Benefit of an Extended Stroke Unit Service With Early Supported Discharge
A Randomized, Controlled Trial

Bent Indredavik, MD, PhD; Hild Fjærtoft, RPT; Gun Ekeberg, RN; Anne D. Løge, RPT; Birgitte Mørch, RN

Background and Purpose—Several trials have shown that stroke unit care improves outcome for stroke patients. The aim of the present trial was to evaluate the effects of an extended stroke unit service (ESUS), with early supported discharge, cooperation with the primary healthcare system, and more emphasis on rehabilitation at home as essential elements.

Methods—In a randomized, controlled trial, 160 patients with acute stroke were allocated to the ESUS and 160 to the ordinary stroke unit service (OSUS). The primary outcome was the proportion of patients who were independent as assessed by the modified Rankin Scale (RS) (RS $\leq 2$ = global independence) and independent in activities of daily living (ADL) as assessed by Barthel Index (BI) (BI $\geq 95$ = independent in ADL) after 26 weeks. Secondary outcomes were RS and BI scores after 6 weeks; the proportion of patients at home, in institutions, and deceased after 6 and 26 weeks; and the length of stay in institutions.

Results—After 26 weeks, 65.0% in the ESUS versus 51.9% in the OSUS group showed global independence (RS $\leq 2$) ($P=0.017$), while 60.0% in the ESUS versus 49.4% in the OSUS group were independent in ADL (BI $\geq 95$) ($P=0.056$). The odds ratios for independence (ESUS versus OSUS) were as follows: RS, 1.72 (95% CI, 1.10 to 2.70); BI, 1.54 (95% CI, 0.99 to 2.39). At 6 weeks, 54.4% of the ESUS group and 45.6% of the OSUS group were independent according to RS ($P=0.118$), and 56.3% versus 48.8% were independent according to BI ($P=0.179$). The proportion of patients at home after 6 weeks was 74.4% for ESUS and 55.6% for OSUS ($P=0.0004$), and the proportion in institutions was 23.1% versus 40.0%, respectively ($P=0.001$). After 26 weeks, 78.8% in the ESUS group versus 73.1% in the OSUS were at home ($P=0.239$), while 13.1% versus 17.5% were in institutions ($P=0.277$). The mortality in the 2 groups did not differ. Average lengths of stay in an institution were 18.6 days in the ESUS and 31.1 days in the OSUS group ($P=0.0324$).

Conclusions—An ESUS with early supported discharge seems to improve functional outcome and to reduce the length of stay in institutions compared with traditional stroke unit care. (Stroke. 2000;31:2989-2994.)

Key Words: clinical trials • stroke management • stroke unit

Several trials have shown that stroke unit care improves outcome for acute stroke patients. More limited information exists about the most effective way to organize the follow-up after acute care in a stroke unit. Stroke patients conventionally receive a substantial part of their rehabilitation in hospitals or in other institutions that offer a 24-hour stay. Some trials have tried to evaluate the effects of rehabilitation at home compared with rehabilitation in day clinics or in 24-hour institutions, but only one of them was able to show a significantly positive effect of rehabilitation at home. In other trials a service has been developed that offers patients in the hospital an early discharge with a follow-up that consists of different kinds of community-based rehabilitation. In the Cochrane Library such services have been classified with the term “early supported discharge service.” Organization of early supported discharge service seems to reduce the length of hospital stay, but whether this management improves outcome compared with more traditional inpatient rehabilitation remains unclear.

We have previously shown that treatment in our combined acute and rehabilitation stroke unit during the acute stage of a stroke (ie, the first 1 to 2 weeks) is beneficial. For several years we have investigated possibilities for further improvement of our stroke unit care. During the last several years we have developed an extended stroke unit service (ESUS) with early supported discharge. Close cooperation with the primary healthcare system and more emphasis on rehabilitation at home are essential elements in this service. The primary aim of the present trial was to test the hypothesis that stroke patients who receive ESUS have improved out...

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come compared with stroke patients who receive ordinary stroke unit service (OSUS).

Subjects and Methods

Patients with signs and symptoms of acute stroke from the city of Trondheim, Norway, who were admitted to the stroke unit were screened for inclusion in the trial. Inclusion criteria were as follows: signs and symptoms of an acute stroke according to the World Health Organization definition of stroke;22 Scandinavian Stroke Scale (SSS) score between 2 and 57 points; living at home before the stroke; included within 72 hours after admission to the stroke unit and within 7 days after the onset of symptoms; lack of participation in other trials; and provision of informed consent. Patients fulfilling the inclusion criteria were included and randomly allocated to either an OSUS or a newly constructed ESUS.

OSUS was developed during a previous trial20–24 and consisted of treatment in a combined acute and rehabilitation stroke unit and further follow-up organized by rehabilitation clinics and/or the primary healthcare system. The service, which includes systematic diagnostic evaluation, standardized observation of vital signs and neurological deficits, an acute medical treatment program, and very early mobilization and rehabilitation in a stroke unit, has previously been described in detail.24 In a randomized, controlled trial, OSUS has shown to be very beneficial compared with treatment in general wards.20–23 In terms of follow-up after initial stroke unit care, OSUS was similar to the system used in our previous stroke unit trial.24 Hence, OSUS may be defined as stroke unit treatment according to evidence-based recommendations combined with further inpatient rehabilitation when more long-term rehabilitation is necessary and a follow-up program organized by the primary healthcare system after discharge.

As part of the present trial, a more extended service (ESUS) was developed. The goal for ESUS was to create a healthcare service system and a chain of care that was able to optimize recovery for patients to return them to an active life at home as soon as possible. The evidence is strong for better outcome for patients in stroke units.1,9,20–23 Hence, the first link in our chain of care in ESUS consisted of acute care in the stroke unit that was similar to care in OSUS and similar to care in our previous trial.24 In the development of a follow-up program in ESUS, 2 hypotheses were essential. The first hypothesis was that close cooperation between the stroke unit and the primary healthcare system was beneficial for the recovery of the patient. The second hypothesis was that training and rehabilitation at home or in day clinics were more effective than 24-hour inpatient rehabilitation if the patient did not need continuous care and nursing 24 hours a day.

On the basis of these hypotheses, we developed ESUS and performed a pilot trial25 that convinced us that the hypotheses were worth testing in a randomized trial. A mobile stroke team was developed and established as part of this trial to organize and coordinate the extended service. ESUS may therefore be defined as stroke unit treatment similar to OSUS combined with service from a mobile team that offers early supported discharge and coordinates further rehabilitation and follow-up in close cooperation with the primary healthcare system.

The mobile team had its base in the stroke unit but was specially designed to cooperate with the primary healthcare system and to offer support during the first period after discharge. The team consisted of a nurse, a physiotherapist, an occupational therapist, and the part-time services of a physician. As soon as a patient was randomized to ESUS, a member of the team collected basic information about the patient and his/her medical condition, comorbidity, the situation at home before the stroke, and existing support from family, friends, and eventually the healthcare system. Together with the staff in the stroke unit, a preliminary evaluation of the needs of the patient during the recovery phase was made. Simultaneously, the primary healthcare system was informed about the patient. In cases in which direct discharge to home was likely to occur, a visit at home was usually performed as soon as the medical condition of the patient was stable. The patient, the family if possible, and representatives from the primary healthcare system and the mobile stroke team participated. During the visit, a plan for further follow-up for necessary nursing, support, and rehabilitation was made. Furthermore, the different tasks necessary for the follow-up program were delegated to dedicated members of the service system. The mobile stroke team was responsible for coordination of the different agencies and activities.

The team tried to establish a service and support system that allowed the patient to live at home as soon as possible after the stroke and to continue necessary training and rehabilitation at home, in a day clinic, or by a combination of those 2 alternatives. In most cases the primary role of the team was coordination, but for some patients with more extensive needs, the team also offered training and support at home in addition to service from other agencies. However, most of the service and support was offered by trained staff in the community healthcare system, which played an important role in the support system.

On the day of discharge, a dedicated discharge meeting was organized in which all plans were again checked, and the patient and family were informed in detail about further plans for treatment, rehabilitation, support, help, and follow-up.

For patients with very extensive deficits after the stroke who needed continuous help and support 24 hours a day, a plan for further inpatient rehabilitation in a rehabilitation clinic was made in close cooperation between the mobile team, the stroke unit, and the rehabilitation clinics. Similar to the case for patients who were discharged directly to home, early discharge and further treatment/rehabilitation while the patient stayed at home were emphasized. Hence, the stay in rehabilitation clinics was kept as short as possible.

The close follow-up by the mobile team was present for the first month after discharge to home and was terminated with an outpatient consultation. The physician who had treated the patient during the acute stage in the hospital (ie, the stroke unit), a member of the mobile team, the patient, and eventually the family participated during this outpatient consultation. An evaluation and summary of the period from stroke onset through the acute stage to the establishment at home were made. During this evaluation the patient and the family were invited to present their view about plans that did not work, plans and goals that had to be changed, and needs, hopes, and worries they had for the future. An evaluation of the treatment program for secondary prophylaxis was also made, and improvements and changes were introduced if necessary.

A final report was sent to the family physician with advice for further follow-up. The home nursing personnel and therapists or other members of the primary healthcare system, when indicated, were also informed about the present condition of the patient, the treatment and rehabilitation thus far, and further plans. After care by the outpatient clinic 1 month after discharge, the primary healthcare system was responsible for all further follow-up but could immediately contact members of the stroke team if problems occurred that were difficult to solve by the primary healthcare system alone. Three months after discharge, the patients and their families were invited to a meeting for a larger group of stroke patients. There they were generally informed about stroke and the problems and possibilities for stroke victims.

The main points in ESUS are summarized in Figure 1. The Regional Committee on Medical Research Ethics evaluated the study protocol and approved the trial.

Evaluation

The primary outcome was Barthel Index (BI) and modified Rankin Scale (RS) scores 26 weeks after the onset of stroke. Secondary outcomes were BI and RS scores at 6 weeks; the proportion of patients at home, in institutions, and deceased after 6 and 26 weeks; and length of stay in an institution before discharge to final residence. Finally, a subgroup analysis of patients with moderate to severe stroke, defined as SSS score ≤52 at baseline, was performed using the same outcomes as for the whole trial population.

Neutral assessors specially trained in the use of BI and RS performed all assessments. Hence, the evaluation was blinded as far as blinding is possible in these kinds of trials.
Patients with a BI score $\geq 95$ were classified as independent in activities of daily living (ADL). Independence according to RS (global independence) was present if a patient achieved a RS score $\geq 2$. Differences between groups in the proportion of patients independent, at home, in institutions, and deceased were compared by the $\chi^2$ test. For independence we also calculated the odds ratio (OR). The length of stay in institutions was compared by the Mann-Whitney test.

Group homogeneity was analyzed with the $\chi^2$ test for sex, medical history, living conditions, and distribution of diagnoses. Age and severity of the stroke according to the SSS score at baseline were analyzed by the Mann-Whitney test. In all analyses the principle of intention to treat was applied, and a $P$ value $<0.05$ was considered significant.

Five patients did not want to participate in all examinations during the whole follow-up. For these patients the assessments on RS and BI were performed by other available information. All patients had participated in at least 1 assessment, and with the results of this assessment combined with telephone interviews of the patient and information from readmissions to the hospital, it was possible to categorize their functional level.

### Results

During a period of 24 months after March 1, 1995, 468 acute stroke patients from the city of Trondheim were screened for inclusion in the trial. Of these patients, 320 fulfilled the inclusion criteria and were included in the trial. The reasons for exclusion (148 patients) were as follows: SSS score $<2$ or $\geq 57$, 105 patients; onset of symptoms $>7$ days before the screening for inclusion, 14 patients; admission to the unit $>72$ hours before the screening for inclusion, 3 patients; included in other trials, 12 patients; admitted from nursing homes, 4 patients; and no informed consent, 10 patients. The 320 patients included were randomly allocated to the 2 different stroke service systems: 160 patients to OSUS and 160 patients to ESUS.

Table 1 shows the baseline characteristics of the 2 groups. No significant difference existed concerning age, sex, living conditions, and medical history. The average and median SSS scores at baseline (immediately before inclusion/randomization) were almost identical in the 2 groups, as were the BI and RS performed within 24 hours after randomization. The distribution of diagnoses was also similar in the 2 groups of patients (Table 2).

The primary outcome was RS and BI scores after 26 weeks. Sixty-five percent of the patients treated in the ESUS and 51.9% of the patients treated in the OSUS were independent according to RS after 26 weeks (RS score $\geq 2$) ($P=0.017$) (Figure 2). As also shown in Figure 2, the proportion of patients independent in ADL after 26 weeks, defined as BI score $\geq 95$, was 60.0% in ESUS versus 49.4% in OSUS ($P=0.056$). Table 3 shows the OR for independence in the ESUS group versus the OSUS group after 26 weeks.
As shown in Figure 3, 54.4% of the patients in the ESUS group and 45.6% of the patients in the OSUS group had global independence (RS score ≥2) after 6 weeks (P = 0.118), while 56.3% versus 48.8% had a BI score ≥95 (P = 0.179).

Table 4 shows that after the initial stay in the stroke unit, 64.4% of the patients in the ESUS were discharged directly to home compared with 45.6% of the patients from the OSUS (P = 0.001). Additionally, 33.1% of the ESUS patients were discharged to another institution (mainly rehabilitation clinics) versus 51.3% in the OSUS group (P = 0.001). The mortality was similar in the 2 groups during the stay in hospital.

The average stay in the hospital (stroke unit plus rehabilitation clinics) was 18.6 days in the ESUS group versus 31.1 days in the OSUS group (P = 0.0324). However, the average length of stay in the stroke unit was similar in the 2 groups (11 days).

As shown in Table 4, 74.4% of the patients in the ESUS group and 55.6% in the OSUS group were at home after 26 weeks (P = 0.0004), while 23.1% (ESUS) versus 40.0% (OSUS) were in institutions (P = 0.001). The mortality in the ESUS group was 2.5% versus 4.4% in the OSUS group, but this difference was not significant (P = 0.3573).

Table 4 also shows that 78.8% of the patients from ESUS were at home after 26 weeks versus 73.1% from the OSUS group (P = 0.239). The proportion of patients in institutions was 13.1% in the ESUS group and 17.5% in the OSUS group (P = 0.277), while mortality after 26 weeks also was similar in the 2 groups (8.1% versus 9.4%) (P = 0.692) (Table 4).

Subgroup analyses in which patients with very mild strokes, defined as SSS score ≤2, were excluded showed that patients with moderate to severe stroke (121 of 160 in the ESUS group and 122 of 160 patients in the OSUS group) benefited most from our extended service, with a significantly favorable outcome on both RS and BI after 26 weeks (Table 5).

**Discussion**

For the first time it has been shown that ESUS with early supported discharge and close cooperation between the stroke unit and the primary healthcare system improves outcome compared with OSUS with further inpatient rehabilitation and the usual follow-up by the primary healthcare system.

The RS showed significantly better outcome for the ESUS group after 26 weeks (P = 0.017) (OR = 1.72; 95% CI, 1.10 to 2.70), and BI also showed a clear result in favor of ESUS (P = 0.056) (OR = 1.54; 95% CI, 0.99 to 2.39). After 6 weeks there was a strong trend toward a higher proportion of patients being independent in the ESUS group, indicating that the ESUS not only improved the final outcome but also hastened recovery. Similar to the results from previous early supported discharge trials, the average hospital stay was

**TABLE 3. OR for Independence Assessed by RS and BI at 26 Weeks**

<table>
<thead>
<tr>
<th></th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS</td>
<td>1.72</td>
<td>1.10–2.70</td>
</tr>
<tr>
<td>BI</td>
<td>1.54</td>
<td>0.99–2.39</td>
</tr>
</tbody>
</table>

*RS ≤2 vs RS 3–6.
†BI ≥95 vs death or BI <95.

**TABLE 4. Number and Proportion of Patients at Home, in Institutions, and Deceased at Discharge From the Stroke Unit and After 6 and 26 Weeks From Onset of Stroke in ESUS and OSUS**

<table>
<thead>
<tr>
<th>Time</th>
<th>ESUS (n = 160)</th>
<th>OSUS (n = 160)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td>Discharge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To home</td>
<td>103</td>
<td>64.4</td>
<td>73</td>
</tr>
<tr>
<td>To institution</td>
<td>53</td>
<td>33.1</td>
<td>82</td>
</tr>
<tr>
<td>Dead</td>
<td>4</td>
<td>2.5</td>
<td>5</td>
</tr>
<tr>
<td>6 weeks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At home</td>
<td>119</td>
<td>74.4</td>
<td>89</td>
</tr>
<tr>
<td>In institution</td>
<td>37</td>
<td>23.1</td>
<td>64</td>
</tr>
<tr>
<td>Dead</td>
<td>4</td>
<td>2.5</td>
<td>5</td>
</tr>
<tr>
<td>26 weeks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At home</td>
<td>126</td>
<td>78.8</td>
<td>117</td>
</tr>
<tr>
<td>In institution</td>
<td>21</td>
<td>13.1</td>
<td>28</td>
</tr>
<tr>
<td>Dead</td>
<td>13</td>
<td>8.1</td>
<td>15</td>
</tr>
</tbody>
</table>

Figure 2. Proportion of patients with BI score ≥95 and RS score ≥2 at 26 weeks in ESUS and OSUS groups.

Figure 3. Proportion of patients with BI score ≥95 and RS score ≥2 at 6 weeks in ESUS and OSUS groups.
also significantly reduced in the ESUS group in our trial ($P=0.0324$). The reduction of inpatient stay occurred mainly because more of the subacute rehabilitation occurred in day clinics or at home, and it is worth noting that both groups received acute stroke unit care for an average of 11 days. Because of the early discharge, a significantly higher proportion of ESUS patients were at home after 6 weeks. After 6 months there was only a slight trend toward more patients at home, indicating that most OSUS patients were finally discharged to home. Without extended support, they needed a longer period in institutions before discharge.

Today in our country almost all acute stroke patients are admitted to the hospital. Several of our patients had mild strokes, and the outcome might have been favorable with any service system. Subgroup analyses indicate that patients with moderate/severe strokes assessed by SSS ($\leq 52$ at baseline) had the greatest benefit from our service system. The subgroup analyses were post hoc analyses, and caution is necessary in the interpretation of these latter results.

The patients in the control group (OSUS) probably received high-quality care because they received the same stroke unit care previously shown to be beneficial. The stroke unit has also previously cooperated with the primary healthcare system. However, in our standardized stroke unit care, the systematic program for acute treatment and acute rehabilitation probably was emphasized more than cooperation with the primary healthcare system. ESUS, which also greatly emphasizes postdischarge service, can therefore be regarded as a further development of stroke unit care.

The dedicated team was likely essential in the organization of ESUS. The team, together with the primary healthcare system, created a network that was able to support the patient and family when needed. A new approach in ESUS compared with OSUS was that we developed a systematic organization of support not only during inpatient stroke unit care but also during the difficult transition from the hospital to the home environment.

Our results indicate that this service system improves outcome for stroke patients. The improvement is large and is in fact similar in size to the effect of thrombolytic treatment with alteplase within 3 hours. Our ESUS can be applied to almost all stroke patients, indicating that the systematic organization of stroke care is currently more important for the burden of stroke than drug treatment. Systematic management or organization of discharge and support after discharge might therefore be even more important than organization of emergency management for the majority of stroke patients. However, we do not know why the present service system seems to work so well. To identify the most important components of the service system may be a challenge for the future. Rehabilitation at home may have some advantages. It may represent an enriched environment and opportunity for social interaction, which in animal studies have been shown to be important for better outcome. We have previously regarded stroke units as enriched environments during the acute stage. As the patient becomes more functionally active, the environment at home may be more stimulating than an inpatient rehabilitation setting. Some studies have also shown that most of the time in an inpatient rehabilitation clinic is not occupied by training. Other explanations might be that training in an institution has a low degree of transmission to activities and functioning at home. The network and support that were established may create a continuity of care and a security system for the patient and the patient’s relatives, which may also contribute to better outcome. Early discharge without dedicated support seems to reduce recovery compared with inpatient rehabilitation. Hence, early discharge most likely must be linked to a support system to be an effective system of care, although not all attempts to create support for the patient and the patient’s family have been successful.

Few trials and a selected group of patients are thus far included in the systematic review on early supported discharge in the Cochrane Library. The results are not as favorable as in our trial but indicate a positive effect on ADL.

In 2 articles published recently, patients who received early supported discharge did not achieve a better outcome than patients treated in a more traditional way. There are many differences between these 2 trials and our trial, which makes comparisons somewhat difficult. First, none of the trials had dedicated stroke units as the usual care, which we believe should be standard care today. Compared with our trial, they included patients who entered the trial long after onset of stroke, they included a very selected group of patients, the number of patients included was quite low, and at randomization the patients had a much higher functional level than in our trial. Furthermore, they offered mainly rehabilitation at home, while we offered a combination of different treatment and service options. In addition to acute care in the stroke unit, we offered further inpatient rehabilitation when necessary; rehabilitation at home or in day clinics when appropriate; nursing support at home; and outpatient clinic services for all patients. Additionally, all options were coordinated by our dedicated mobile team. Compared with other trials, our trial may have offered a more complete service system that emphasizes more links in the chain of care for an effective stroke management. At present we do not know whether these differences affected our results, which seem to be somewhat more favorable than in other trials.

Further analyses of long-term effects, quality of life, burden of the family, and costs of the 2 service systems in our trial are necessary before general recommendation of such a

### TABLE 5. Subgroup Analyses of Patients With Baseline SSS $\leq 52$: Number and Proportion of Patients With BI Score $\geq 95$ and RS Score $\leq 2$ After 6 and 26 Weeks in ESUS and OSUS

<table>
<thead>
<tr>
<th></th>
<th>ESUS ($n=121$)</th>
<th>OSUS ($n=122$)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 weeks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BI $\geq 95$</td>
<td>56 (46.3%)</td>
<td>42 (34.4%)</td>
<td>0.060</td>
</tr>
<tr>
<td>RS $\leq 2$</td>
<td>52 (43.0%)</td>
<td>38 (31.2%)</td>
<td>0.056</td>
</tr>
<tr>
<td>26 weeks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BI $\geq 95$</td>
<td>63 (52.1%)</td>
<td>47 (38.5%)</td>
<td>0.034</td>
</tr>
<tr>
<td>RS $\leq 2$</td>
<td>70 (57.9%)</td>
<td>49 (40.2%)</td>
<td>0.006</td>
</tr>
</tbody>
</table>
service system can be made. However, from the results of this trial, it may be possible to conclude that close cooperation/coordination between a stroke unit and other agencies in the stroke service system, emphasizing early supported discharge and more rehabilitation at home or in day clinics, seems to improve the outcome beyond ordinary stroke unit care.

According to the results in our trial, the improvement in outcome is substantial and more important for the vast majority of stroke patients than most of the other treatment options offered to stroke patients today. More research in this field of organization after acute care is clearly indicated and should be strongly emphasized.

Acknowledgments
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