In a prospective, controlled study, we compared the clinical outcome in patients admitted to the acute phase of a non-intensive stroke unit (SU) to the outcome in stroke patients admitted to general medical wards (GMWs). We demonstrated that functional disability was diminished and that the need for long-term hospitalization over the first year was reduced in SU patients compared to GMW patients. Since stroke unit resources are limited, it is important to identify subgroups of stroke patients that benefit more from SU care. The present investigation is an extension of our previous study comparing care in a SU and in GMWs in the acute phase of stroke. We have related the clinical outcome to some factors known to affect the prognosis in stroke patients, such as age, neurological deficits on admission, and previous history. In subgroups where the general prognosis is fair or good, SU care accelerated the process of rehabilitation, but the need for institutional care very late after the stroke was influenced only little. In groups with a poor general prognosis, the ultimate proportion of patients able to return home was enhanced by SU care. It is concluded that care in a stroke unit benefits the great majority of stroke patients and that such care should be designed to admit all acute stroke patients without selection.

Patients and Methods

Umeå University Hospital serves a population of about 118,000 inhabitants in the city of Umeå and the surrounding rural area. All acute stroke patients in this district are admitted to the Department of Medicine. Admissions to the SU and the GMWs are closely similar in all prognostic indicators. Subsets of patients were analyzed in an attempt to identify groups that benefit more than others from stroke unit care.

The Stroke Unit

The stroke unit is a six-bed care and research unit for patients with acute cerebrovascular disease. Admission criteria are: all patients who, without preceding trauma to the head, present with focal neurological dysfunctions with a duration not exceeding one week or patients with TIA (transitory ischaemic attack) during the last week. Standardized regimes for investigation, treatment and rehabilitation are applied.

Study Design

During a 16-month period (October 1979 to January 1981), all 293 acute stroke patients fulfilling the admission criteria of the stroke unit were included in the study when admitted to the Department of Medicine. Patients with subarachnoidal hemorrhage were all transferred directly from the emergency room to the Department of Neurosurgery; otherwise no patients were excluded. Patients were admitted either to the stroke unit provided a bed was available, or to one of the other four general medical wards. The organization and operation of the stroke unit, allocation procedure and the differences between the stroke unit regime and general medical wards have been described previously.

Patients

During the study period 110 patients fulfilling the inclusion criteria were admitted to the SU and 183 to the GMWs. Mean age (± SD) was 72 ± 11 yrs in SU patients and 73 ± 9 yrs in GMW patients. The proportion of males was 58% and 54%, respectively, in the two groups. Some other essential characteristics of the two patient populations are given in Table 1. Detailed...
Table 1: Patient Characteristics on Admission to Hospital and Mortality at 3 and 12 Months' Follow-up in Stroke Patients Admitted to a Stroke Unit (SU) and/or General Medical Wards (GMW) Related to Age, Neurological Deficits on Admission and Previous Medical History

<table>
<thead>
<tr>
<th>Patient characteristics on admission</th>
<th>Total number of patients (%)</th>
<th>Mortality at 3 months</th>
<th>Mortality at 12 months</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SU (54)</td>
<td>GMW (46)</td>
<td>SU (44)</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 75 years</td>
<td>59 (75)</td>
<td>90 (49)</td>
<td>44 (44)</td>
</tr>
<tr>
<td>&lt; 75 years</td>
<td>51 (46)</td>
<td>93 (51)</td>
<td>21 (21)</td>
</tr>
<tr>
<td>Hemiparesis*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present†</td>
<td>66 (60)</td>
<td>116 (63)</td>
<td>38 (38)</td>
</tr>
<tr>
<td>Not present†</td>
<td>38 (35)</td>
<td>64 (35)</td>
<td>16 (16)</td>
</tr>
<tr>
<td>Previous medical history</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cardiac disease‡</td>
<td>71 (65)</td>
<td>95 (52)</td>
<td>39 (39)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>55 (50)</td>
<td>92 (50)</td>
<td>38 (38)</td>
</tr>
<tr>
<td>Previous completed stroke</td>
<td>20 (18)</td>
<td>42 (23)</td>
<td>35 (35)</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>19 (17)</td>
<td>36 (20)</td>
<td>53 (53)</td>
</tr>
<tr>
<td>None of the above</td>
<td>12 (11)</td>
<td>37 (20)</td>
<td>17 (17)</td>
</tr>
</tbody>
</table>

*For definitions, see text.
†Comatose patients are excluded.
‡Angina pectoris, myocardial infarction, congestive heart failure and atrial fibrillation isolated or in combinations.
§p < 0.05, x2-test, SU vs GMW patients.

description of the populations has been presented previously.1

To ensure that the mode of patient selection to the SU was unbiased not only in the entire population but also in subgroups, patients were compared in several characteristics on admission to the SU and the GMWs, respectively. Sex, age, side and extent of neurological deficits, previous stroke, cardiac disorders, hypertension and diabetes were analyzed in a multiple linear regression model. There were only weak bivariate correlations between each of these items on one hand and admission to the SU or to GMWs on the other (r values = 0.02-0.12). When all these items were combined in the analysis, they offered only a low degree of explanation (R2 = 0.04, p = 0.13), indicating that there was no systematic bias in the selection of patients to the SU. Only in one subgroup did the statistical analyses indicate a difference between SU and GMW patients: a history of cardiac disorder was more common among SU patients (p < 0.05).

Mean length of initial hospital stay was similar for SU and GMW patients who died (14 vs. 15 days) or were discharged to their homes (15 vs. 18 days). For patients transferred to long-stay hospital, the waiting period for SU patients was shorter than for patients from the GMWs (43 vs. 58 days), due to a special agreement with the Department of Long-Term Care Medicine.

Statistics

To estimate mortality and need for hospital care, the life-table technique and log-rank tests according to Peto et al. were used.3 In these analyses, trial time was defined as the number of days from admission to hospital for acute stroke to discharge from the Department of Medicine or, for patients transferred, from the Department of Long-Term Care Medicine. If the patient was discharged to another clinic or to a nursing home, he/she was regarded as being hospitalized at the end of trial time. Relative rates of discharge were calculated as follows:

Rel. rate (GMW:SU) = (observed frequency/estimated frequency) in GMW pts
(observed frequency/estimated frequency) in SU pts

Multiple linear regression was calculated as described by Snedecor and Cochran,4 where beta is the standardized regression coefficient. P values are from tests of \( \beta_i \) against 0.

Results

Mortality Rates

As shown in figure 1 there were no major differences in survival rates between the 110 patients treated in the SU and the 183 treated in GMWs. Statistical comparison by log-rank test between the two groups over the entire trial time yielded a p-value of 0.38. The one-year probability of survival calculated by the life-table technique was 0.60 in SU patients and 0.56 in GMW patients.

Table 1 shows the mortality at 3 and 12 months after stroke when patients were subclassified with regard to age, neurological deficit on admission and previous medical history. No important differences between SU and GMW patients emerged in any subgroup. Not shown in the table is the outcome in patients comatose on admission. All 6 comatose patients admitted to the SU died. Of the 3 comatose subjects admitted to GMWs, 2 died early; the survivor was apparently, on admission, in a postictal phase after stroke-induced epileptic seizures.
Figure 1. Probability of survival after inclusion into the study when all patients are considered (SU n = 110, GMW n = 183). The insert shows survival during the first 50 days in more detail. The life-table technique and log-rank test according to Peto et al² are used.

Need for Hospital Care

Among survivors, the need for hospitalization was markedly reduced throughout the first year after initial treatment in the SU (fig. 2). Log-rank testing confirmed that the difference in favour of the stroke unit regime was of high statistical significance (p = 0.0001). The relative GMW:SU rate for discharge from hospital after stroke was 0.59:1.

To determine whether or not SU care was of particular benefit to any subgroup of patients, the outcome was related to several basic patient characteristics. The results of log-rank analyses and tests of these subsets of patients are summarized in fig. 3 as relative rates of discharge. It appears that the relative rates were lower in all categories, if the patients had been treated in the SU; the differences were statistically significant in most subgroups. Since age is one of the factors that would be considered when selecting patients for admission to the SU, it was notable that the probability of discharge from hospital was reduced as much in patients ≥ 75 years as in those < 75 years of age (fig. 3). In these two groups, the relative GMW:SU rates of discharge from hospital were 0.58:1 and 0.59:1, respectively (p < 0.01 in both groups). Another putative basis for patient selection to the stroke unit, is the extent of neurological deficit on admission. Therefore, patients were subdivided to those "with hemiparesis" involving the upper as well as the lower extremity and those with lesser deficits ("without hemiparesis"). The relative GMW:SU rate of discharge from hospital was 0.58:1 in patients "with hemiparesis" and 0.62:1 in subjects "without hemiparesis"; in both groups the difference in favour of the SU was of high statistical significance (fig. 3).

The life-table analysis we used takes into account only a continuous period of hospital care after the stroke. Many of the stroke patients are readmitted for various reasons and, hence, the life-table analyses underestimate their entire consumption of hospital care. To get an estimate of this, a survey of patients in hospital or in nursing home one year after the stroke was made (fig. 4A). Up to this one-year follow-up, 12 of the 27 SU patients (44%) and 29 of the 72 GMW patients (40%) transferred to long-term hospital died. In the inventory at one year after the index event, too, the difference in hospitalization in favour of the SU regimen was marked in subjects ≥ 75 years old (7% vs. 20% in GMW patients; p < 0.02 by chi-square test). In patients < 75 years old, the effect of initial care in the SU vs. the GMW on the need for hospital care at one year after the stroke was less evident, the proportions being 8% and 13%, respectively, in the two groups (p > 0.05). As shown in fig. 4B, the inventory revealed a difference that was still apparent in patients "with hemiparesis" (9% vs. 21%; p < 0.05 by chi-square test). In patients "without hemiparesis"
Multivariate Analysis

To rank the effect of different factors of importance for the clinical outcome, particularly SU vs. GMW acute care, multiple regression analysis was performed. In the calculations, all 227 patients still alive at discharge from the Department of Medicine (SU and GMW patients) were included and possible determinants were analyzed in relation to home care or further hospital care. In these calculations, only subjects discharged alive from the Department of Medicine were considered. The relative GMW:SU rate of discharge was similar among married patients (0.40:1) and others, i.e. unmarried individuals and widow(er)s (0.44:1).

on admission, the corresponding proportions at the one-year follow-up were 5% and 9% in SU and GMW patients, respectively (p > 0.1).

We also considered if our emphasis on active family involvement in the SU care contributed to the favourable outcome or not. Therefore, married and non-married patients were analyzed separately. In these calculations, only subjects discharged alive from the Department of Medicine were considered. The relative GMW:SU rate of discharge was similar among married patients (0.40:1) and others, i.e. unmarried individuals and widow(er)s (0.44:1).

Overall mortality rates were similar in the SU and the GMWs over the first year. In view of the small number of deaths in some of the subgroups, the effect of SU care on mortality in these groups should be interpreted with care. Nevertheless, it seems safe to conclude that there is no major impact of non-intensive SU care on mortality, even in groups with high mortality rates such as patients with diabetes, concomitant cardiac disorders, severe neurological deficit on admission or age above 75. Other investigators have previously found that mortality rates in the acute phase of stroke are little influenced by SU intensive-care. The mortality rate in comatose stroke patients is very high and the possibilities to improve their survival are limited. The present results support the view that patients in coma are not likely to benefit from SU care. Because mortality was so closely similar in SU and GMW patients, it seems appropriate to discuss the clinical outcome in surviving stroke patients and their need for long-term hospitalization in more detail.

Whether or not long-term care in hospital or nursing home is required after a stroke is determined not only by persisting neurological deficits — mental, psychological and social aspects are also involved. In particular, the extent of family involvement could be important and we have regarded intense family support and family education as cornerstones in our SU strategy. This contention is not supported by the present SU vs. GMW comparison of patients with different marital status, right-sided vs. left-sided neurological deficits, presence/absence of cardiac disorders, diabetes, previous stroke and hypertension. All these factors had low beta (0.077-0.003) and high p values (0.225-0.967).

Discussion

In a previous report, we concluded that the mode of patient selection to our SU is unbiased and that those admitted are representative of all subjects hospitalized for acute stroke within a well-defined population. Using a different statistical approach — multiple regression analysis of several patient characteristics on admission to hospital — we now have confirmed that it is unlikely that patients in the SU and GMWs differ at entry. The apparent greater prevalence of previous cardiac disorders in SU patients could have resulted from more determined search for cardiovascular diseases in patients that enter the SU. It seems that the distribution of background variables elucidated in the present study well serve the purpose of identifying subgroups within the stroke population that benefit from care in the SU.

In the multiple regression analysis of variables that determine the need for long-term hospital care, three prominent factors were recognized: the extent of paresis on admission, advanced age and care in GMWs (as opposed to SU). This confirms and amplifies our previous conclusion.

The proportion of patients who are dead, hospitalized or at home 12 months after inclusion into the study as related to age (A) and neurological deficit on admission (B). "Hemiparesis" is defined as all degrees of concomitant arm and leg paresis. Patients "without hemiparesis" did not present with concomitant arm and leg paresis. Comatose patients are not included in fig. 4B. Chi-square test was used for testing the significance of differences in proportions of patients in hospital vs. patients at home. Figures in parentheses denote numbers of patients in each group and figures in the columns are percentages.
before we refute family support as an important aspect of SU care.

An effect of SU care was demonstrated in patients below as well as above 75 years of age. The two age groups were somewhat different when the temporal aspects were considered. Thus, among patients < 75 years old, the impact of SU care on the need for hospitalization was greatest during the first months after the stroke, the difference in favour of the SU regime being smaller by one year after the stroke. In patients ≥ 75 years, the difference between SU and GMW patients was modest early after the index event but sustained over one year. It seems that, in the younger age group, an active regime in the SU early after the stroke hastened the rehabilitation process, but that the same (or nearly the same degree of independence was ultimately reached after GMW care. The sustained difference in favour of the SU in very old stroke patients indicates that an early active approach is required to uncover their entire rehabilitative potential even in a long-term perspective. In these elderly patients, it is not only a question of regaining functional capacity that has been lost, but also of countering the slowly progressing functional deterioration that seems to be the norm for impaired geriatric patients.11

The advantage of SU care seemed to be valid for patients with ma as well as minor extremitu paroses. One year after the stroke, the difference in favour of the SU was still apparent in the former group, less conspicuous in the latter. From this observation and the findings in the two age groups discussed above, a more general pattern emerges: If the natural prognosis for residual function is fair or good, SU care accelerates the process of rehabilitation, but the need for institutional care late after the stroke is influenced only little. If, on the other hand, the prognosis is poor,12 the ultimate proportion of patients ever able to return to home is enhanced by SU care.

Subclassification of the stroke patients with regard to their previous medical history failed to recognize a group with a particularly great impact of the SU regime on the need for long-term hospital care. Hence, selection of patients to a SU on the basis of their previous medical history does not seem to be warranted.

In many patients, stroke is but one of many serious vascular complications in the final years of life. It could be argued that early active therapeutic intervention resulting in increased survival is dubious from an ethical point of view, because the quality of life may be poor in some of the surviving but severely disabled patients. Since the difference in favour of the SU over the GMWs applied only to hospitalization in survivors and not to mortality, this reservation does not seem too appropriate. Instead, it appears that among old patients, those with severe neurological deficits on ad-

mission or with coexisting cardiovascular disorders benefit as much as from SU care as patients with more favourable spontaneous prognosis. This conclusion is valid only for the first year after stroke. To make up a final long- perspective balance sheet of SU and GMW care in subgroups of patients, the reduced life expectancy in some risk groups must also be taken into account. Our data do not permit such calculations.

We conclude that a stroke unit regime — which reduces functional disability and the need for long-term hospital care — should be applied to all patients with acute stroke with one possible exception: we have no indications that patients that are comatose on admission to hospital benefit from care in a SU. In all other patient groups, the psychological, social and economic gains attending a reduced need for long-term hospitalization are expected to be substantial. Active, structured intervention in the acute phase of stroke could be multidimensionally profitable. As discussed in some detail previously,11 it is now essential to identify and further develop those components of the integrated stroke unit care that are of particular benefit to the patient.

Acknowledgments

We are indebted to Margareta Engle, our stroke nurse, Axel Fugl-Meyer, head of the Department of Rehabilitation Medicine, and all members of the staff at the Stroke Unit for making this study possible.

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Stroke. 1986;17:377-381
doi: 10.1161/01.STR.17.3.377

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