well as cooling-tower water.[10 11] This study shows that the organism may also be found in water-distribution systems within hospitals and hotels. The findings so far suggest that infected water systems may be associated with cases in the absence of air-conditioning equipment in the establishment concerned. When both the water-distribution system and air-conditioning cooling-water system are infected the relative importance of each needs further clarification.

We plan to extend the survey to determine how frequently *L pneumophila* may be found in various types of plumbing systems as well as in humidification and heat-exchange recirculating systems. The principal objective of the project is to identify factors which permit establishment of the organism, with a view to devising inexpensive and effective control measures. At this stage it is clear that, in view of the apparently ubiquitous nature of *L pneumophila*, its demonstration in water systems in the absence of associated cases should not be an indication for active measures of eradication by methods whose long-term efficacy is as yet unknown. Spending large sums of money on these in an attempt to prevent a very occasional hazard may divert resources needed for other, more frequent and equally serious conditions.

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Remedial therapy after stroke: a randomised controlled trial

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Abstract

Of 1094 patients with a confirmed stroke admitted to Northwick Park, a district general hospital, 364 (33%) died while in hospital, 215 (20%) were fully recovered when discharged, and 329 (30%) were too frail or too ill from diseases other than stroke to be considered for active rehabilitation. Only 121 (11%) were suitable for intensive treatment. They and 12 patients referred direct to outpatients were allocated at random to one of three different courses of rehabilitation. Intensive was compared with conventional rehabilitation and with a third regimen which included no routine rehabilitation, but under which patients were encouraged to continue with exercises taught while in hospital and were regularly seen at home by a health visitor. Progress at three months and 12 months was measured by an index of activities of daily living. Improvement was greatest in those receiving intensive treatment, intermediate in those receiving conventional treatment, and least in those receiving no routine treatment. Decreasing intensity of treatment was associated with a significant increase in the proportions of patients who deteriorated and in the extent to which they deteriorated.

Probably only a few stroke patients, mostly men, are suitable for intensive outpatient rehabilitation, but for those patients the treatment is effective and realistic.

Introduction

Remedial therapists spend much of their time[1] rehabilitating patients disabled by strokes, though this has not been convincingly shown to improve chances of recovery. If rehabilitation is ineffective therapists' efforts are wasted and patients inconvenienced. If, on the other hand, rehabilitation is effective more investment in it might be justified.

Three randomised controlled trials[2-4] on the effectiveness of rehabilitation after stroke have been inconclusive, possibly because of their small numbers. Garraway *et al*[5] have recently shown that patients admitted to a special stroke unit fared better than those admitted to medical units, but their trial was concerned largely with the effects of inpatient management, and the advantage was not sustained on longer follow-up.[6] This paper compares the effectiveness of three intensities of outpatient rehabilitation.

Patients and methods

All 1094 patients with a recent confirmed stroke who were admitted to Northwick Park Hospital from October 1972 to September 1978 were considered for the trial. Of these, 364 (33%) died while in hospital and 215 patients (20%) made a full recovery while in hospital, in terms not only of day-to-day activities but also of limb function and speech. The remaining 515 patients were considered for the trial. The main criterion for entry was that the patient should

be able to manage the most intensive of the three regimens, even if they were eventually allocated to one of the other regimens. A further 329 patients (30%) were excluded by this criterion: most of these were elderly patients, predominantly women, who were either too old or too frail for intensive rehabilitation or had other serious diseases. Forty-three patients lived outside the district and were excluded. Twenty-two patients did not enter the trial for other reasons; none of these included refusal to participate. The 121 suitable patients (11%) were included, and a further 12 were recruited from outpatient referrals, giving a final total of 133. They were each allocated at random to one of the three regimens used.

To increase the number of eligible patients we extended the trial in 1977 to include patients admitted to two north London hospitals, the Prince of Wales's Hospital and St Ann's Hospital. Similar admission criteria were used and 20 patients were included in the trial. Results for these patients are considered separately from those for the Northwick Park patients, for reasons discussed later.

During the inpatient period medical treatment and rehabilitation —for example, early ambulation—were prescribed according to the usual practice of the staff concerned and the requirements of each individual patient.

Shortly after discharge, eligible patients were assessed on the activities of daily living (ADL) index, the chief measure of progress. Our modification of this index has been described in detail elsewhere.[7] Seventeen items on mobility, self-care, and simple household tasks were rated on a three-point scale. Ability to carry out the activity without help from another person (but with a physical aid, if necessary) was scored as 1; ability to make the main contribution to the activity, though with some help from another person, was scored as 2; inability to make any contribution, even with help, was scored as 3. A person requiring no help with any item therefore scored 17 and a person unable to make any contribution on any item scored 51. The method is highly repeatable, is subject to little within-person variability over short periods, and gives scores in hospital which correlate well with those obtained at home.[7] Patients were also assessed clinically using a standard method of examination and for their ability to carry out a number of movements using either the whole body or individual limbs.

The three rehabilitation regimens compared were: (*a*) intensive—attendance in the rehabilitation department four whole days a week (group 1, 46 patients); (*b*) conventional—attendance three half days a week (group 2, 43 patients); and (*c*) no routine rehabilitation; these patients were regularly visited at home by a health visitor, referred back to hospital or to other services if necessary, and encouraged to continue with exercises taught while in hospital (group 3, 44 patients).

Patients in groups 1 and 2 received physiotherapy and occupational therapy in groups and individually for up to six months (except for four patients in group 1 and five in group 2 who made a full recovery earlier), and time spent in therapy was recorded. Thirty-three patients with speech difficulties also received speech therapy. (Results of this component of the trial will be reported separately.)

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Of these 33 patients seven had only speech difficulties and scored 17 on their entry ADL assessments. Thirteen other patients in groups 1 and 2 also scored 17 but had residual difficulties reflected in one of the other assessments. These 20 (groups 1 and 2) patients were included in the analysis in view of the possibility of later deterioration —that is, an initial ADL score of 17 but a higher score later on. Seven patients in group 3 with entry ADL scores of 17 are also included in the results.

Patients were re-assessed at three, six, and 12 months after entry, though only the three- and 12-month results are presented here. The assessments were all made by therapists not concerned in treatment. Death or the onset of serious illness resulting in non-attendance accounted for missing ADL scores at three months for five patients in group 1, three in group 2 and two in group 3 and at 12 months for 10 in group 1, seven in group 2, and nine in group 3.

Results

Table I compares the main characteristics of the patients in each group. There was a smaller proportion of men in group 3 than in the other two groups. Another imbalance was in the social class composition of the three groups. Mean ages and mean intervals between stroke and entry to the trial were similar. ADL scores were similar for the groups as a whole, though the women in group 3 had a lower entry value than the women in the other two groups.

TABLE I—*Characteristics of trial patients*

	Group 1 (n=46)	Group 2 (n=43)	Group 3 (n=44)
Men (%)	67	73	59
Mean age (years)	63	66	65
Social class (%):			
I–II	25	25	16
III	57	59	74
IV–V	18	18	9
Interval from stroke to trial entry (days)	35	41	37
Mean total ADL score at entry:			
Men	21·2	21·2	21·5
Women	24·0	23·1	20·5
All patients	22·0	21·5	21·1

Table II shows details of treatment given. On average, patients in group 1 received about twice as much physiotherapy and occupational therapy as those in group 2. The health visitor paid an average of seven visits (range 3-13) to each patient in group 3. These visits usually lasted one to two hours and took place during the six months after discharge from hospital. A total of 46 referrals were made to hospital—for example, for a frozen shoulder—or for various social services. No patients needed to be transferred from group 3 to a more active rehabilitation regimen during the six-month treatment period.

TABLE II—*Mean hours of treatment given in groups 1 and 2*

	Group 1	Group 2
Physiotherapy:		
Individual	48·3	22·3
Group	31·3	16·3
Total	79·6	38·6
Occupational therapy	44·5	27·4

Details of deaths and recurrences of stroke are summarised in table III. During the year 16 patients died. Five had further non-fatal strokes; rehabilitation was discontinued in one of these patients (group 2) but was continued in the other four. Nine patients developed other serious illnesses as a result of which they were withdrawn from further rehabilitation (groups 1 and 2). Corresponding figures for the three-month follow-up are also shown in table III. The differences between the groups in death or stroke recurrence did not suggest an effect, beneficial or harmful, attributable to rehabilitation.

Table IV shows the mean changes in ADL score at the two follow-up examinations, for men and women separately and for both sexes together. At three months the greatest improvement had occurred in patients in group 1, the results for group 2 being intermediate between those for groups 1 and 3. Results at one year were similar.

Because the average level of disability at entry was not high, as judged by mean entry ADL values (table I), the scope for improvement was limited. Each patient who deteriorated was therefore identified, deterioration being defined as any increase in ADL score between entry and the relevant follow-up visit. The findings are shown in table V. In those who deteriorated the extent of deterioration was greater in group 3 than in groups 1 and 2, especially at one year. (Some patients who had deteriorated between entry and three months had improved at 12 months.)

TABLE III—*Deaths and non-fatal recurrences of stroke between entry to trial and 3-month and 12-month follow-up*

	Group 1	Group 2	Group 3
Between entry and 3-month review:			
Deaths	3	1	2
Recurrences	1	1	0
Between entry and 12-month review*:			
Deaths	7	3	6
Recurrences	2	1	2

*These figures include those at 3-month review.

TABLE IV—*Decrease in total ADL scores between entry to trial and 3-month and 12-month follow-up. Figures in parentheses are numbers of patients*

	Group 1	Group 2	Group 3
Between entry and 3-month review:			
Men	2·96 (27)	2·80 (30)	1·88 (26)
Women	4·64 (14)	3·10 (10)	0·88 (16)
Total	3·54 (41)	2·87 (40)	1·50 (42)
Between entry and 12-month review:			
Men	2·68 (25)	2·42 (26)	0·36 (22)
Women	5·36 (11)	4·10 (10)	1·00 (13)
Total	3·50 (36)	2·89 (36)	0·60 (35)

For all patients (both sexes): at three months: 1 *v* 3, $p<0.01$; 1 and 2 *v* 3, $p<0.01$; at 12 months: 1 *v* 3, $p<0.05$.

TABLE V—*Numbers of patients who deteriorated between entry to trial and 3-month and 12-month follow-up. Figures in parentheses are mean increases in ADL scores for those who deteriorated*

	Group 1	Group 2	Group 3
Between entry and 3-month review*:			
Deteriorated	1 (1)	4 (1)	10 (1·9)
Total	41	40	42
Between entry and 12-month review†:			
Deteriorated	2 (2·5)	4 (2·5)	8 (7·6)
Total	36	36	35

Test for trend: *$p<0.01$, †$p<0.05$.

We did not think that it was justifiable to combine the results from the Northwick Park patients with those from the two north London hospitals. Compared with Northwick Park, a slightly smaller proportion (8·3%) of the north London patients was eligible for the trial. Those who were eligible had a mean ADL score of only 17·7 and they stayed in hospital for an average of 42 days, rather longer than the Northwick Park patients. The numbers from north London in each of the three groups were small, particularly as four patients died or were withdrawn within the year after entry. The results were comparable with the Northwick Park series, with greater improvements in ADL scores in groups 1 and 2 than in group 3, and a higher proportion of patients deteriorating in group 3 than in groups 1 and 2.

Discussion

The results of this trial indicate that outpatient rehabilitation after stroke is effective. The actively treated groups (1 and 2) fared significantly better than group 3, although patients in this group improved slightly. Patients in group 1 tended to progress better than those in group 2, suggesting also that an intensive regimen is more effective than a conventional one. The beneficial effect of treatment was almost entirely achieved in the first three months; it was largely maintained though not increased during the rest of the first year. The "spontaneous" improvement shown in group 3 emphasises the need for controlled comparisons. In numerical terms the ADL decrease attributable to treatment may not seem large. A decrease of two points, however, means the difference, for example, between needing help with dressing and washing and being able to do these without any help. There is little doubt that decreasing amounts of treatment were associated with a greater tendency to deteriorate.

The main concern in attributing improvement to treatment is that the trial was not blind. Assessments of outcome were made by therapists not concerned in treatment, however, and we therefore think it is unlikely that the ADL and other measures were biased. The lower average ADL score at entry for women in group 3 compared with groups 1 and 2 means that the scope for improvement in group 3 women was rather limited. Results in the women, however, showed the same general trends as those in the men. Socical class did not affect outcome, so any imbalance between the groups in this respect (table II) is probably not important.

Conclusions depend largely on the acceptability of the ADL index as a measure of outcome. This or a similar index is highly correlated with other measures of independence or ability for self-care.[8–10] Findings in our trial based on functional assessments of body and limb movements are not shown, but they also strongly suggest that the more active the rehabilitation the greater its benefit. These findings will be reported in detail elsewhere.

The patients from the Prince of Wales's and St Ann's Hospitals mostly came from a less favourable socioeconomic background than those at Northwick Park. Another difference is the association of a physiotherapy training school with the two north London hospitals. It is almost certain that patients in these hospitals received considerably more inpatient rehabilitation than those in Northwick Park. This, and possible differences in policies governing referral and discharge, may account for the low mean ADL at entry in the north London patients. The trends in the north London patients, however, were the same as in Northwick Park patients, which suggests that the results have some general applicability. The possibility that the low entry ADL scores in the north London patients were partly due to intensive inpatient rehabilitation indicates the need for further trials based on treatment starting immediately after the stroke.

The small proportion of patients eligible for the trial meant that recruitment was spread over a period of six years. Fortunately, there were few staff changes among the treatment and assessment therapists during this time and no major changes in remedial practice. It should be emphasised that the trial was chiefly one of different intensities of the same treatments and not of qualitatively different treatments. We cannot be sure which parts of the overall regimen—physiotherapy, occupational therapy, or non-specific care and attention—were responsible for the observed improvement apparently associated with active treatment. This is a subject for further trials. The patients in group 3 did receive a considerable amount of non-specific care from the health visitor and the various agencies to which they were referred. Although by no means conclusive, this suggests that the better outcome in patients in groups 1 and 2 may have been due, at least in part, to specific remedial therapeutic procedures.

Our criteria for exclusion from the trial may have been a little more rigorous than those used in day-to-day district hospital practice, as we had to be sure that patients could manage the intensive regimen if allocated to it. But it seems unlikely that the trial patients were seriously unrepresentative of those referred for rehabilitation in many district general hospitals. Only a small proportion of stroke patients have significant disabilities a few months after their strokes; the others mostly either quickly die or recover.[11] In short, outpatient rehabilitation after stroke is effective but the opportuni-

ties for using it are considerably less than is generally believed, common though the condition is. Consequently, intensive outpatient treatment for those who stand to benefit from it is probably a realistic policy within National Health Service resources. Although in absolute numbers more women have strokes than men, it is likely that considerably more men than women are suitable for intensive outpatient rehabilitation.

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SHORT REPORTS

Status epilepticus treated by barbiturate anaesthesia with continuous monitoring of cerebral function

Status epilepticus is a hazardous condition with a mortality of 6% to 18%.[1] In most cases it is controlled by intravenous diazepam or phenytoin or other anticonvulsive drugs. In severe tonic-clonic status epilepticus unresponsive to anti-epileptic drugs the induction of general anaesthesia has been suggested, although the anaesthetic agent of choice has not been defined.[1]

The anticonvulsive properties of short-acting barbiturates are well known, and in status epilepticus thiopentone sodium has been reported to be effective in low doses that do not depress the level of consciousness.[2] We have found, however, only one report of the use of barbiturate anaesthesia in the treatment of severe status epilepticus.[3] We report the use of general anaesthesia induced with intravenous thiopentone sodium in five patients with prolonged status epilepticus. These patients had failed to respond to ordinary treatment, including diazepam and phenytoin.

Patients, methods, and results

In 1979 the casualty department of the University Central Hospital, Helsinki, dealt with 743 cases of convulsions. Forty-seven of these patients developed status epilepticus, defined as repetitive convulsions over at least 30 minutes or as repeated generalised seizures without return to consciousness in between. Five patients failed to respond to ordinary anticonvulsive therapy within 48 hours. These patients were admitted to the intensive care unit. All underwent endotracheal intubation, with assisted ventilation when necessary. Cerebral function was monitored by a Devices cerebral function monitor using three silver-silver chloride disc electrodes at sites P3 and P4 and a ground electrode on the forehead.[4] In two patients relaxation with curarisation was tried before the induction of general anaesthesia, but cerebral monitoring still showed seizure activity. Thiopentone sodium was given as an initial intravenous dose of 100 to 250 mg, followed by 50 mg at intervals of two to five minutes until no epileptic discharges were seen on the monitor. The infusion rate was regulated according to intra-arterial blood pressure. Maintenance therapy with phenytoin or benzodiazepines was continued during the anaesthesia, and dexamethasone (5 mg intramuscularly every six hours) was given for brain oedema. The level of anaesthesia was adjusted with an intravenous thiopentone infusion (2500 mg in 500 ml isotonic saline given at a rate of 0·5 to 1·5 ml/min) to keep the patients free of epileptic discharges visible on the cerebral function monitor. The infusion was continued at a steady rate for at least 12 hours after the last paroxysm seen on the monitor. The infusion rate was then gradually reduced and stopped within the following 12 hours.

Four patients responded well without recurrence of the seizures (see table). Status epilepticus recurred in one patient, who was then successfully treated with concomitant infusions of chlormethiazole and lidocaine (case 5). No permanent sequelae attributable to status epilepticus were seen in any of these patients.

Comment

Several lines of evidence seem to argue in favour of the use of barbiturates as general anaesthetic agents in prolonged status

History and clinical details of the five patients

Case No	Age and sex	History of epilepsy and cause of status epilepticus	Duration of status epilepticus and total dose of drugs given before barbiturate anaesthesia
1	34 M	No previous epilepsy, psychiatric problems, chlordiazepoxide 150 mg/day changed to amitriptyline 40 mg/day	Duration 84 hours. Diazepam 420 mg, phenytoin 1750 mg, clonazepam 14 mg, paraldehyde 20 ml, chlormethiazole 2,000 mg, lidocaine 3000 mg, curarisation with pancuronium
2	21 M	Post-traumatic 10 years, clonazepam 4 mg/day changed to sodium valproate 1200 mg/day	Duration 56 hours. Diazepam 210 mg, phenytoin 1000 mg, clonazepam 6 mg, paraldehyde 24 ml, chlormethiazole 4000 mg, curarisation
3	57 M	No previous epilepsy, intracerebral haemorrhage	Duration 48 hours. Diazepam 210 mg, phenytoin 1550 mg, clonazepam 5 mg
4	35 M	Post-traumatic 15 years, alcohol abuse	Duration 48 hours. Diazepam 180 mg, phenytoin 1250 mg, clonazepam 6 mg
5	19 M	Post-traumatic 10 years, cause of status epilepticus unknown	Duration 50 hours. Diazepam 100 mg, phenytoin 1150 mg, paraldehyde 18 ml, clonazepam 5 mg, chlormethiazole 4000 mg, lorazepam 2 mg IV

Modes of drug administration were as follows: Diazepam 10-20 mg intravenously initially followed by infusion of 100 mg/500 ml 5% dextrose solution 0·5-2 ml/min. Clonazepam 1-2 mg slowly intravenously. Phenytoin 125-500 mg slowly intravenously. Paraldehyde 8-10 ml divided in two doses intramuscularly. Chlormethiazole (8 mg/ml) infusion 24-60 mg/min initially followed by 4-8 mg/min. Lidocaine (0·4% solution) 100-200 mg intravenously initially followed by infusion of 3-5 mg/kg/h.