Not All Stroke Units Are the Same
A Comparison of Physical Activity Patterns in Melbourne, Australia, and Trondheim, Norway

Julie Bernhardt, PhD; Numthip Chitravas, MD; Ingvild Lidarende Meslo, PT; Amanda G. Thrift, PhD; Bent Indredavik, MD, PhD

Background and Purpose—Very early mobilization may be one of the most important factors contributing to the favorable outcome observed from a stroke unit in Trondheim, Norway. The aims of this study were to (1) describe and compare the pattern of physical activity of patients with stroke managed in a stroke unit with specified mobilization protocols (Trondheim) and those without in Melbourne, Australia; and (2) identify differences in activity according to stroke severity between the 2 sites.

Methods—Melbourne patients were recruited from 5 metropolitan stroke units. Trondheim patients were recruited from the stroke unit at University Hospital, Trondheim. All patients <14 days poststroke were eligible for the study. Patients receiving palliative care were excluded. Consenting participants were observed at 10-minute intervals from 8:00 AM to 5:00 PM over a single day. At each observation, patient location, activity, and the people present were recorded. Negative binomial regression analyses were undertaken to assess differences in physical activity patterns between stroke units in the 2 cities.

Results—Patients in Melbourne and Trondheim had similar baseline characteristics. Melbourne patients spent 21% more time in bed and only 12.2% undertook moderate/high activity (versus 23.2% in Trondheim, \( P < 0.001 \)). This difference was even more pronounced among patients with greater stroke severity. The incidence rate ratio for time spent doing standing and walking activities in Melbourne was 0.44 (95% CI: 0.32 to 0.62) when compared with Trondheim.

Conclusion—Higher activity levels were observed in Trondheim patients, particularly among those with more severe strokes. A greater emphasis on mobilization may make an important contribution to improved outcome. Further investigation of this is warranted. (Stroke. 2008;39:2059-2065.)

Key Words: early mobilization • rehabilitation • stroke • stroke units

In a recent update of a systematic review, stroke units that incorporated rehabilitation into their care model were found to be effective in reducing death and long-term dependency.\(^1\) In contrast, neither acute stroke units (providing intensive or semiintensive care without simultaneously offering rehabilitation) nor mobile stroke teams were found to have clear benefit.\(^1\) Defining what is rehabilitation in this context however is less clear. Beyond inclusion of a multidisciplinary team, few authors have defined the content of the rehabilitation program within their stroke units. In 2 of these studies,\(^2,3\) early mobilization (out-of-bed activity within 24 hours of stroke symptom onset) was noted as a key feature of early stroke unit care. In addition, both studies demonstrated substantial improvements in outcomes when patients were treated in a stroke unit versus a general medical ward. Although early mobilization forms just one part of a package of care, Indredavik and colleagues provide indirect evidence that early mobilization may play an important role in reducing death and long-term disability.\(^4\)

In 2004, we reported the results of an observational study conducted to establish the levels of physical activity and rehabilitation of patients in the acute phase of their stroke care in Melbourne, Australia.\(^5\) These data served as comparison data for the current study, which examines the physical activity patterns of patients managed in stroke units in Melbourne, Australia, where early mobilization is not a formalized part of acute care, and those of patients managed within the stroke unit in Trondheim, Norway, a unit in which early mobilization is actively promoted as part of standard stroke care. The specific aims of this study were to: (1)
determine whether the amount and type of physical activity patterns of patients < 14 days poststroke were different between the 2 sites; and (2) compare activity patterns across patients of different stroke severity.

Methods

Study Populations and Settings

The Australian population comprised patients with stroke managed in 5 of the 7 acute stroke units in metropolitan Melbourne. The Norwegian population comprised patients with stroke managed at St Olav’s University Hospital, Trondheim. All stroke units were well established and in large teaching hospitals. All cases of confirmed stroke admitted < 14 days after a first or recurrent stroke were eligible for inclusion, except for those with devastating stroke receiving end-of-life palliative care.

Approval for this study was obtained from the medical ethics committee of each institution, and informed consent was obtained.

Study Design

This was an open observational behavioral mapping study.

Duration

Data from the 5 Melbourne sites were acquired over a 7-month period ending May 2002. Data from Trondheim were acquired between March 2004 and February 2005.

Observational Technique

At between 2-weekly and 4-weekly intervals, the stroke unit population at each site was screened to determine whether observation was feasible at that time. A minimum of 3 and a maximum of 10 patients who met inclusion criteria and provided informed consent were required to make observation feasible. Observations were conducted between 8:00 AM and 5:00 PM, the most active part of a patient’s day. Data from Melbourne were collected over 2 consecutive days by a single trained observer (JB) and data for each patient were averaged. Examination of patient activity data over the 2 days of sampling showed no interaction effect with behavior highly consistent across days (P = 0.959). The observation protocol was therefore amended to require only a single day of observation per patient. Data from Trondheim were therefore gathered over 1 day by a single trained observer (ILM). Neither observer had worked on the participating stroke units before the study.

Patients were observed every 10 minutes with the exception of 4 randomly scheduled 10-minute breaks. At each time point, patient activity was recorded together with the person attending the patient and their location. Observations lasted for approximately 1 minute per patient and the highest level of activity observed during each period was recorded. The route through the ward remained consistent. When bedrest was prescribed, this was recorded.

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Patients were informed that we would monitor them throughout the day and it was emphasized that they should do nothing different on the day of observation. Staff was told that stroke unit processes were of interest. Therapists recorded the duration and content of all patient treatments.6 The emphasis was on acquiring processes were of interest. Therapists recorded the duration and content of all patient treatments.6 The emphasis was on acquiring

People Present During Activity

Eleven categories could be selected, including family, nurses, doctors, therapists, interpreters, porters, and so on.

Location of Activity

The 5 categories were bathroom, bedroom, hall, therapy area on ward, and off ward.

Other Definitions

Patients were classified according to the Oxfordshire Community Stroke Project classification.7 We used the World Health Organization definition of stroke8 and neurological impairment was determined using the National Institutes of Health Stroke Scale (NIHSS)9 obtained retrospectively from the medical record.10 Patients were grouped into mild (NIHSS < 8), moderate (NIHSS 8 to 16), and severe (NIHSS > 16) stroke categories.11

Other Prespecified Data

Living arrangements and mobility (categorized as independent, supervised, or dependent) before admission were recorded together with level of function at the time of observation (rated by the treating therapist) using the Mobility Scale for Acute Stroke Patients.12

Data Management and Statistical Analysis

The database (Microsoft Access 2000) was designed to automatically calculate the highest level of activity (activity categories 0 to 4) in every 10-minute interval. Activity data were pooled across the 5 Melbourne units and data averaged over days. Averaged Melbourne data were used in all analyses. To assess differences between Melbourne and Trondheim groups, categorical variables were analyzed using a χ² test, age was analyzed using t test, and the 2-sample Wilcoxon rank sum (Mann–Whitney) test was used to assess continuous data that were not normally distributed (NIHSS and number of days since stroke; Table 1). Three multivariable analyses were undertaken. Initially, Poisson regression models were fitted. However, because these models underestimated the amount of dispersion in the outcome, negative binomial regression models were undertaken instead. A backward stepwise approach was used to examine differences between the 2 sites in the number of occasions patients were observed (1) in bed (activities 0 and 1); (2) engaged in standing and walking activity (activities 3 and 4); and (3) the number of transitions among lying, sitting, and standing. In all 3 models, a full model with all significant variables on univariable analysis as well as other potentially confounding variables was fitted with serial removal of the least contributing variables until all variables in each model had a probability value < 0.10. When this was achieved, each excluded variable was then entered separately into each model to determine its contribution to the final model. Therapist contact, reported in mean minutes of therapy per day was compared using the Student t test. Upper limb and mobility-related therapy were reported separately. All statistical analyses were performed with Stata version 9.2.

Results

Stroke Unit Characteristics

The 5 Melbourne stroke units had between 6 and 20 dedicated stroke beds. Average length of stay on each stroke unit ranged from 6 to 14 days. Four of the hospitals had acute stroke units. Only one unit was described as comprehensive providing both acute and rehabilitation care with a therapy room on site. Staff patient ratios were: 1:4 for nurses all of whom were
Table 1. Baseline Characteristics of Patients

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Melbourne, n (%)</th>
<th>Trondheim, n (%)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>58</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>71.3 (12.6)</td>
<td>76.5 (9.0)</td>
<td>0.03</td>
</tr>
<tr>
<td>Range</td>
<td>30–96</td>
<td>54–91</td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>29 (50.0)</td>
<td>19 (51.4)</td>
<td>0.89</td>
</tr>
<tr>
<td>First-ever stroke</td>
<td>38 (65.5)</td>
<td>29 (78.4)</td>
<td>0.18</td>
</tr>
<tr>
<td>Time since stroke (days)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>5 (4–8)</td>
<td>5 (2–8)</td>
<td>0.46</td>
</tr>
<tr>
<td>Range</td>
<td>1–13</td>
<td>1–14</td>
<td></td>
</tr>
<tr>
<td>Stroke type, n (%)</td>
<td></td>
<td></td>
<td>0.54</td>
</tr>
<tr>
<td>Infarct</td>
<td>51 (87.9)</td>
<td>34 (91.9)</td>
<td></td>
</tr>
<tr>
<td>Hemorrhage</td>
<td>7 (12.1)</td>
<td>3 (8.1)</td>
<td></td>
</tr>
<tr>
<td>NIHSS, n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>8.5 (6–13)</td>
<td>8 (4–16)</td>
<td>0.71</td>
</tr>
<tr>
<td>Range</td>
<td>1–27</td>
<td>0–34</td>
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<tr>
<td>OCSP infarct classification</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>LACI</td>
<td>19 (32.8)</td>
<td>8 (21.6)</td>
<td>0.09</td>
</tr>
<tr>
<td>PACI</td>
<td>19 (32.8)</td>
<td>8 (21.6)</td>
<td></td>
</tr>
<tr>
<td>POCI</td>
<td>5 (8.6)</td>
<td>10 (27.0)</td>
<td></td>
</tr>
<tr>
<td>TACI</td>
<td>8 (13.8)</td>
<td>8 (21.6)</td>
<td></td>
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<tr>
<td>Side of symptoms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left</td>
<td>26 (44.8)</td>
<td>21 (56.8)</td>
<td>0.20</td>
</tr>
<tr>
<td>Right</td>
<td>32 (55.2)</td>
<td>15 (40.5)</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>0 (0.0)</td>
<td>1 (2.7)</td>
<td></td>
</tr>
<tr>
<td>Prestroke accommodation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home alone</td>
<td>14 (24.1)</td>
<td>27 (73.0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Home with family</td>
<td>39 (67.3)</td>
<td>10 (27.0)</td>
<td></td>
</tr>
<tr>
<td>Supported accommodation</td>
<td>5 (8.6)</td>
<td>0 (0.0)</td>
<td></td>
</tr>
<tr>
<td>Prestroke mobility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Independent aids</td>
<td>57 (98.3)</td>
<td>37 (100.0)</td>
<td>0.44</td>
</tr>
<tr>
<td>Dependent</td>
<td>1 (1.7)</td>
<td>0 (0.0)</td>
<td></td>
</tr>
</tbody>
</table>

*No. and percentage unless otherwise indicated.
IQR indicates interquartile range (reported as 25th and 75th percentiles); OCSP, Oxfordshire Community Stroke Project; LACI, lacunar circulation infarct; PACI, partial anterior circulation infarct; POCI, posterior circulation infarct; and TACI, total anterior circulation infarct.

registered or enrolled nurses (nurse assistants do not exist in Australia), from 1:10 to 1:12 for physiotherapists, 1:11 to 1:14 for occupational therapists, and 1:20 to 1:24 for speech therapists. The Trondheim stroke unit, a comprehensive stroke unit, had 14 dedicated stroke beds; however, the high demand for beds in this unit led to the need for patients to be managed behind screens in the main corridor of the ward on a regular basis. Average length of stay was 11 days with an active early supported discharge program. The Trondheim unit had a dual-purpose meeting and therapy room with a mobile diagnostic ultrasound machine. Staff patient ratios were: 1:3 for nurses (which included registered nurses and nurse assistants), 1:8 for physiotherapists, and 1:28 for speech therapists. Occupational therapists formed part of the early supported discharge (postacute) program and were rarely involved in acute patient care. In both countries, therapists worked a 5-day week.

**Patient Characteristics**

At the selected intervals, all patients with stroke were screened for inclusion in this study. In Melbourne, 2 patients declined to participate and one was receiving palliative care. There were no exclusions or refusals in the Trondheim group. The characteristics of the 58 Melbourne patients and the 37 Trondheim patients are shown in Table 1. Patients from Trondheim were older (P=0.03) and more often lived alone before their stroke than patients from Melbourne. The patients were similar in all other characteristics.

**Rest in Bed**

Over the 30 observation days, only 10 patients (9 Melbourne; one Trondheim) were restricted to bed. Reasons for restricting mobility included unstable blood pressure (n=3), reduced consciousness (n=2), pulmonary emboli (n=1), chest infection (n=2), suspected deep vein thrombosis (n=1), and bleeding complications after cystoscopy (n=1). Data from these patients were included in all analyses because bedrest policies impact on physical activity patterns.

**Physical Activity Patterns**

Patients managed in Trondheim spent on average 21% less time resting in bed and approximately 10% more time in both sitting out of bed and standing and walking activities (Figure 1). The median number of transitions (changes in positions) was almost double in the Trondheim group.

Because more patients in Melbourne were restricted to bed, we examined the effect of removing the 9 Melbourne patients restricted to bed from the Melbourne data set. Those Melbourne patients not restricted to bed (n=49) spent only 3.8% less time in bed compared with the total group and high-level (standing and walking) activity increased by only 1.1% with their removal. These differences were not significant (P>0.47 in all cases).

In univariable negative binomial regression analysis patients, the incidence rate ratio for undertaking no activity in Melbourne was 1.57 (95% CI: 1.24 to 1.98) when compared with Trondheim (Table 2). Melbourne patients spent significantly less time in standing/walking activities and less often changed position each day. When adjusting for differences in other potentially confounding factors using multivariable analyses, when compared with Trondheim, Melbourne patients were still found to spend significantly more time in bed (incidence rate ratio: 1.78; 95% CI: 1.44 to 2.19) and less time in standing and walking activities (incidence rate ratio: 0.44; 95% CI: 0.32 to 0.62). The number of transitions was also less (incidence rate ratio: 0.53; 95% CI: 0.41 to 0.68) in Melbourne.

**Activity Differences According to Stroke Severity**

The proportion of the day that patients with mild, moderate, and severe stroke spent in bed and in standing and walking activity during observation are shown in Figure 2. The largest differences between groups were seen in those patients with...
moderate and severe stroke who spent on average more time standing and walking and less time in bed in Trondheim.

**Location of Activity**

Patients in both groups spent the greatest proportion of the day in their bedrooms (Melbourne 88.5%; Trondheim 75.6%) and only a small proportion of the day in the bathroom (Melbourne 3.1%; Trondheim 4.2%). Trondheim patients were observed more often in the hallway (often with a therapist) compared with Melbourne patients (Melbourne 2.4%; Trondheim 11.8%) and patients were off the ward for less than 8% of the day (Melbourne 5.9%; Trondheim 7.7%). We were unable to locate the patients on only 19 occasions (0.2%).

**Off-Ward Activity**

Although off-ward activity makes up a relatively small proportion of the day, there were some interesting differences observed. In Melbourne patients, 77% of off-ward time was spent undergoing tests or procedures. In Trondheim, only 16% of off-ward time was taken up with tests. Over 50% of the off-ward time in Trondheim, patients were in the adjacent therapy area. This made up 2.8% of Melbourne patients’ off-ward time. Both groups spend approximately 16% of their off-ward time engaged in recreation (eg, watching television, visiting with family) in a dedicated area.

**Contact With Others**

Patients in both groups spent over half the day alone (Melbourne 60.4%; Trondheim 53.9%). Family were present more often in the Melbourne group (Melbourne 15.3%; Trondheim 11.8%), but this was not significantly different. Trondheim patients spent more than twice as much time during the active day with a therapist (Melbourne 5.2%; Trondheim 14.3%). It should be remembered here that the Trondheim therapist group consists of physiotherapists only, whereas the Melbourne group include data from physiotherapists, occupational therapists, and speech therapists. In Trondheim, nurses spent 23.2% of the day with patients (compared with 14.0% in Melbourne). More often in Trondheim, nurses were observed to be working together with nurses compared with Melbourne (Melbourne 0.3%; Trondheim 5.2%).

**Therapy Provided**

To enable comparison of therapy sessions across countries, data from Melbourne occupational therapy and physiotherapy
services were combined because occupational therapy services are not provided in the Trondheim stroke unit (Table 3). Upper limb therapy was reported separately because mobility-related therapy was the therapy of interest in this study. The average duration (minutes) of therapy per session was higher in Trondheim, although this difference was not significant ($P = 0.09$). However, patients in Trondheim averaged twice as many therapy sessions per day ($P < 0.001$).

### Discussion

Although we expected differences in the physical activity patterns of patients managed in a stroke unit with explicit mobilization policies (Trondheim) as compared with stroke units without such policies (Melbourne), the extent of the difference was somewhat surprising. Patients with stroke managed in the Trondheim unit spent significantly more time engaged in moderate- to high-level therapeutic activities and were more frequently moved from one position to another throughout the active day (8:00 AM to 5:00 PM). Differences in levels of physical activity between Trondheim and Melbourne were particularly pronounced in patients with moderate and severe stroke. These effects remained when adjustment was made for other differences between the 2 samples.

Differences in patients’ physical activity can be directly attributed to differences in the rehabilitation program. Trondheim has a general early mobilization program that aims to begin mobilization in the first 24 to 48 hours after stroke. This continues as an intensive rehabilitation program up until 2 weeks poststroke. An important focus of the intervention is that it occurs 24 hours a day led primarily by a nursing team who have undergone high levels of education and training in rehabilitation. Consequently, nurses were highly involved with mobilization in Trondheim and spent 23.2% of the active day (compared with 14.1% in Melbourne). In contrast, none of the Melbourne stroke units had early mobilization policies. First contact with a therapist within 24 hours typically occurs only 43% of the time. Differences in levels of physical activity between Trondheim and Melbourne were particularly pronounced in patients with moderate and severe stroke. These effects remained when adjustment was made for other differences between the 2 samples.

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Another important difference between sites was the lower proportion of patients prescribed bedrest in the Trondheim stroke unit ($n = 1$). In the first days after stroke, bedrest is only recommended for patients who had hemorrhages with breakthrough to the ventricular system or uncontrolled blood pressure ($> 200/110$ mm Hg). In Melbourne, other conditions such as reduced consciousness and pneumonia were cited as contraindications to mobilization. When these
patients were removed from the sample, levels of bedrest observed in the remaining Melbourne sample reduced by approximately 4% but with little increase in standing and walking activity (1.1%).

Other relevant differences between Trondheim and Melbourne include staffing and the physical environments of the stroke units. Nurse–patient ratio was 1:3 in Trondheim (including nurse assistants) but only 1:4 in Melbourne, and physiotherapist–patient ratio was 1:8 in Trondheim compared with an average 1:11 in Melbourne. The Trondheim unit had few en suite bathrooms adjacent to the patients’ beds, and the need to transport a patient to the shower or toilet was seen as an opportunity for mobilization. Another process in place in Trondheim that was viewed as supporting mobilization was the program to control fluid balance to avoid dehydration. All patients received intravenous saline solutions (1000 to 2000 mL per day during the first 24 to 48 hours), which may explain why early mobilization very seldom causes a drop in blood pressure in the Trondheim unit.14 Time away from the ward was most often spent in an adjacent therapy space in Trondheim, whereas in Melbourne, it was often spent having diagnostic tests with little opportunity for physical activity.

Staff in Melbourne hospitals were required to observe a “no-lift” policy, the aim of which was to reduce staff injury by limiting manual handling of patients. In these hospitals, use of hoists was encouraged during transferring patients from, for example, the bed to the chair. In Trondheim, there were no restrictions to manual handling of patients. Trondheim staff were able to help patients transfer as they saw fit. The emphasis of the extensive patient handling training in the Trondheim unit was not on lifting patients, but rather on learning how to help patients to help themselves in a way that was both safe for the patient and the nursing and therapy staff. Staff injury in the unit was reported as very low. Using equipment for moving patients can take considerable time and these policy differences may have contributed to differences between countries.

This study has several limitations. Like in any observational study, there was a potential for bias, and staff or patient behavior may have been altered by the observers’ presence. In general, we would expect activity to increase under observation, in which case we might have overestimated activity levels. Conversely, our assumption that patients were not physically active when away for tests may be incorrect. Intermittent observation also means that the activity observed and recorded during the 1-minute observation may be higher or lower than the average activity over the 9 minutes when the patient was not observed. Although we are confident that in-bed activity, particularly for those patients with moderate and severe stroke, is representative of activity (because all transfer maneuvers in these patient groups take time), it is possible that other activity was missed. Only continuous monitoring can overcome this difficulty. A further shortcoming was that the data capture periods were different with Melbourne data captured from 5 hospitals over 7 months ending 2002 and Trondheim data captured from a single hospital over a longer period ending February 2005. However, all stroke units in this study had been established for at least 10 years, and no major changes had occurred in the Melbourne units between 2002 and 2004. A recent smaller study conducted at 2 of the 5 Melbourne units during 2004 to 2006 also found no change in the activity patterns of acute patients when compared with 2002 data.17 Furthermore, the populations under study here were similar to other samples of patients with stroke from these countries.2,15 A final limitation of the current study relates to the fact that the first 14 days poststroke were described as a block. To investigate differences between Trondheim and Melbourne in very early mobilization practices, we would have needed to assess activity in the first 24 to 48 hours for each patient. Observational studies are time-intensive. It is not therefore feasible to conduct mapping of a single individual for 9 hours. This makes the technique less suitable for studying very early mobilization practices on a case-by-case basis. Nevertheless, it is a technique that allows researchers to obtain a detailed snapshot of physical activity patterns, as the current study intended.

Demonstrating that patients are less active in Melbourne stroke units than in Trondheim is only meaningful if it can be shown that early physical activity improves patient outcome. There is some indirect evidence that very early mobilization has a positive effect on rehabilitation outcome.2–4 There is also evidence that greater intensity and frequency of therapy improves functional outcome.18 The Trondheim group has demonstrated that a rehabilitation program that includes very early mobilization is safe and feasible.3 The feasibility of adopting a very early mobilization protocol has been confirmed recently in a Melbourne pilot study.19 Nevertheless, the practice of very early mobilization after stroke remains controversial, primarily due to concerns around the potential for injury to the ischemic penumbra early after stroke.20,21 More research is needed into the optimal timing, intensity, duration, amount, and kind of therapy that leads to the most beneficial outcome after stroke. The logical next step, therefore, is to conduct a well-designed and adequately powered randomized controlled trial of very early mobilization versus standard stroke care. A clinical trial of very early rehabilitation (AVERT), with a mobilization protocol based on the Trondheim model, is now being undertaken.22

Since the publication of the Stroke Unit Trialists’ Collaboration review,23 much has been written about characteristics of stroke units that form part of effective stroke unit care. Rehabilitation practices are rarely considered as part of quality evaluations in acute stroke care. Not all models will be the same with variations between and within countries according to the resources available. Recent pilot work has demonstrated vast disparities in stroke care between countries.24 However, we should aim, wherever possible, to replicate models of care that promote better outcomes for patients. This will contribute toward the development of agreed standards of care based on evidence of effectiveness. Simply putting up a “stroke unit” sign will not create an effective stroke unit. The task before us is to determine, through rigorous evaluation wherever possible, the critical components of best practice stroke care.

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None.

References
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