Facilities Available in European Hospitals Treating Stroke Patients

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Background and Purpose—Stroke units decrease mortality and need for institutional care, but they are not widely available. The objective of the study was to determine, among European hospitals admitting acute stroke patients, how many are able to provide an appropriate level of care.

Method—We randomly selected 886 hospitals in 25 countries. We used definitions derived from a European expert survey for comprehensive stroke centers (CSC), primary stroke centers (PSC), and minimum level required for any hospital ward (AHW) admitting stroke patients. We determined the proportion of hospitals meeting criteria for each category, and which facilities were not available.

Results—Participating hospitals treated approximately one-third of all strokes supposed to have occurred in these countries in 2005. Forty-three (4.9%) met criteria for CSC, 32 (3.6%) for PSC, 356 (40.2%) for AHW, and 455 (51.4%) provided a lower level of care. In 2005, hospitals meeting criteria for CSC, PSC, AHW, and none of them admitted 27,644 (8.3%), 17,365 (5.2%), 146,175 (44.1%), and 140,306 (42.3%) patients. There was no 24-hour availability for brain CT scan in 25% of hospitals not meeting criteria for AHW. Of 448 hospitals admitting at least 1 stroke per day, 51 (11.4%) met criteria for PSC or CSC, and 227 (50.7%) for AHW.

Conclusions—Less than 10% of European hospitals admitting acute stroke patients have optimal facilities, and in 40% even the minimum level is not available. Because the availability of facilities does not grant their use, our study suggests that only few acute stroke patients are treated in appropriate centers in Europe. (Stroke. 38;2985-2991.)

Key Words: European stroke facilities ■ stroke care ■ stroke unit ■ survey

Randomized trials have shown that stroke unit care prevents 1 death and 1 institutionalization for 33 and 20 patients treated, respectively.1 This benefit has been proven before specific therapies became available,1 and does not depend on age, gender, stroke subtype, and severity.1,2 On top of this, the scientific community has added 2 additional helpful measures, ie, thrombolytic therapy3 and automated continuous monitoring during the first 48 to 72 hours.4 Although there is only little evidence on which components should be present in stroke units,3–8 similar approaches concerning assessment procedures, early management policies, and ongoing rehabilitation policies were present in 11 trials published between 1985 and 2000,5 in which a significant benefit of stroke unit care was found.5 In addition to evidence-based data,1,3,5–8 the European Stroke Initiative (EUSI) recently listed, from expert opinions, which facilities should be available in comprehensive stroke centers (CSC), primary stroke centers (PSC), and in any hospital ward (AHW) admitting stroke patients routinely.9 However, not all stroke patients have access to optimal care in practice,10 often because of lacking facilities.10

The primary objective of this survey conducted in a large sample of randomly selected European hospitals where at least 1 acute stroke patient had been admitted in 2005 was to determine the proportion of hospitals meeting criteria for CSC, PSC, and AHW. The secondary objective was to identify the facilities that were not available to meet these criteria.

Method

The survey was conducted in 25 countries, ie, countries members of the European Union (except Cyprus and Malta), plus Switzerland and Norway.

For each country surveyed, a list of hospitals was obtained by an independent company (Datamonitor, UK), using governmental websites when available, or purchasing it from brokers. The lists were checked for accuracy by native speakers in the local language, who removed entries of dubious quality and redundant data. From these lists, hospitals were randomly selected as detailed here, and a first telephone contact was made. To be eligible, hospitals had to have admitted at least 1 acute stroke patient in 2005. Hospitals that were not supposed to admit acute strokes (maternities, psychiatric hospitals, nursing homes, rehabilitation centers, etc) were excluded. The respondent was the senior physician with responsibility for acute stroke care. Respondents received a 9-page questionnaire, with a letter from the

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chairman of the EUSI, explaining the purpose. Questionnaires were available in English, German, French, Spanish, Italian, Greek, Polish, and Russian. They were mailed in January 2006 and could be returned by surface mail, fax, or e-mail, or be completed online. Nonresponders were contacted 1 and 2 weeks later by telephone in their own language. If they did not respond within 1 week after the second telephone call, they were considered as nonresponders and replaced by the next center on the random list. If they responded after the deadline of 1 week after the second call, their answer was not taken into account.

Table 1. Facilities Evaluated in the Questionnaire Sent to Hospitals

<table>
<thead>
<tr>
<th>List of Facilities</th>
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</thead>
</table>

Personnel
- Neurologist 24/7
- Neurologist on-call
- Neurologist on staff
- Stroke trained physician 24/7
- Stroke trained physician on-call
- Diagnostic radiologist 24/7
- Diagnostic radiologist on-call
- Interventional neuroradiologist on-call
- Neurosurgeon 24/7
- Neurosurgeon on-call
- Multidisciplinary team
- Trained stroke nurses
- Emergency department staff
- Social worker
- Speech therapy start within 2 days
- Physiotherapy start within 2 days

Monitoring
- Automated ECG monitoring at bedside
- Automated monitoring of pulsoximetry
- Automated monitoring of blood pressure
- Automated monitoring of breathing
- Automated monitoring of temperature
- EEG monitoring
- Monitoring of intracranial pressure
- Monitoring of evoked potentials

Invasive treatments provided
- Respiratory support
- Intravenous rt-PA protocols 24/7
- Intra-arterial thrombolysis 24/7
- Carotid surgery
- Angioplasty and stenting
- Intra-arterial thrombectomy
- Ventricular drainage
- Surgery for hematoma
- Surgery for aneurysms
- Coiling 24/7
- Coiling 8/5

Diagnostic procedures
- Brain CT scan
- Brain CT scan 24/7
- MRI (T1, T2, T2*, FLAIR)
- MRI (T1, T2, T2*, FLAIR) 24/7
- Diffusion-weighted MRI
- Diffusion-weighted MRI 24/7
- Perfusion-MRI
- Perfusion-MRI 24/7
- MR angiography
- MR angiography 24/7
- CT angiography
- CT angiography 24/7
- Transfemoral cerebral angiography
- Transfemoral cerebral angiography 24/7
- Extracranial Doppler ultrasound
- Extracranial color-coded duplex ultrasound
- Extracranial color-coded duplex ultrasound 24/7
- Transcranial Doppler ultrasound
- Transcranial Doppler ultrasound 24/7
- Transcranial duplex ultrasound
- Transcranial duplex ultrasound 24/7
- Transcranial echocardiography
- Transthoracic echocardiography
- Transthoracic echocardiography 24/7
- Transoesophageal echocardiography
- Transoesophageal echocardiography 24/7

Protocols and procedures
- Stroke faculty
- Stroke care map for patients admission
- Stroke pathways/algorithms
- Emergency medical services training program
- Emergency medical services stroke prioritization
- CT priority for stroke patients
- Intravenous thrombolysis protocols
- Community stroke awareness program
- Prevention program

rtPA indicates recombinant tissue plasminogen activator.
Table 2. Facilities Absolutely Necessary to Meet Criteria for Comprehensive Stroke Centers

<table>
<thead>
<tr>
<th>Categories</th>
<th>Facilities</th>
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</thead>
<tbody>
<tr>
<td>Personnel</td>
<td>Neurologist (24/7)</td>
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<tr>
<td></td>
<td>Stroke-trained physician (24/7)</td>
</tr>
<tr>
<td></td>
<td>Interventional neuroradiologist on-call</td>
</tr>
<tr>
<td></td>
<td>Neurosurgeon on-call</td>
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<tr>
<td></td>
<td>Multidisciplinary team*</td>
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<td></td>
<td>CEA vascular surgeon</td>
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<td></td>
<td>Stroke-trained nurses*</td>
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<tr>
<td></td>
<td>Emergency department staff</td>
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<td></td>
<td>Physician expert in carotid ultrasonology</td>
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<td></td>
<td>Physician expert in echocardiography</td>
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<td></td>
<td>Social worker</td>
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<td></td>
<td>Physician trained in rehabilitation</td>
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<td></td>
<td>Speech therapy start within 2 days</td>
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<td></td>
<td>Physiotherapy start within 2 days</td>
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<tr>
<td>Diagnostic procedures</td>
<td>Brain CT scan 24/7</td>
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<tr>
<td></td>
<td>CT priority for stroke patients*</td>
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<tr>
<td></td>
<td>MRI (T1, T2, T2*, FLAIR) 24/7</td>
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<tr>
<td></td>
<td>Diffusion-weighted MRI</td>
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<tr>
<td></td>
<td>Extracranial Doppler sonography*</td>
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<td></td>
<td>Extracranial Doppler sonography/24/7</td>
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<td></td>
<td>Extracranial duplex sonography*</td>
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<td></td>
<td>Extracranial duplex sonography/24/7</td>
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<td></td>
<td>Transcranial Doppler 24/7</td>
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<td></td>
<td>CT angiography 24/7</td>
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<td>Magnetic resonance angiography 24/7</td>
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<td></td>
<td>Transfemoral cerebral angiography 24/7</td>
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<td></td>
<td>Transesophageal echocardiography*</td>
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<td></td>
<td>Extracranial Doppler sonography*</td>
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<td></td>
<td>Automated ECG monitoring at bedside</td>
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<td>Automated monitoring of pulsoximetry*</td>
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<td>Automated monitoring of blood pressure*</td>
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<td>Automated monitoring of breathing</td>
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<td>Monitoring of temperature</td>
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<tr>
<td>Invasive treatments</td>
<td>Intravenous rt-PA protocols 24/7</td>
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<td>provided</td>
<td>Intra-arterial thrombolysis 24/7</td>
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<td></td>
<td>Respiratory support</td>
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<td></td>
<td>Surgery for aneurysms</td>
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<td>Carotid surgery*</td>
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<td></td>
<td>Angioplasty and stenting*</td>
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<td>Hemicraniectomy</td>
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<td>Ventricular drainage</td>
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<td>Surgery for hematoma</td>
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<td>Infrastructures</td>
<td>Emergency department (in-house)</td>
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<td></td>
<td>Stroke outpatients clinic</td>
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<td></td>
<td>Multidisciplinary intensive care unit</td>
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<td></td>
<td>Inpatients rehabilitation (in-house)</td>
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<td>Outpatients rehabilitation available</td>
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(Continued)

Table 2. Continued

<table>
<thead>
<tr>
<th>Categories</th>
<th>Facilities</th>
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<tbody>
<tr>
<td>Protocols and procedures</td>
<td>Stroke faculty</td>
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<tr>
<td></td>
<td>Stroke care map for patient admission</td>
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<td></td>
<td>Stroke database</td>
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<td></td>
<td>Intravenous rt-PA protocols*</td>
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<td></td>
<td>Community stroke awareness program</td>
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<td>Prevention program</td>
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<td></td>
<td>Stroke pathways*</td>
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<td></td>
<td>Clinical research*</td>
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<td>Research grants</td>
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<td></td>
<td>Drug research</td>
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<td>Stroke clinical fellowship</td>
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<td></td>
<td>Stroke study coordinator</td>
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<td>Stroke research unit</td>
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*To be qualified, hospitals should have 80% or more of facilities rated as absolutely necessary by at least 50% of experts in each category, plus the 19 components considered as absolutely necessary by >75% of experts.

The number of hospitals recruited per country was predefined and based on the country population: 1.5 to 2 hospitals were surveyed per one million inhabitants, with a minimum of 2 per country. Hospitals were contacted by Datamonitor, and the writing committee was blinded to the final list of participating hospitals to prevent any potential bias in the interpretation of the results and for confidentiality.

The questionnaire used for this hospital survey was based on the results of a previously published expert survey. It included 4 categories of questions: (1) Are each the 78 facilities (listed in Table 1) available for stroke patients in your hospital? (2) How many acute stroke patients have been admitted in your hospital in 2005? (3) How many stroke patients have been treated by thrombolytic therapy in your hospital in 2005? and (4) Does your hospital participate in the SITS-MOST registry.

Different levels of stroke care and their components have been described in detail elsewhere. CSC are centers with necessary staffing, infrastructure, expertise, and programs to provide appropriate diagnosis and treatment for stroke patients who require a high intensity of medical or neurological care, specialized tests, or interventional therapies; to act as referral center for other hospitals in their area; and to be an educational resource for health care professionals. PSC are centers with necessary staffing, infrastructure, expertise, and programs to provide appropriate diagnosis and treatment for most stroke patients; although PSC provide high-quality care, some patients with rare disorders, complex strokes, or multi-organ diseases may need more specialized care and resources that are available in CSC. AHW are centers where general acute care is provided, and where >50 acute stroke patients are admitted per year. The main components of the various levels of stroke care have been described in detail elsewhere.

To meet criteria for CSC, the hospitals should have availability of at least 80% of the components rated as absolutely necessary by at least 50% of experts who participated in the previous expert survey, in each of the 6 categories (listed in Table 2), and the 19 components rated as absolutely necessary by >75% of experts. To meet criteria for PSC, the hospitals should have availability of at least 80% of the components rated as absolutely necessary by at least 50% of experts in each of the 6 aforementioned categories and the 8 components rated as absolutely necessary by >75% of experts (Table 3). To meet criteria for AHW, we arbitrarily decided that hospitals should offer...
Monitoring Automated ECG monitoring at bedside*

Facilities that were not available to meet criteria for PSC and AHW.9
day (post hoc subgroup of hospitals where at least 1 stroke patient is admitted per whole group of hospitals (prespecified analysis) and in the patients they had admitted in 2005. This analysis was performed in the whole group of hospitals (prespecified analysis) and in the subgroup of hospitals where at least 1 stroke patient was admitted per day (post hoc analysis). The second step consisted in determining the facilities that were not available to meet criteria for PSC and AHW.* Facilities not available for CSC were not further evaluated because the differences between CSC and PSC are mainly attributable to invasive treatments that are required for only few patients.

Results

Of 4261 hospitals contacted, 2573 (60.4%) answered they never admit acute stroke patients. They were mainly hospitals dedicated to psychiatry, rehabilitation, or obstetrics, nursing homes, and hospitals without emergency admissions. Of 1688 hospitals admitting acute stroke patients, 886 (52.5%) agreed to participate and returned the questionnaire. These 886 hospitals reported to have treated 331 490 acute stroke patients in 2005, ie, a mean of 376 per hospital (ischemic stroke 78%, intracerebral hemorrhage 16%, and subarachnoid hemorrhage 6%). Only 60 hospitals (6.8%) had treated <50 stroke patients in 2005, half of them being located in France and Germany. In the participating hospitals, 8489 stroke patients had been treated by thrombolytic therapy in 2005 (3.3% of ischemic strokes), and 156 (17.6%) of all hospitals participated in the SITS-MOST registry (ie, 22.9% of hospitals from countries participating in the SITS-MOST registry).

The number of participating hospitals per country, the number of hospitals treating <50 patients per year, and the number of hospitals meeting criteria for CSC, PSC, AHW, and none of them are detailed in Table 4.

Of 886 hospitals, 43 (4.9%) met criteria for CSC, 32 (3.6%) for PSC, 356 (40.2%) for AHW, and 455 (51.4%) did not meet any of these levels. In 2005, these hospitals had treated 27 644 patients (8.3%) in CSC, 17 365 (5.2%) in PSC, 146 175 (44.1%) in AHW, and 140 306 (42.3%) in hospitals not meeting any of these levels.

In the subgroup of 448 hospitals admitting at least 1 stroke patient per day, 51 (11.4%) met criteria for PSC or CSC, 227 (50.7%) for AHW, and 170 (37.6%) did not meet criteria for any of these levels.

Facilities not available in the 811 hospitals not qualifying for CSC or PSC mainly consisted in a lack of multidisciplinary approach, stroke nurses, CT priority for stroke patients, availability of extracranial Doppler sonography, and intravenous recombinant tissue plasminogen activator protocols (Table 5). Facilities not available in the 455 hospitals not qualifying for any of the 3 levels mainly consisted of a lack of availability of brain CT scan and stroke pathways inside the hospital (Table 6).

Discussion

Our study has shown that only few European hospitals can provide an optimal level of care for stroke, with huge disparities between countries. We aimed at selecting a large random sample of hospitals representative of hospitals where stroke patients are treated in practice. Several characteristics suggest that these hospitals are actually involved in daily stroke care: (1) they admitted an average of 376 strokes in 2005; (2) <7% admitted ≤50 strokes; (3) >3% of ischemic stroke patients were treated by thrombolytic therapy, which is better than the 0.5% and 0.6% reported in Israel12 and in the USA;13 (4) more than one-fifth of participating centers contributed to the SITS-MOST registry in the countries where SITS-MOST was
conducted; 11 and (5) assuming that 2400 strokes occur per one million inhabitants per year, participating hospitals admitted approximately one-third of all strokes supposed to have occurred in these countries in 2005. These characteristics suggest that participating hospitals were really representative of all hospitals treating stroke patients in practice. The characteristics of hospitals that did not agree to participate are not available, but because responders are likely to be more involved in stroke care than non responders, there is probably an over-representation of hospitals with special interest in stroke care in these hospitals. This strengthens the results of this study showing an overall lack of stroke facilities.

Our study has limitations. The definition of CSC and PSC differed from that used in randomized trials. Therefore, the need for several facilities was based on expert opinion rather than on evidence-based data, and we have no formal proof that CSC and PSC improve outcome. Our

<table>
<thead>
<tr>
<th>Table 4. Breakdown of the Different Types of Hospitals Per Country</th>
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<td>Country</td>
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<td>Austria</td>
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<td>Belgium</td>
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<td>Czech Republic</td>
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<td>Denmark</td>
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<td>Estonia</td>
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<td>Finland</td>
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<td>France</td>
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<td>Sweden</td>
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<td>Switzerland</td>
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<td>United Kingdom</td>
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</tbody>
</table>

CSC, PSC, AHW indicates number of hospitals meeting criteria for comprehensive stroke center, primary stroke center, and any hospital ward treating stroke patients; N, number of participating hospitals; N=50, number of hospitals treating < 50 patients per year in routine; None, hospitals not meeting criteria for comprehensive stroke center, primary stroke center, and any hospital ward treating stroke patients; P/y, median number of patients treated per year (range).

<table>
<thead>
<tr>
<th>Table 5. Facilities Not Available in Hospitals Not Qualifying for CSC or PSC Among Facilities Considered as Absolutely Necessary by at Least 75% of the Experts</th>
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</thead>
<tbody>
<tr>
<td>Facilities</td>
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<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Multidisciplinary team</td>
</tr>
<tr>
<td>Stroke trained nurses</td>
</tr>
<tr>
<td>Brain CT scan 24/7</td>
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<tr>
<td>CT priority for stroke patients</td>
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<tr>
<td>Extracranial Doppler sonography</td>
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<tr>
<td>Automated ECG monitoring at bedside</td>
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<tr>
<td>Intravenous rt-PA protocols 24/7</td>
</tr>
<tr>
<td>Emergency department (in-house)</td>
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<table>
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<tr>
<th>Table 6. Facilities Not Available in Hospitals Not Qualifying for CSC, PSC, or AHW Among Facilities Considered as Absolutely Necessary by at Least 50% of the Experts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilities</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Emergency department staff</td>
</tr>
<tr>
<td>Brain CT scan 24/7</td>
</tr>
<tr>
<td>CT priority for stroke patients</td>
</tr>
<tr>
<td>Emergency department (in-house)</td>
</tr>
<tr>
<td>Collaboration with outside rehabilitation center</td>
</tr>
<tr>
<td>Prevention program</td>
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<tr>
<td>Stroke pathways/algorithm</td>
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</table>
study was not designed to answer this question; that would require a randomized trial. We studied facilities available in randomly selected hospitals, but their availability does not necessarily grant their use for stroke patients in practice. The results were based on the declaration of those who answered the questionnaires, and there was no local monitoring to check the answers. In countries where many hospitals are small and admit only a few stroke patients per year, especially France and Germany, the method used to select hospitals has probably led to an over-representation of poorly equipped hospitals. The questionnaire was not available in all the languages spoken in the various countries, but at least in each country in the most common first or second language. We cannot exclude, however, that a few centers did not answer for linguistic reasons. However, this is not likely to have really influenced our results for the following reasons: (1) 12 countries were interviewed in their own languages; (2) in the 13 remaining countries, many physicians are usually fluent either in English or in one of the other available languages; and (3) if a selection bias was introduced for linguistic reasons, it is more likely to have occurred in small centers, and this would have skewed the results toward a selection of more experienced centers and, therefore, cannot explain the overall poor level.

The response rate was only 50%, which is in the usual range in surveys with questionnaires of this length.15 This rate may be explained also by the short notice before centers were considered as nonresponders. In the North Carolina survey, the response rate was 100%, but the area covered was much smaller, the cover letter was signed by a local stroke expert and the deputy director of the State Department of Health and Human Services, the answers were not anonymous, and the questionnaire was shorter.16,17

Facilities selected for AHW were only those evaluated as important or absolutely necessary by >50% of the experts and in centers where only 50% of the requirements were met in each category qualified for this. This definition implies that the level of requirement for AHW can be considered as very low and obviously a suboptimal level of care. We found that 51.4% of hospitals do not provide the minimum facilities required to treat stroke patients on a routine basis, although they treat 42.3% of all stroke patients. This finding suggests a substandard level of care in many European countries, probably leading to lost chances to survive and to recover for stroke patients. There also is probably some degree of lost chance for more serious cases in these hospitals. Finally, only 8.5% of hospitals provide optimal facilities required to treat stroke patients at a CSC or PSC level, and they treat 13.5% of all stroke patients. We cannot exclude that hospitals with a low level of facilities refer selected patients to a PSC or CSC, or use telemedicine facilities, but this survey was not designed to address this question. The objective was to evaluate which facilities were available, not how patients were treated.

Our survey found a huge heterogeneity of facilities among countries. In 4 countries (Finland, Luxemburg, the Netherlands, and Sweden), >25% of hospitals met at least the minimum level, whereas in 4 countries (Estonia, France, Greece, Portugal), at least 75% of selected hospitals did not meet the minimum level. In France, the high proportion of small hospitals treating <50 strokes per year may have contributed to the poor results. This is supported by the fact that 3 of 4 countries performing well (Finland, Luxemburg, and Sweden) have no hospital treating <50 patients, and the fourth (the Netherlands) has only 1 of 20. Small hospitals treating <50 stroke patients per year may also explain why 35% of hospitals in Germany did not reach the minimum level, although many hospitals meet criteria for PSC or CSC.

In hospitals admitting at least 1 stroke per day, ie, where it makes sense to implement a PSC (or CSC), the results are obviously better, but still far from being optimal. Nine of 10 do not provide appropriate stroke unit care and 1 of 3 does not provide the minimum level considered as acceptable.

The analysis of facilities that were not available necessary for PSC showed that almost 20% of the 811 hospitals that did not meet criteria for PSC or CSC have no 24-hour availability for brain CT, and >50% have no protocol for intravenous thrombolysis 24 hours per day. The analysis of facilities not available for AHW in 455 hospitals showed that more than one-fourth of them do not provide 24-hour access to brain CT, and more than one-third have no CT priority for stroke patients. Almost half of these hospitals have no predefined in-hospital stroke pathways or algorithms.

Our study showed that most hospitals in Europe should offer more, and better-equipped, facilities to treat stroke patients. The next step of this survey is to perform more specific analyses per country. Health deciders should also bear in mind that the contribution of small hospitals to these overall poor results should be evaluated more extensively and more critically. Besides offering more facilities in reasonably equipped hospitals, a complementary and helpful action is probably to prevent admission of stroke patients in small under-equipped hospitals by health authority regulation. Another action in the future will be to evaluate whether those facilities, when available, are really used for stroke patients.

Acknowledgments
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Disclosures
None.

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References


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