

Stroke Unit Versus General Medical Wards, II: Neurological Deficits and Activities of Daily Living A Quasi-Randomized Controlled Trial

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Background and Purpose—The efficacy of stroke units has been extensively examined. It is unknown, however, whether the superiority of the stroke unit will remain after the increased focus on stroke treatment in general medicine. This study of patients admitted to the hospital early and with a short length of stay determines the effect and identifies certain important components of a stroke unit.

Methods—Five hundred fifty patients aged 60 years or older with acute stroke were allocated by a quasi-randomized design to a stroke unit or a general medical ward based on date of birth in the month. Patients admitted within 24 hours of onset were enrolled. Outcomes after 7 months were death, proportion needing long-term care, and change in neurological and functional state assessed by the Scandinavian Stroke Scale and Barthel Index.

Results—Seven months after admission there was a trend in favor of the stroke unit in all outcome measures, but no significant differences in clinical outcomes were found except for change in the Scandinavian Stroke Scale score. Recurrent stroke during hospitalization occurred more often in the general medical ward ($P=.03$). The stroke unit was significantly more aggressive in mobilization out of bed ($P<.01$) and use of parenteral fluid ($P<.0001$), aspirin ($P<.0001$), antipyretics ($P<.0001$), and antibiotics ($P<.0001$).

Conclusions—Our study confirms the benefit of the stroke unit, but the effects on the most reliable clinical outcomes were modest and insignificant. Treatment in this stroke unit hastened recovery. More aggressive rehabilitation and use of parenteral fluid, aspirin, antipyretics, and antibiotics appeared in the stroke unit. (*Stroke*. 1998;29:586-590.)

Key Words: stroke management ■ stroke outcome ■ stroke units

Every eighth death in Norway is directly caused by stroke, and the estimated incidence is 280/100 000.¹ However, there is no effective acute medical treatment available for most stroke victims. Studies indicate that treatment in specialized acute SUs or rehabilitation units is beneficial.²⁻¹⁰ Patients offered treatment in such units are less likely to die, they have a faster recovery and a shorter length of stay in the hospital, and they are more often discharged to their homes. The time span from stroke occurrence to entry to specialized treatment varies in many trials, from <3 days to 60 days.¹¹ This raises the question of whether the effect of the treatment offered is caused by the rehabilitation or acute medical care.

In published studies, the most frequent outcome measures used are length of stay in the hospital,^{6-10,12} need of care after hospitalization,^{2,3,7,8,11} and disability measured by an ADL index.^{5-7,9,10,12-14} Only two trials reported an effect on neurological impairment between entry and assessment after 3 months but with no additional effect after another 3 months.^{4,6} Early mobilization is expected to be essential, but few studies have focused on early activation, and only one experimental and two quasi-experimental studies focusing on early activa-

tion reported positive effects.^{13,15,16} The results of many studies have been restricted by small samples, late inclusion of patients, a selected stroke population, and/or outcome measures with unknown validity or reliability, unblinded studies, or studies without an experimental design.¹⁷⁻¹⁹ On the basis of these studies it is impossible to document with certainty that the acute medical treatment is of benefit.

If the acute treatment is effective, what could be the cause? A meta-analysis of studies with heterogeneous treatment patterns showed that improvement in performance appeared to be related to early initiation of treatment.¹⁷ However, a review by the Stroke Unit Trialists' Collaboration showed that even delayed admission of patients to treatment in organized inpatient stroke care was effective compared with conventional care.²⁰ Several characteristics of organized care are believed to be important for effectiveness, including coordination of care, education, training and specialization of staff, and comprehensiveness of rehabilitation input. No previous SU or rehabilitation unit study has described in detail the particular factors that differed in individual treatment patterns between patients treated in SUs and those treated in GMWs. It has been maintained that it is probably not possible to determine

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Selected Abbreviations and Acronyms

ADL = activities of daily living
BI = Barthel Index
GMW = general medical ward
SSS = Scandinavian Stroke Scale
SU = stroke unit

whether the effectiveness of these units is due to the total package of care or particular components.²¹

This study was performed to assess whether the acute treatment in an SU with a short length of stay is effective in improving outcome 7 months after stroke compared with treatment in a GMW and to identify the extent to which individual treatment differs between an SU and a GMW.

Subjects and Methods

The Central Hospital of Akershus county in Norway serves a population of 291 905, of whom 49 303 are 60 years or older.²² It is medical policy in the catchment area to admit patients with acute stroke to the hospital as early as possible. The trial involved patients aged 60 years or older admitted to the hospital within 24 hours of onset of symptoms of a stroke. Between March 1, 1994, and December 31, 1995, 570 patients were admitted to the hospital and included in the study. Another study that only focused on survival included patients admitted to the hospital between January 1, 1993, and January 31, 1995.²³ Patients in that study admitted after March 1, 1994, are also included for recording of severity, neurological deficits, functional state, and need of long-term care.

Stroke was defined according to World Health Organization criteria as a vascular lesion of the brain resulting in a neurological deficit persisting for ≥ 24 hours or resulting in death of the individual.²⁴ Patients with intracerebral hemorrhage, prior stroke(s), or cognitive deficits and those living in nursing homes were not excluded. Patients with primary subarachnoid hemorrhage or subdural hematoma were excluded from the study.

Once admitted, patients were allocated to either an SU or a GMW. Because the number of beds in the SU was limited, the hospital management decided that selection of patients to this unit should be based on the two first digits of date of birth. Stroke patients with the first digits from 1 to 15 were treated in the SU, and patients with digits from 16 to 31 were treated in a GMW.

Stroke Unit

The medical treatment in the 10-bed SU followed current practice guidelines for the management of patients with acute stroke.^{1,25}

A standard examination was performed including neurological assessment, blood tests, ECG, and a CT of the brain within 2 hours after admittance. If an ischemic stroke was suspected after clinical and CT evaluation, 160 mg of aspirin per os was immediately administered. As early as possible, the patient was mobilized, often within the first hours after admittance to the hospital. The routine of mobilization of patients with hemorrhages was the same as for those with ischemic strokes. Patients with paralysis and patients who were impossible to mobilize because of inability to cooperate were given subcutaneous low-molecular-weight heparin to prevent thromboembolic complications. Parenteral iso-osmolar fluid was administered routinely the first 24 hours. Hyperglycemia was treated with insulin when serum glucose was ≥ 12 mmol/L. Fever was treated with antipyretics (acetaminophen, 500-mg tablet) when temperature was $\geq 38^\circ\text{C}$. Antihypertensive treatment was not initiated the first week except for markedly elevated blood pressure. If the patient used antihypertensive medication, this medication was most often continued. If cardioembolic stroke was suspected, a cardiologist was consulted and eventually anticoagulation was initiated as secondary prophylaxis. Anticoagulation was not given as an acute treatment. The staff was multidisciplinary, with neurologists, trained nurses, physiotherapists, an occu-

pational therapist, and a speech therapist. A stroke team met weekly for evaluation of progress and to plan further treatment for each patient. The nurses were specially trained to detect and avoid complications. Special forms were constructed to discover changes early. The physiotherapists followed the Bobath technique²⁶ and instructed the staff to follow this approach for 24 hours. A multidisciplinary team met with the relatives weekly to plan treatment and care after discharge.

General Medical Ward

The hospital has one department of medicine with five wards. Stroke patients were admitted to all of these wards, dependent on capacity. Patients treated within the GMW were given traditional, good medical treatment without special efforts or standardized effort toward this patient group. As in the SU, a CT scan was requested but not routinely as an emergency examination. Patients were immobilized until hemorrhage was excluded by CT scan. Patients with ischemic strokes were then mobilized, while patients with hemorrhages were often immobilized for 1 week. Aspirin was given if the CT scan did not reveal a hemorrhage. Prophylactic administration of low-molecular-weight heparin was given to prevent venous thrombosis for immobilized patients. There was no routine of giving antipyretics or parenteral iso-osmolar fluids, as in the SU. Anticoagulation was started when a possible cardiogenic embolic source was detected. Patients were offered physiotherapy, occupational therapy, and evaluation of a neurologist when the staff requested it.

Both Departments

After acute medical treatment, stabilization, and early rehabilitation, patients were discharged either to their homes, to nursing homes, to community-based long-term rehabilitation, or to hospital-based long-term rehabilitation. This treatment was given independent of their early treatment. One hundred eight patients were randomly transferred to the hospital-based long-term rehabilitation after treatment in the SU or GMW (54 patients from each department) ($P=.87$). CT scans of the brain were performed on 549 patients (99.8%) and were interpreted by the same radiologists. Patients were followed up from entry to the study until August 1, 1996. Demographic characteristics, medical history, CT results, ECG, impairment, disability, treatment, and complications were recorded.

Outcome and Measures

The primary outcomes were death, need for long-term care, and number of patients who improved, deteriorated, or died. Information on death was collected through the National Register, an official register containing name, date of birth, address, and date of death. This register is continually updated. Follow-up assessments on day 1, day 5, and after 7 months were performed by the primary investigator. The assessments after 7 months were done without knowledge of the date of birth and hence the treatment group, unless the investigator was told so by the patient. The observation period for patients suffering a stroke between March 1, 1994, and December 31, 1995, ranged from 213 to 884 days for those who were not dead by the end of the observation. Secondary outcomes were difference in change in neurological impairment and functional disability. For clinical assessment of neurological impairment, the SSS²⁷ was used. Neurological impairment was assessed on admission, the next day, the fourth or fifth day, and after 7 months (± 1 month). The practitioner on duty did the first neurological assessment immediately on arrival of the patient and determined a neurological score. The SSS provides a reliable instrument for stratification of stroke patients and has good interobserver agreement.²⁸ Patients from both branches with SSS scores between 12 and 51 were further randomized to hospital-based or community-based rehabilitation after medical stabilization, acute treatment, and early rehabilitation.

Disability was assessed by the BI of ADL²⁹ the first day after admittance, the fourth or fifth day, and after 7 months (± 1 month). The assessments were based on the patient's ability to perform the activity with or without help. The BI is a relatively valid and reliable measure of disability.^{30,31}

TABLE 1. Final Diagnoses for Patients Excluded From the Study

Diagnosis	SU (n=7)	GMW (n=13)
Transient ischemic attack	2	3
Onset of symptoms >24 h	3	1
Syncope		1
Epilepsy		1
Septicemia		1
Pneumonia	1	1
Diabetic coma		1
Hyponatremia		1
Heart infarction	1	
Cerebral tumor		1
Subdural hematoma		1
Radial nerve paralysis		1

All clinical assessments except at admittance were performed by the primary investigator. He performed the score the next day without knowing the score at admission. ADL scores were set by the primary investigator in cooperation with the nurse who was responsible for the patient and/or the patient's relatives. Patients who had a sudden deterioration with new neurological deficits >24 hours after admittance were considered to have suffered a recurrent stroke. This evaluation was made by the same primary investigator.

The study was approved by the ethical committee for medical research (approval No. S-93231).

Study Population

Of the 570 patients originally included, 20 patients were excluded because of unfulfilled criteria (Table 1). Demographic characteristics, medical history, neurological impairment and disability on admission, and severity and type of stroke in both groups are shown in Table 2. The mean duration of hospitalization was 7.7 days (median, 6 days; SD, 6.2; range, 1 to 29 days) in the GMW and 9.5 days (median, 8 days; SD, 6.9; range, 1 to 38 days) in the SU ($P=.0005$; t test, Mann-Whitney test). All patients included were followed up concerning death and residency. Of those who survived ≥ 7 months, 28 (10.3%) from the SU and 25 (9.0%) from the GMW were not reached for assessment of neurological impairment and disability. Six patients treated in the SU and 4 in the GMW lived >70 km from hospital and hence were not evaluated. Two patients from SU and 3 from GMW withdrew from the study between discharge and follow-up 7 months after the stroke. Twenty from the SU and 18 from the GMW did not answer repeated mail or telephone calls. The mean neurological scores on admission for patients examined after 7 months, patients missing, and patients dead within 7 months did not differ significantly between treatment groups.

Statistical Analysis

Differences between the groups in outcome are presented in proportions and odds ratios with 95% confidence intervals except for differences in BI and SSS scores, which were analyzed by the Mann-Whitney test. We used χ^2 statistics and the two-sample t test when appropriate to determine significance of differences among background variables that were compared. Patients were studied on an intention-to-treat basis.

Results

Table 3 shows the outcome 7 months after stroke. All of these results favored the SU, but they were not statistically significant. The improvement from admission to follow-up 7 months after stroke was highly significant within both groups, but

TABLE 2. Characteristics, Neurological Status, and Type of Stroke of Eligible Stroke Patients Allocated to Receive Care in the SU or GMW

Characteristics	SU (n=271)	GMW (n=279)	P
Mean age, y (SD)	76.8 (7.4)	76.1 (7.0)	.62
Mean age of men, y (SD)	75.1 (7.1)	74.9 (7.0)	.85
Mean age of women, y (SD)	78.7 (8.3)	77.5 (6.7)	.20
Female sex	127 (46.9%)	131 (47.0%)	.98
Living alone	92 (33.9%)	100 (35.8%)	.53
Nursing home	6 (2.2%)	10 (3.6%)	.48
>7 years of education	45 (16.6%)	45 (16.1%)	.61
Prior medical history			
Prior stroke	58 (21.4%)	71 (25.4%)	.12
Myocardial infarction	51 (18.8%)	41 (14.7%)	.32
Atrial fibrillation	55 (20.3%)	60 (21.5%)	.90
Hypertension	118 (43.5%)	116 (41.6%)	.21
Diabetes	39 (14.4%)	43 (15.4%)	.52
Malignancy	24 (8.9%)	27 (9.7%)	.79
Former smoker	75 (27.7%)	89 (31.9%)	.46
Current smoker	60 (22.1%)	60 (21.5%)	.91
SSS	41 (22–49)	44 (26–52)	.22
BI	45 (10–80)	50 (2.5–85)	.54
Urinary incontinence	80 (29.5%)	85 (30.5%)	.81
Unconscious	23 (8.5%)	28 (10.0%)	.53
Hemorrhage on CT	38 (14.0%)	28 (10.0%)	.15

Continuous data are expressed as mean \pm SD. SSS and BI are expressed as median values with interquartile ranges. Categorical data are expressed as number of patients with/without a given characteristic and also in (%).

improvement in neurological score was significantly better among patients treated in the SU than in the GMW ($P=.036$). This effect appeared during the first 5 days and was sustained until the end of the observation. There was no significant difference in change of BI ($P=.152$). The between-groups effect 7 months after stroke was insignificant for both neurological score and ADL (Table 4). The change in neurological score for missing patients during the first 5 days showed the same pattern as that for patients who were not missing.

TABLE 3. Outcome by Treatment Groups 7 Months After Stroke

	SU (n=271)	GMW (n=279)	OR (95% CI)
Death	61 (22.5%)	70 (25.1%)	0.87 (0.59–1.28)
Need of long-term care	40 (14.8%)	43 (15.4%)	0.95 (0.60–1.52)
Survived and improved	157 (64.6%)*	154 (60.6%)†	1.12 (0.80–1.57)
Survived but did not improve	13 (5.3%)*	12 (4.7%)†	1.12 (0.50–2.50)
Deteriorated	12 (4.9%)*	19 (7.5%)†	0.63 (0.30–1.33)
Deteriorated or died	73 (30.0%)*	89 (35.0%)†	0.79 (0.55–1.14)

Data are expressed as number of patients with/without a given characteristic and also in (%) and odds ratios (OR) with 95% confidence intervals (CI).

*n=243.

†n=254. (Patients missing are not included in the analysis of improvement/deterioration.)

TABLE 4. Comparison of Change in SSS and BI Scores by Treatment Group and Time Intervals

	SU	GMW	P*
SSS day 1	46	49	
SSS day 5	50	51	
SSS 7 months	55	54	.036
BI day 1	55	60	
BI day 5	66	68	
BI 7 months	83	84	.152

SSS and BI scores are median values.

*Probability value between groups by time from day 1 to 7 months for patients who survived and were eligible at 7 months (Mann-Whitney test).

Table 5 shows the difference in treatment offered to the two groups. Patients in the SU were mobilized out of bed earlier after admission than patients in the GMW. Patients in the SU were more often given parenteral fluids <24 hours after admission and aspirin <12 hours after arrival. During the stay in the SU, patients were more frequently given acetaminophen and antibiotics. Patients in the GMW were more often treated with low-molecular-weight heparin. Recurrent stroke >24 hours after admittance but during hospitalization occurred in 13 of the patients in the GMW and 2 of the patients in the SU (*P*=.03).

Discussion

This study is the first of this size to focus on the benefit of an SU with a relatively short length of stay compared with a GMW. Our results favored the SU 7 months after stroke, but none were statistically significant. There was no difference in SSS or BI scores between the treated groups at 7 months. Our study, however, indicates that treatment in an acute SU with a short length of stay hastens recovery by decreasing neurological deficits and that the first 5 days of treatment are of particular importance. We believe that the effect on impairment ob-

TABLE 5. Treatment Offered in the SU and GMW

Treatment	SU (n=279)	GMW (n=271)	OR (95% CI)
Mobilization out of bed <24 h	44.0	26.5	2.18 (1.47–3.24)
Parenteral fluid, %	97.0	32.7	67.3 (31.9–142)
Aspirin <12 h, %	55.9	18.8	5.47 (3.72–8.04)
Aspirin 12–24 h, %	14.1	25.7	0.47 (0.31–0.73)
Aspirin >24 h (%)	6.7	29.3	0.17 (0.10–0.30)
Acetaminophen, %	56.7	27.2	3.50 (2.45–5.01)
Penicillin, %	15.2	10.9	1.47 (0.89–2.43)
Antibiotics except penicillin, %	23.3	7.6	3.70 (2.18–6.26)
Insulin, %	6.3	3.3	1.99 (0.87–4.55)
Warfarin, %	10.4	14.9	0.66 (0.40–1.11)
Low-molecular-weight heparin, %	11.1	44.6	0.16 (0.10–0.24)
β-Blocker, %	16.7	12.7	1.38 (0.85–2.22)
Diuretics, %	25.9	23.9	1.11 (0.76–1.64)
Calcium antagonists, %	18.1	21.7	0.80 (0.52–1.22)
Other antihypertensive agents, %	20.4	19.9	1.03 (0.68–1.56)

OR indicates odds ratios; CI, confidence interval.

served in this study was due to the acute care, since the difference in outcome was present within the first days after admittance. However, as shown in Table 2, the groups were not entirely comparable on admission, and therefore a ceiling effect or low interrater reliability in the first assessment of the SSS theoretically may have contributed to the difference in change in neurological scores. The treatment offered in the SU and the GMW differed in organization, time from admission to mobilization, acute medical treatment, and length of stay. The longer hospitalization in the SU could explain some of the difference in outcome, but since most of the difference occurred before day 5, the extra days of treatment were probably not of major importance for the effect. The study also shows that acute treatment in an SU with this length of stay is not sufficient to improve ADL. Previous studies of patients treated in an SU have shown a better functional outcome measured as reduced disability,^{2–4,6–9} but in these studies the length of stay was considerably longer.

Even with the most precise research designs, many elements of care within SUs are difficult to assess, eg, the extent and quality of communication between patients and caregivers and communication between professionals. However, this study can document several factors in the treatment package that differed significantly between the two departments. Patients in the SU were mobilized earlier, more often received aspirin within 12 hours after admittance, and were significantly more often given parenteral fluids. The SU group was also more often given acetaminophen and antibiotics. Early mobilization and intensive rehabilitation are believed to be important^{6,13} to reduce intracerebral pressure and cerebral edema and prevent complications. Parenteral fluids may have reduced the occurrence of dehydration. High plasma osmolality has been shown to be a predictor of reduced survival, and it has been shown that hemodilution can improve cerebral hemodynamics.^{32–34} Fever is shown to worsen prognosis,^{35–38} and the use of antipyretic agents may have contributed to the effectiveness of the SU. Insulin was given twice as often in the SU as in the GMW (Table 5). Hyperglycemia after acute stroke has proven to predict a poorer chance of survival and independence.³⁹ There was a more widespread use of antibiotics in the SU, which may have prevented development of serious infections. The staff in the SU particularly focuses on avoiding and detecting complications, and consequently such conditions were probably discovered early. The treatment in the SU is organized and multidisciplinary. The staff is continually trained in stroke, and there are regular meetings. We have identified differences in the treatment package, but we cannot with certainty rank the importance of the different treatment factors.

One strength of this study is that it represents the general population of stroke patients because all acute strokes were included. General practitioners in the area were reminded several times to send all persons with acute stroke to the hospital without delay. Even patients with minor symptoms or patients living in nursing homes were hospitalized. It is likely, however, that some patients with minor strokes did not seek medical advice or were not admitted to the hospital by health services in the community. Some severely disabled patients already living in nursing homes were probably not transferred to the hospital when they had a stroke.

In regard to possible sources of bias of this study, we performed a subgroup analysis that did not reveal a ceiling effect of the SSS used for this stroke population.

The data regarding patients and type of stroke should be of high quality. One of the researchers examined every record carefully before coding. To test the accuracy of coding, several sets of records were assessed twice, revealing identical results. The initial difference in median SSS scores may partly be due to unreliable baseline assessments because of several practitioners on duty. However, the assessments were performed the next day by the primary investigator, and the difference in median SSS and BI scores still existed. If the difference in SSS score on admission was not due to low interrater reliability, the randomization procedure may have produced two unbalanced treatment groups. Hence, in this study the effect of the SU on SSS score is to gradually approach the SSS score of patients treated in the GMW. The scales used are crude, which should reduce the effect of observer bias. Indredavik et al⁶ showed a high correlation between open and blind testing of functional state using the reported instruments.

In conclusion, we found a SU with a relatively short length of stay to be beneficial compared with a GMW. The effects are compatible with other SU studies reported.²⁰ Several components in the treatment package differed significantly between the treatment groups. Future studies should evaluate the effect of certain components of treatment in the SU.

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