Does the Organization of Postacute Stroke Care Really Matter?

Peter Langhorne, PhD, FRCP; Pamela Duncan, PhD, PT

Background and Purpose—Postacute rehabilitation stroke services represent a large component of stroke care. In the United States and elsewhere, major changes in the organization and funding of these services are limiting patient access to organized inpatient multidisciplinary care. We conducted a systematic review to evaluate the effectiveness of such services.

Summary of Review—We defined our intervention as organized inpatient multidisciplinary rehabilitation commencing at least 1 week after stroke and sought randomized trials that compared this model of care with an alternative. The analysis was stratified by the particular service characteristics. We identified a heterogeneous group of 9 trials (6 of stroke rehabilitation units; 3 of general rehabilitation wards) recruiting 1437 patients. Organized inpatient multidisciplinary rehabilitation was associated with a reduced odds of death (odds ratio, 0.66; 95% CI, 0.49 to 0.88; P<0.01), death or institutionalization (odds ratio, 0.70; 95% CI, 0.56 to 0.88; P<0.001), and death or dependency (odds ratio, 0.65; 95% CI, 0.50 to 0.85; P<0.001), which was consistent across a variety of trial subgroups. For every 100 patients receiving organized inpatient multidisciplinary rehabilitation, an extra 5 returned home in an independent state.

Conclusions—The results indicate that there can be substantial benefit from organized inpatient multidisciplinary rehabilitation in the postacute period, which is both statistically significant and clinically important. (Stroke. 2001;32:268-274.)

Key Words: meta-analysis ■ rehabilitation ■ stroke outcome ■ stroke units

Stroke is a common cause of premature death and disability and presents a major global public health challenge. Despite recent advances in acute stroke care, we still lack powerful and widely applicable routine drug therapies to improve the outcome after stroke. Therefore, it is essential that stroke patients receive the most appropriate care to enhance their recovery and minimize disability. In Western countries these are conventionally provided by rehabilitation services operating either in a hospital setting or on an outpatient basis. However, they can be very variable in organization. In the United Kingdom, stroke services have previously been criticized as being haphazard and poorly tailored to patients’ needs. Rehabilitation services in the United States are currently undergoing radical organizational and funding changes. There is a clear need to establish which rehabilitation services are effective and (if they are effective) to ensure that they are delivered in an appropriate and equitable manner. We therefore reviewed the evidence concerning the organization of postacute stroke care, with particular emphasis on stroke rehabilitation.

Subjects and Methods

We performed a systematic review of randomized trials of the organization of postacute stroke care. We first defined our review criteria and chose as our “benchmark” a definition of organized inpatient multidisciplinary care. This incorporates input from a team of physicians, nurses, and therapists whose work is coordinated through regular weekly meetings and is dedicated to rehabilitation. We chose this benchmark for 3 reasons: (1) multidisciplinary care in the hospital is a standard model of rehabilitation practice; (2) evidence from trials of stroke unit care and of geriatric medical services supports this model of care; and (3) it provided a workable definition for selecting trials for review. Our selection criteria are discussed below.

Intervention

We selected trials that evaluated inpatient services (ie, patient was resident in the hospital) incorporating multidisciplinary team care (provided by medical, nursing, and therapy staff). We included any trials that compared organized inpatient multidisciplinary care with an alternative service. This could include an absence of multidisciplinary care (eg, conventional care in a general medical ward) or an alternative service aiming to provide a similar content of multidisciplinary care in a different setting (eg, comparing 2 different models of organized inpatient multidisciplinary rehabilitation). We stratified our analysis by service type, service setting, host department, and major confounders such as intensity of rehabilitation.

Study Methods

We included randomized controlled trials in which intervention and control group services appeared to have been allocated in a prospec-
tive random manner. Other aspects of trial design (for example, blinding, completeness of follow-up) were recorded but not used as exclusion criteria.

Participants
We focused on trials that had recruited patients with a clinical diagnosis of stroke and in whom the majority of patients were recruited at least 1 week after stroke (this was done to remove a possible confounding effect of acute care interventions). We therefore excluded those stroke unit trials that recruited patients in the first week after stroke.

Outcome
Our main outcomes were all-cause case fatality, place of residence, physical dependency (dependent in activities of daily living), and activities of daily living score. We recorded these outcomes at the end of scheduled follow-up. We also recorded length of stay in the hospital.

Search Strategy
We have largely taken information from established systematic reviews of different aspects of stroke service provision8,10–12 that were known to have searched (up to 1999) for trials of organized inpatient multidisciplinary care. This search included the main Cochrane Stroke Group Search Strategy,13 which incorporates detailed searches of MEDLINE, EMBASE, the Cochrane Controlled Trials Register, and multiple hand-searching activities of journals and conference proceedings. The 4 systematic reviews from which information was sought all incorporated independent reviewers to select trials and extract data. For this analysis trial eligibility was established by one reviewer (P.L.) and checked by the other (P.D.).

Statistical Analysis
We used the odds ratio (95% CI) for analyzing dichotomous outcomes using a fixed effects model unless there was evidence of statistical heterogeneity (in which case the random effects model was used). Length of stay was analyzed by the standardized mean difference and 95% CI.

Results
We identified 36 potentially relevant trials in which one stroke patient group received organized inpatient multidisciplinary care (see references 8, 10–12). Of these, 27 trials were excluded: 4 did not include formal randomization procedures, and 23 incorporated services that included acute care inpatient care (12 evaluated different forms of hospital care, and 11 compared acute hospital services with community services). The remaining 9 trials14–22 are outlined in Table 1. All the trials incorporated organized inpatient multidisciplinary care dedicated to stroke in comparison with an alternative service. The alternative services were stratified into 2 groups: (1) no multidisciplinary team care or (2) inpatient multidisciplinary care in a general rehabilitation ward.

Organized Inpatient Multidisciplinary Care Versus Alternative Services

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Organized Inpatient Multidisciplinary Care Versus No Multidisciplinary Team Care
Five trials14–18 compared care in a stroke rehabilitation unit with conventional care in a general medical ward. One19 compared care in a stroke rehabilitation unit with discharge to a range of community-based services. Two20,21 compared care in a general rehabilitation ward with conventional care in a general medical ward or neurological ward. One22 compared care in a generic rehabilitation ward with a nursing-based rehabilitation program.

Organized Inpatient Multidisciplinary Care Versus Inpatient Multidisciplinary Care in a General Ward
Three trials14,16,17 compared care in a stroke rehabilitation unit with that of a generic rehabilitation ward (geriatric medicine ward).

The total number of comparisons is greater than the number of trials because in 3 trials14,16,17 treatment allocation was stratified such that younger patients could be randomized between a stroke rehabilitation unit or a general medical ward, while the older patients could be randomized between a stroke rehabilitation unit and a rehabilitation ward in a department of geriatric medicine.

Despite the diversity of service settings, the organized multidisciplinary rehabilitation care had a number of consistent features, as noted in the study of Langhorne and Dennis.23 First, they were staffed by medical, nursing, and physiotherapy staff and usually by occupational therapy, speech therapy, and social work staff. Second, their work appears to have been coordinated through regular (weekly) multidisciplinary meetings with involvement of caregivers in the process. Third, the staff members appear to have had an interest in stroke or rehabilitation. Finally, the majority reported a program of ongoing training for staff. These services were provided in a variety of departments, including geriatric medicine, neurology, and rehabilitation medicine.

Two of the trials15,20 provided a higher intensity of rehabilitation in the intervention group.

The alternative services were usually provided in general medical or neurology wards. They reported that nursing and therapy staff were available but did not describe coordination of this care through multidisciplinary meetings.24 In one trial20 patients in the control group were discharged from the hospital to a variety of community-based services, including private nursing homes and home-based physiotherapy; however, there was no multidisciplinary coordination of these services.

The 3 trials that stratified older control patients to a geriatric medicine rehabilitation unit14,16,17 described a process of multidisciplinary team care coordinated through regular meetings by staff who have an interest in rehabilitation. These data have been analyzed in a subgroup analysis.

Organized Inpatient Multidisciplinary Care Versus Alternative Services

The primary analysis was established to compare organized inpatient multidisciplinary care with any alternative service. However, in recognition of the 2 major types of alternative service identified (those with no multidisciplinary care or those with multidisciplinary care in a general ward), we have also performed subgroup analyses based on these comparisons.

Case Fatality
We first established the effect of organized inpatient multidisciplinary care on long-term case fatality (median, 1 year after stroke). No trial showed a convincing reduction in case fatality in its own right, but there was a general pattern of a
reduced odds of death among the patients receiving organized multidisciplinary care (Figure 1). The overall result was 0.66 (95% CI, 0.49 to 0.88; P<0.01), with no significant heterogeneity ($\chi^2=6.9; df=9; P>0.1$). The results were similar if we excluded the older trials, those providing intensive rehabilitation, or those without a fixed period of follow-up (ie, follow-up ended at hospital discharge).

This analysis included 3 trials$^{14,16,17}$ in which some of the control group patients ($n=164$) received organized multidisciplinary rehabilitation in a geriatric medicine ward. Exclu-

### TABLE 1. Characteristics of Included Trials

<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Interventions</th>
<th>Outcomes</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dover$^{14}$ Stroke patients up to 9 wk after stroke onset; fit for transfer to rehabilitation ward</td>
<td>Stroke rehabilitation ward based in geriatric medicine department ($n=98$) vs general medical wards ($n=89$)</td>
<td>Death, Rankin score, place of residence, length of stay in hospital up to 1 y after stroke</td>
<td>Randomization resulted in more patients with poor prognosis in control group</td>
<td></td>
</tr>
<tr>
<td>Kuopio$^{15}$ Stroke patients at 7 d after stroke onset; able to tolerate intensive rehabilitation</td>
<td>Intensive rehabilitation in neurological rehabilitation unit ($n=50$) vs general wards ($n=45$)</td>
<td>Death, Lehman (disability) score, place of residence, total time in hospital up to 1 y after stroke</td>
<td>Majority of patients screened failed to meet inclusion criteria for trial</td>
<td></td>
</tr>
<tr>
<td>Nottingham$^{16}$ Stroke patients at 2 wk after stroke; able to participate actively in rehabilitation</td>
<td>Stroke rehabilitation ward in department of geriatric medicine ($n=98$) vs general medical wards ($n=76$)</td>
<td>Death, Barthel Index, place of residence, Nottingham Health Profile, length of hospital stay up to 1 y after stroke</td>
<td></td>
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</tr>
<tr>
<td>Orpington (1993)$^{17}$ Stroke patients at 2 wk after stroke; suitable for transfer to rehabilitation ward</td>
<td>Stroke rehabilitation ward in department of geriatric medicine ($n=53$) vs general medical wards ($n=48$)</td>
<td>Death, Barthel Index, place of residence, length of initial hospital stay at end of follow-up</td>
<td>Variable duration of follow-up (hospital discharge)</td>
<td></td>
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<tr>
<td>Orpington (1995)$^{18}$ Stroke patients who had poor prognosis at 2 wk after stroke; suitable for transfer to rehabilitation ward</td>
<td>Stroke rehabilitation ward in geriatric medicine department ($n=36$) vs general medical wards ($n=37$)</td>
<td>Death, Barthel Index, place of residence, length of hospital stay at end of follow-up</td>
<td>Variable duration of follow-up (hospital discharge)</td>
<td></td>
</tr>
<tr>
<td>Stroke rehabilitation unit vs community services</td>
<td>Inpatient rehabilitation in a stroke rehabilitation unit ($n=127$); controls ($n=124$) received a variety of nonspecialist community-based rehabilitation services (41% nursing home rehab, 25% home physiotherapy, 30% no treatment)</td>
<td>Death, place of residence, Barthel Index (in current analysis dependency=Barthel Index $&lt;15–20$), Short Form 36, length of stay</td>
<td>12 intervention and 7 control patients could not be contacted at 7 mo</td>
<td></td>
</tr>
<tr>
<td>General rehabilitation unit vs general wards</td>
<td>Intensive rehabilitation ($n=29$) vs normal care in general medical wards ($n=23$)</td>
<td>Death and functional status at end of follow-up (6–8 mo)</td>
<td>Timing of outcomes and intervention not clearly stated</td>
<td></td>
</tr>
<tr>
<td>Illinois$^{21}$ Stroke patients up to 1 y after stroke; appropriate for rehabilitation service</td>
<td>Rehabilitation service ($n=56$) vs general medical wards (some specialist nursing input; $n=35$)</td>
<td>Functional status and place of residence at end of follow-up</td>
<td>Intervention and control services not clearly defined</td>
<td></td>
</tr>
<tr>
<td>General rehabilitation unit vs nursing facility</td>
<td>Rehabilitation in a rehabilitation center ($n=42$) vs program of care in general wards ($n=40$) that had specialist nursing input</td>
<td>Functional status and place of residence at end of follow-up (approximately 1 y)</td>
<td>No deaths reported; minor anomaly in published data table</td>
<td></td>
</tr>
<tr>
<td>Stroke rehabilitation unit vs general rehabilitation unit</td>
<td>Stroke rehabilitation ward ($n=18$) vs geriatric medical wards ($n=28$)</td>
<td>Death, Rankin score, place of residence, length of stay in hospital up to 1 y after stroke</td>
<td>One arm of larger trial (see above)</td>
<td></td>
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<tr>
<td>Nottingham$^{16}$ Stroke patients at 2 wk after stroke; able to participate actively in rehabilitation</td>
<td>Stroke rehabilitation ward in department of geriatric medicine ($n=78$) vs conventional care in geriatric medical ward ($n=63$)</td>
<td>Death, Barthel Index, place of residence, Nottingham Health Profile, length of hospital stay up to 1 y after stroke</td>
<td>One arm of larger trial (see above)</td>
<td></td>
</tr>
<tr>
<td>Orpington (1993)$^{17}$ Stroke patients at 2 wk; suitable for transfer to rehabilitation ward</td>
<td>Stroke rehabilitation ward ($n=71$) vs conventional care in geriatric ward ($n=73$)</td>
<td>Death, Barthel Index, place of residence, length of hospital stay at end of follow-up</td>
<td>One arm of larger trial (see above)</td>
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</table>
sion of these data did not alter the conclusions (odds ratio, 0.67; 95% CI, 0.48 to 0.94; \( P < 0.01 \)).

**Death or Institutional Care**

All-cause mortality is a limited outcome for rehabilitation studies in which one would hope to demonstrate an increased number of survivors returning home and regaining independence. We therefore examined the combined adverse outcome of death or requirement of long-term institutional care. Again, this was recorded at the end of scheduled follow-up (median, 1 year). Patients who received organized multidisciplinary care showed a reduced odds of death or requirement of institutional care, with no significant heterogeneity between the trials (\( \chi^2 = 9.7; df = 10; P > 0.1 \)). The combined odds ratio for all trials was 0.70 (95% CI, 0.56 to 0.88; \( P < 0.001 \)). Results were similar if we excluded the older trials, those of more intense rehabilitation, those without a fixed follow-up period, or those that had an unblinded assessment of outcome.

Exclusion of data from the 3 trials which included organized multidisciplinary care in the control service did not alter the conclusions (odds ratio, 0.65; 95% CI, 0.50 to 0.85; \( P < 0.001 \)).

**Activity of Daily Living Scores**

Activity of daily living data were available for 5 trials in the forms of a Barthel Index or Lehman score. We planned to analyze these outcomes using a standardized mean difference. However, insufficient data were available in a standard format to allow a combined analysis. The pattern of reduced dependency noted above appeared to be reflected in activity of daily living scores.

**Absolute Outcomes**

We also calculated the proportion of patients in each of the 4 outcome categories (death, requirement of long-term institu-
tional care, living at home but physically dependent, living at home and independent) at the end of scheduled follow-up and the absolute risk reduction across all the trials (Table 2). This analysis included an assumption that no independent patients would reside in institutional care and excluded 1 small trial (Birmingham) that had incomplete data. Overall, the analysis (Table 2) indicates that for every 100 patients receiving organized multidisciplinary rehabilitation, 5 extra patients returned home, of whom most were independent.

Length of Stay
Length of stay data were available for 5 trials. There was considerable heterogeneity, with the older trials having mean lengths of stay of 100 days. The length of stay in the 3 trials published in the last 10 years had an average length of stay of 61 days. However, in comparison with their contemporary alternative services, the length of stay in the organized inpatient multidisciplinary care setting was not prolonged (standardized mean difference, 0.299; 95% CI, 0.982 to 0.385; \( P > 0.1 \); fixed effects model).

**Figure 2.** Organized inpatient multidisciplinary rehabilitation vs alternative care: dead or dependent at the end of scheduled follow-up. Data are presented as the proportion (n/N) of patients in the organized inpatient rehabilitation (Expt) or alternative service group (Ctrl) who died or were judged to be dependent at the end of scheduled follow-up (median, 1 year) together with the odds ratio and 95% CI. Results are stratified by trial and trial subgroup (see Results).

### Table 2. Organized Multidisciplinary Rehabilitation vs Alternative Care: Absolute Outcomes

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Organized Multidisciplinary Rehabilitation (n=727)</th>
<th>Alternative Care (n=658)</th>
<th>Risk Difference (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>100 (14%)</td>
<td>133 (20%)</td>
<td>-5 (-8, 0)</td>
</tr>
<tr>
<td>Institutional care</td>
<td>161 (22%)</td>
<td>158 (24%)</td>
<td>-2 (-6, 2)</td>
</tr>
<tr>
<td>Home (dependent)</td>
<td>166 (23%)</td>
<td>147 (22%)</td>
<td>+1 (-6, 7)</td>
</tr>
<tr>
<td>Home (independent)</td>
<td>300 (41%)</td>
<td>220 (35%)</td>
<td>+5 (1, 9)</td>
</tr>
</tbody>
</table>

Data are presented as the number (percentage) of patients in each outcome group at the end of scheduled follow-up. The risk difference (stratified by trial) was calculated using a random effects model.
expertise in rehabilitation but not specifically stroke. Relatively few data are available, and the results have wide CIs. They indicate a trend toward a lower risk of death (odds ratio, 0.51; 95% CI, 0.29 to 0.90; \( P < 0.05 \)) and the combined adverse outcomes of death or requirement of long-term institutional care (odds ratio, 0.71; 95% CI, 0.46 to 1.09; \( P > 0.1 \)) and death or dependency (odds ratio, 0.80; 95% CI, 0.45 to 1.42; \( P > 0.1 \)) in the stroke rehabilitation unit.

Discussion

Definitions
We used a simple definition of organized rehabilitation that was easily applicable and broadly captured the ethos of rehabilitation. This incorporated the following: (1) input from a multidisciplinary team of medical, nursing, and therapy staff with an expertise in stroke and rehabilitation whose work was coordinated through regular weekly meetings; (2) involvement of patients and family in the rehabilitation process; and (3) program of staff training. The control groups generally had access to the same range of staff, but there was no system of organized, coordinated, multidisciplinary team care. With the exception of 2 trials, there does not appear to have been any significant differences in the staffing levels or intensity of rehabilitation.

Benefits of Organized Multidisciplinary Rehabilitation
Our results indicate that there can be substantial benefit from organized multidisciplinary rehabilitation in the postacute period that is both statistically significant and clinically important. We focused on postacute care because in many countries this aspect of stroke care has been subject to various threats and challenges. For example, in the United Kingdom stroke rehabilitation services have been criticized as variable and haphazard, and in the United States they have been subject to major financially driven organizational changes.

We believe that the provision of such services should reflect their effectiveness, and hence rigorous research evaluation is essential. The stroke unit trials certainly indicate that the whole package of specialist acute stroke care and rehabilitation will enhance patient recovery. However, the present analysis demonstrates that the postacute rehabilitation component of such care can have an independent influence on recovery. There were insufficient data to determine whether a stroke rehabilitation unit (dedicated to stroke care) obtained better results than a general rehabilitation ward, but the trends are in favor of the stroke rehabilitation unit model of care. One of the trials reviewed has recently published a 5 year follow-up of their patients confirming sustained benefits in the stroke unit group.

In addition to randomized clinical trials, the beneficial effects of treatment in units that provide multidisciplinary care have been supported by prospective cohort studies. In a community-based study of outcome in 1241 consecutive stroke patients in 2 communities in Copenhagen, Denmark, in one community treatment and rehabilitation of stroke patients were given in a general neurological and medical ward, and in the other community care was provided in a large stroke unit. The relative risks of initial death, poor outcome (death during hospitalization or discharge to a nursing home), and 1-year and 5-year mortality rates were reduced by 40% on average in patients treated in stroke units. In a comparison of stroke patients in the United States who received poststroke care in rehabilitation hospitals or in nursing homes, elderly stroke patients treated in rehabilitation hospitals were more likely to return to the community and recover activities of daily living.

Limitations of the Review
The main problem of our analysis was the need to use a diverse group of randomized trials, some of which are relatively old. In particular, many older studies had prolonged lengths of stay compared with current practice. However, we should recognize that differences between countries in length of hospital stay may be due to a variety of medical, social, and cultural factors. It is more useful to compare results with their contemporary controls, which suggested that organized inpatient rehabilitation did not systematically increase length of stay. The diversity between studies may well increase the generalizability of our conclusions, particularly since many results seemed to be consistent across a range of different trials.

We were also obliged to use a superficial definition of rehabilitation services that does not indicate the processes of care within these units. Finally, although our analysis included all the randomized data we were able to identify, we finally had relatively small amounts of data that centered on very basic outcomes (death, dependency, institutional care). These outcome measures are valid indicators of poststroke recovery, but our analysis will have had a limited ability to reliably detect differences between treatment groups.

Implications
In planning our analysis, we chose organized multidisciplinary rehabilitation in the hospital as our benchmark. The results indicate that, for the patients recruited into these trials, this form of care resulted in better outcomes than alternative service models. We therefore contend the following: (1) All disabled stroke survivors should be considered for such organized multidisciplinary care (which should include a multidisciplinary team of medical, nursing, and therapy staff with the necessary skills and interest in stroke and/or rehabilitation who coordinate their work through regular multidisciplinary meetings), (2) Alternative rehabilitation services (such as community-based rehabilitation, skilled nursing facilities) should be judged against this benchmark. (3) Major policy changes should not be enacted unless the alternative service has been shown to be at least equally as effective as organized inpatient multidisciplinary care. (4) Stroke-specific rehabilitation services probably represent the system of choice, but in circumstances in which there are relatively small numbers of stroke patients (eg, rural areas, specialist rehabilitation problems), stroke care could be developed through general rehabilitation services.

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