for. However, limitations include a small sample size and its use of 'crude' administrative datasets such as 'Diagnostic Related Group' as a measure of stroke severity during the acute phase. Furthermore, the lead in period was only two-months before the "after" data was collected, meaning that the staff may still have been adjusting to the new model of care, which potentially underestimates the overall performance of the "after" period.

Overall, these findings confirm that improvement in clinical outcomes, using a CSU model, is possible by admitting acute stroke patients directly into a previously designated post-acute rehabilitation ward. The feasibility of establishing such a model in a metropolitan hospital was also demonstrated.

The successful implementation of a CSU service in a metropolitan setting is also echoed in Canada. In an Ontario community hospital CSU unit of 14 beds, Bisaillon et al[16] reported shorter LOS than the national standard as well as improvements in provider and patient satisfaction.

d) Evidence from a "case study" - a regional experience

The establishment of CSU has been tried in a regional setting. The CSU model was set up in a district hospital, in part of Greater Newcastle in regional NSW, Australia. Approximately 50 – 80 stroke patients are admitted each year. Stroke patients are admitted via the Emergency Department under the care of an acute general physician, and then referred on to a dedicated stroke rehabilitation interdisciplinary (part-time) team. The patients may remain as shared care with the Acute and Rehabilitation physicians, or care may be wholly handed over to the Rehabilitation Physician. There are four co-located stroke rehabilitation beds embedded within an acute general medical ward. The mean time to admission into the care of the Stroke Team is just under three-days, with the unit therefore functioning virtually as a CSU.

Data have been collected since the inception of the unit in 2004 (but no pre-baseline data). Data have been submitted to the Australian Rehabilitation Outcomes Centre

(AROC) for analysis and benchmark reporting (against other casemix-standardized units). Despite an older age group (seven years on average), which reflects the local population demographic, there are still demonstrable improvements in LOS (10 days), FIM efficiency, and higher likelihood for return to private residence (unpublished data).

This case study demonstrates that the CSU model is not only feasible in a regional hospital setting, it can still provide better outcomes even when benchmarked against metropolitan (rehabilitation) units which provide stroke care. Despite a relatively low patient turnover, staff skills were still maintained within the specialized team.

Components of Care in CSU that may contribute to a better model for stroke care

What are the components of effective organized inpatient stroke unit care that reduce mortality and improve outcome?

In general, stroke units are more effective in providing early mobilization (within 24 hours), aspirin, antipyretic and antibiotic therapy when compared to general medical wards.[16] It is not known whether such differences exist within different stroke unit models. Langhorne[17] reviewed 11 eligible stroke unit trials concerning the components of a stroke unit that contribute to effective stroke unit care and drew the following conclusions: (i) units should contain good skill mix and assessment procedures should be multidisciplinary, (ii) early management policies such as early mobilization are important, and (iii) ongoing rehabilitation policies should be co-ordinated by a multidisciplinary team and include goal setting and early discharge planning.

A CSU model would seem to offer a balance of all of these features. The area of uncertainty remains that CSU is superior to other models or that continuity of care offered by CSU is beneficial. Indirect evidence to support this is provided in a recent review of 'quality of care and LOS stay among patients with stroke' [18] in which a multi-disciplinary panel identified 12 qualities of care criteria. In addition to expected acute clinical criteria such as early imaging, antithrombotic therapy and deep vein thrombosis prophylaxis, other multidisciplinary criteria included early mobilization, early physiotherapist/occupational therapist assessment, early swallowing and nutritional assessment. Patients receiving 75-100% of care criteria had LOS nearly half that of those receiving 0-24% of care criteria (adjusted relative LOS 0.53; CI 0.48 - 0.59). The criterion associated with the greatest LOS benefit was early mobilization by day 2 (0.67; CI 0.61 - 0.73).

A study comparing early mobilization within 24 hours as part of standard stroke care with stroke care in which early mobilization was not a formal part of acute care found that patients receiving early mobilization spent less time in bed and were more likely to undertake moderate to high activity. [19] This difference was even greater amongst more severe stroke patients. In the only multicentre RCT comparing very early rehabilitation with standard care, very early mobilization (within 24 hours) was found to significantly reduce cost at 3 and 12 months with a non-significant trend towards improved outcome.[20]

A CSU model should do well in many of the salient components of stroke care outlined previously.[17,18] In other models of stroke unit care, often, the essential care components are split into separate phases of inpatient care, with acute medical care and investigation preceding transfer to a rehabilitation environment. This separation

is often driven by historical and geographical constraints, but is entirely artificial and may potentially result in negative consequences including delays in early mobilization and goal setting. An issue of clinical relevance is whether continuity of care improves outcomes. To date, there has been no RCT directly examining the effect of continuity of care.

Cameron et al[21] emphasize the need to ensure patients' transitions between care environments, from acute stroke care to rehabilitation to community is safe and efficient. The authors use the example of the Ontario Stroke System which provides a model of integrated stroke service delivery. A future direction of existing stroke units may be enhancement of the continuity of services, which would require integration at many levels, including clinical policy and management.[21]

Feasibility of establishing a CSU

Combining acute and rehabilitation stroke units can be considered if separate units of acute stroke care and rehabilitation exist in the same facility. Many rehabilitation units are established in stand-alone facilities, which means that there are often insurmountable geographical difficulties in subsequently combining them with acute stroke units. However, as many of these stand-alone units are for general rehabilitation, it may be possible to re-allocate a small number of additional beds for an acute stroke unit and transform the rehabilitation facility into a CSU.

Psychological factors may become barriers to change before CSUs can be considered. For instance, rehabilitation staff may be concerned about the delivery of care to acute patients. Staff may be amenable to training but not all staff may find the transition easy. In other circumstances, issues such as which medical specialty should care for the patient may become an obstacle. A pre-requisite of establishing such an

arrangement is agreement of an organization and operation plan by different stakeholders including sub-specialty clinicians, and final endorsement of a plan by hospital administration.

Future Directions

Clinical guidelines for stroke are likely to change to reflect emerging evidence from the literature of the value of CSUs. For example, the latest version of National Clinical Guidelines for stroke in Australia has incorporated the CSU model as the preferred model of care whenever possible.[22] The evidence for the benefits of stroke unit care is probably clearest for units that provide several weeks of rehabilitation in a CSU or stroke rehabilitation unit. It is our hope that this paper can generate discussion and research in the future in a positive fashion that will ultimately bring benefit to the care of stroke patients.

Conclusions

There is preliminary evidence that CSUs are associated with reduction in LOS and better improvement in functional outcomes when compared to other stroke unit models. Early mobilization may be one factor contributing to better outcomes and LOS in CSU compared to other models. Further studies with better design such as RCT are warranted to test which stroke unit model is superior. A CSU is becoming the preferred choice of many clinicians working in a stroke care unit or rehabilitation unit in Australia.[22] It is our hope that the evidence provided in this paper will generate good interest and ultimately bring benefit to the care of stroke patients globally.

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Table 1. Mortality and dependency rates for different models of stroke care

Model of Stroke Care	Mortality OR (95% CI)	Death/Dependency OR (95% CI)
Acute Stroke Care	0.80 (0.61-1.03) * Non significant	0.70 (0.56-86)
Combined acute and Rehabilitation	0.71 (0.54-0.94)	0.50 (0.39-0.65)
Post-acute rehabilitation	0.60 (0.44-0.81)	0.63 (0.48-0.83)
	Overall 0.71 (0.60-0.83)	0.62 (0.53-0.71)

Table 2: Rehabilitation LOS (days) and functional outcome (FIM change) of the Bankstown-Lidcombe Hospital CSU compared to the rest of NSW [12]

	Mean LOS in rehabilitation (days)					Mean FIM score at discharge					Mean Change in FIM score				
AN-SNAP class	Stroke unit	NSW	Difference* (95% CI)		p†	Stroke unit	NSW	Difference* (95% CI)		p†	Stroke unit	NSW	Difference* (95% CI)		p†
203	27.0	42.2	-10.4	(-23.5 to 2.7)	0.12	45.7	34.0	13.7	(3.1 to 24.2)	0.01	24.7	10.9	17.5	(8.2 to 26.9)	<0.001
204	14.4	17.3	-2.8	(-8.6 to 3.0)	0.34	119.8	115.4	4.4	(-1.3 to 10.0)	0.13	13.5	9.7	4.0	(-0.9 to 9.0)	0.11
205	12.0	23.0	-11.3	(-25.8 to 3.3)	0.13	109.8	101.4	7.1	(-6.8 to 21.0)	0.31	24.8	14.6	8.7	(-3.3 to 20.6)	0.16
206	19.5	28.1	-8.6	(-16.9 to- 0.34)	0.04	111.4	100.9	10.0	(0.9 to 19.1)	0.03	30.1	20.6	9.1	(1.2 to 17.1)	0.02
207	22.7	38.3	-16.1	(-25.0 to -7.2)	<0.001	82.8	69.5	12.8	(2.1 to 23.5)	0.02	34.5	18.7	15.9	(7.9 to 24.0)	<0.001
208	29.7	42.3	-13.1	(-24.6 to -1.5)	0.03	88.9	77.7	12.8	(1.9 to 23.8)	0.02	44.8	26.2	19.5	(10.1 to 28.9)	<0.001
Overall	23.4	30.6	-13.6	(-17.6 to -9.7)	<0.001	83.8	91.0	-6.7	(-12.3 to -1.0)	0.02	30.7	17.8	10.3	(6.8 to 13.8)	<0.001

FIM = Functional Independence Measure.

*Difference in means between the stroke unit and elsewhere in NSW (adjusted for age and admission FIM score for rehabilitation LOS and change in total FIM score, and adjusted for age for discharge total FIM score). † For comparison of means between the stroke unit and elsewhere in NSW.

AN-SNAP – details see reference 16