Background and Purpose—Significant intercenter variability in quality of care and stroke outcomes was found in many countries. The aim of the study was to compare the acute ischemic stroke care and outcomes in centers participating in the Polish National Stroke Prevention and Treatment Registry.

Methods—The World Health Organization Stepwise Approach to Stroke Surveillance–based questionnaire was used to collect data on patients admitted to participating centers between December 1, 2001, and July 31, 2002. To ensure data quality, only centers reporting representative sample of patients were analyzed. Ischemic stroke patient characteristics, in-hospital care, and early outcomes (adjusted for case mix) were compared for participating centers.

Results—There were 26 of 48 centers that met inclusion criteria, with a total of 8736 patients (52% women; mean age 71 years, with a range among institutions from 68 to 75 years). Significant differences between centers were observed for distribution of risk factors and in-hospital care. The rates for death and poor outcome (defined as a Rankin score ≥3 or death) ranged from 8.0% to 31.8% and from 44.2% to 74.7%, respectively. After adjusting for case mix, the death or poor outcome prognoses remained significantly different between centers.

Conclusions—The observed significant differences between Polish stroke centers indicate the need for improvement of patient education, effective stroke risk factor control, and standardized in-hospital care. (Stroke. 2006;37:1837-1843.)

Key Words: stroke, ischemic | quality of health care | treatment outcome

Results from many clinical trials have been used to develop guidelines for acute stroke care and for stroke prevention. Despite these recommendations, marked regional differences remain in quality of stroke care, which may impact recovery and outcome after stroke.1–5 Previous studies have shown that case fatality is high in Poland compared with other European countries.6,7 In 1997, the Ministry of Health in Poland established the National Stroke Prevention and Treatment Program. The aim of the program was to improve stroke care delivery and to determine the use of evidence-based stroke treatment in Poland. Because of insufficient data collection on stroke patients, the Polish National Stroke Prevention and Treatment Registry was established in 2000. The questionnaires were based on the World Health Organization Stepwise Approach to Stroke Surveillance (WHO STEPS Stroke) for hospital-based studies (step 1)8 and expanded with questions to meet local needs. The aim of the present study was to compare acute ischemic stroke care and outcome in participating centers.

Methods

Participating Centers
In Poland, the majority of stroke patients are treated in neurological departments. A small proportion (up to 10%6) of Polish stroke patients are also hospitalized in general medicine units, but these were not part of the present study. Developing of Polish stroke units has been observed since the last decade of the past century. Because the stroke patients are treated in neurological departments in Poland, stroke units are also localized in those departments. The first general definition of stroke unit (ie, part of neurological department with dedicated stroke team of neurologist, internal medicine consultant, physiotherapist, 24-hour access to computed tomography [CT]) was introduced in National Stroke Prevention and Treatment Program Guidelines in 1999,9 although detailed requirements for stroke units were presented in 2003.10

A total of 222 neurological departments (with or without stroke unit) admitting acute stroke patients were invited to participate in the National Stroke Prevention and Treatment Registry.

All participating centers used the same study protocol and the same study questionnaire. The questionnaire was based on the
WHO STEPS Stroke, step 1, manual but expanded with additional data on stroke management to meet the requirement for data collection according to the National Stroke Prevention and Treatment Program. Before data collection, participants were provided with 1-day training.

Patients
In the present study, prospectively collected data are presented for hospitalized ischemic stroke patients who were admitted to centers participating in the Polish National Stroke Prevention and Treatment Registry between December 1, 2001, and July 31, 2002.

All new acute ischemic stroke events were included. Patients were identified based on admission/discharge codes indicating stroke. The I63 International Classification of Diseases (ICD) code was used. Patients with diagnosed hemorrhagic stroke and subarachnoid hemorrhages were also registered but not included in present analysis.

Data were collected on age, gender, previous stroke (only hospital records documenting previous hospitalization; changes on CT scan without documented symptoms do not allow to recognize previous stroke), hypertension (systolic blood pressure >140 mm Hg and diastolic blood pressure >90 mm Hg), atrial fibrillation, coronary heart disease (diagnosed by invasive or noninvasive methods), previous heart attack (only diagnosed and treated with ECG changes 30 days before hospitalization), diabetes, cholesterol level (total cholesterol level >200 mg%), smoking (>1 cigarette per day 6 months before stroke), alcohol consumption (>20 g of pure alcohol per day), and drugs before stroke (recalled by patients or stated in medical records). The registry also provided information on time from onset to admission, symptoms on admission, stroke unit–based treatment, drug use, diagnostic and treatment procedures, Rankin score at discharge, length of hospitalization, and death and cause of death (defined as in WHO STEPS Stroke protocol as death directly related to stroke, death unrelated to stroke, and death of unknown cause).11

Inclusion/Exclusion Criteria
Data were analyzed only for centers that reported ≥200 patients. We excluded centers that reported for the registry <50% of the total number of stroke patients hospitalized in the analyzed period (the total number was independently determined using ICD coding for each centers after completion of registry).

Statistical Analysis
Ischemic stroke patient baseline clinical characteristics, acute stroke care, and early outcomes were compared among centers. Data were presented as the mean value calculated for the whole study population and the range confined by the minimum and maximum value of the means calculated for each center separately. Differences between the centers in case mix were tested using the χ² test for proportions and categorical variables and by using the ANOVA test for continuous variables.

Cox regression model was developed to identify centers that were associated with different outcome for death compared with reference center with qualified stroke unit (ie, Second Neurological Department, Institute of Psychiatry and Neurology). The model controlled for distribution differences in the following: age, sex, history of stroke, atrial fibrillation, coronary artery disease, history of MI, diabetes, consciousness level and Rankin at admission (the only available proxies for stroke severity), and time from onset to admission.

Logistic regression model was developed to adjust for case mix and evaluate odds ratio for poor outcome (defined as a Rankin score ≥3 or death at discharge) controlling for distribution differences in the above-mentioned variables and length of stay in hospital with the same reference center.

Results
Eighty neurological centers (of a total of 222) agreed to participate in the registry. Data were received from 48 participating centers (both neurological departments with or without stroke unit) representing most regions in Po-

Figure 1. Centers participating in the National Stroke Prevention and Treatment Registry (map of Poland with 16 provinces).Filled gray circles indicate rural center (city up to 100 000 inhabitants); filled black circles, urban center (city >100 000 inhabitants).
land. A total of 14,253 patients were registered. There were 26 (54%) centers that met all inclusion criteria, and data of 10,141 stroke patients from these centers were reported. In the final analyses, 8,736 ischemic stroke patients admitted to these units were included.

Twelve (46%) of 26 centers were from the Mazowieckie province, and 9 were rural centers placed in cities of up to 100,000 inhabitants (Figure 1). Cross-checks between the total number of patients treated per center and the number of patients included in the register showed intercenter variability. Seventy percent of the total number of hospitalized patients were registered, although 1 center reported data only for 51%, whereas another reported data for 90%. There were significant differences between centers regarding baseline patient characteristic, risk factors distribution, medical management, and clinical outcomes (Table 1).

**Patient Demographic Characteristics**

There were 4,168 (48%) men and 4,568 (52%) women. The mean age of stroke patients was 70 years, with a range among institutions from 68 years to 75 years (Table 1).

### TABLE 1. Baseline Characteristics of 8,736 Ischemic Stroke Patients From 26 Centers Participating in The Polish National Stroke Prevention and Treatment Registry (data are mean values)

<table>
<thead>
<tr>
<th>Medical history (%)</th>
<th>Age (years)</th>
<th>Stroke risk factors (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All Centers</td>
<td>Low</td>
</tr>
<tr>
<td>Stroke</td>
<td>26.5</td>
<td>14.5</td>
</tr>
<tr>
<td>History of MI</td>
<td>13.6</td>
<td>3.2</td>
</tr>
<tr>
<td>Treatment before stroke</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood pressure–lowering agents (% of hypertensive patients)</td>
<td>82.4</td>
<td>72.2</td>
</tr>
<tr>
<td>Antithrombotics (% of patients with stroke or MI history)</td>
<td>54.9</td>
<td>32.1</td>
</tr>
<tr>
<td>Anticoagulants (% of atrial fibrillation patients)</td>
<td>9.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Antidiabetics (% of diabetic patients)</td>
<td>78.6</td>
<td>64.2</td>
</tr>
</tbody>
</table>

The mean age for women was 73, whereas it was 68 for men.

**Risk Factor Distribution**

There were 5,854 (70%) patients with a history of hypertension, ranging from 54% to 83%, thereby being the most common stroke risk factor in this sample (Table 1). Antihypertensive drugs were used for 82% of hypertensive patients, varying between centers from 72% to 94%. An additional 2508 (30%) patients had atrial fibrillation, but only 10% of them were treated with oral anticoagulants before stroke.

There were 4,254 (51%) patients with diagnosis of coronary artery disease, 1,106 (14%) with a history of myocardial infarction (MI), 2,151 (27%) with a history of previous stroke, and 810 (28%) had hyperlipidemia. However, only 55% patients with history of MI or previous stroke received antithrombotics, and 42% of appropriate patients (ie, hyperlipidemia or history of MI) received statins.

There was a high prevalence of alcohol consumption and smoking before stroke, with 1,589 (21%) of patients being current smokers and 660 (9%) patients drinking >20 g of pure alcohol per day.

**Patient State at Admission**

Admission characteristics are shown in Table 2. A total of 6,545 (76%) patients were admitted within 24 hours and 3,555 (42%) patients within 6 hours from stroke symptom onset. On admission, most of the patients were alert (75%).
TABLE 3. Acute Ischemic Stroke Care (data are mean values)

<table>
<thead>
<tr>
<th>Diagnostic procedures (%)</th>
<th>All Centers</th>
<th>Range Among Centers</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carotid sonography</td>
<td>50.5</td>
<td>4.0 98.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Second CT</td>
<td>6.1</td>
<td>0.6 23.8</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Second MRI</td>
<td>1.7</td>
<td>0.0 6.3</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Angiography</td>
<td>0.6</td>
<td>0.0 1.7</td>
<td>0.117</td>
</tr>
<tr>
<td>Echocardiography</td>
<td>11.3</td>
<td>0.6 62.3</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Lumbar puncture</td>
<td>14.5</td>
<td>0.0 78.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>EEG</td>
<td>18.1</td>
<td>1.1 67.8</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>ECG</td>
<td>97.4</td>
<td>93.5 99.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Holter ECG</td>
<td>6.1</td>
<td>0.5 33.8</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Chest x-ray film</td>
<td>77.4</td>
<td>21.8 97.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Direct ophthalmoscopy</td>
<td>61.4</td>
<td>3.6 96.3</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Drugs used during hospital stay (%)</th>
<th>All Centers</th>
<th>Range Among Centers</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antiplatelets</td>
<td>82.4</td>
<td>53.0 97.8</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Anticoagulants (%) of atrial fibrillation patients</td>
<td>37.2</td>
<td>2.5 85.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Blood pressure–lowering agents (%) of hypertensive patients</td>
<td>88.8</td>
<td>43.4 96.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Statins (%) of hyperlipidemia or MI patients</td>
<td>85.6</td>
<td>55.1 98.7</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Antidiabetics (%) of diabetic patients</td>
<td>85.2</td>
<td>73.6 96.4</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Antibiotics</td>
<td>35.8</td>
<td>19.3 63.2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Piracetam</td>
<td>78.1</td>
<td>0.0 98.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Rehabilitation (%)</td>
<td>81.2</td>
<td>62.4 95.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Physiotherapy</td>
<td>27.9</td>
<td>1.2 58.4</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Mean Rankin score was estimated at 3.3, with significant difference between centers.

In-Hospital Care Delivery

Management procedures varied markedly between centers (Table 3). A total of 7608 (87%) patients had CT or MRI performed on admission. A total of 5657 (67%) patients were admitted to stroke units. Doppler ultrasound of carotid arteries was performed in 50% of stroke cases ranging from 4% to 98%. Eighty-two percent of patients received antiplatelet therapy. Thirty-seven percent of patients with atrial fibrillation received anticoagulant therapy. Seventy-eight percent of patients were treated with piracetam, with a range among participating centers from 0% to 98%. Antibiotic therapy was used in nearly 36% of patients during hospital stay. Eighty-one percent of stroke patients received physiotherapy, with a range from 62% to 96%.

Hospital stay differed insignificantly between centers (mean hospital stays range from 10 to 22 days). At discharge, mean Rankin score was 3.2, ranging from 2.5 to 3.9. A total of 1307 (15.2%) of patients died during hospitalization. The mean time from admission to death was 11 days.

TABLE 4. Discharge/Death Characteristics (data are mean values)

<table>
<thead>
<tr>
<th>Causes of death (%)</th>
<th>All Centers</th>
<th>Range Among Centers</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke directly related</td>
<td>50.9</td>
<td>17.7 77.8</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Attributable to stroke-associated complications</td>
<td>21.9</td>
<td>3.3 44.6</td>
<td></td>
</tr>
<tr>
<td>Indirectly associated with stroke; caused by comorbidities</td>
<td>22.3</td>
<td>0.0 59.6</td>
<td></td>
</tr>
<tr>
<td>Not caused by stroke</td>
<td>1.9</td>
<td>0.0 7.4</td>
<td></td>
</tr>
<tr>
<td>Unknown</td>
<td>2.9</td>
<td>0.0 11.1</td>
<td></td>
</tr>
</tbody>
</table>

Death causes were mainly directly associated with initial stroke or its complications (Table 4).

Patient Outcomes

In the present study, there were marked differences between 26 centers treating stroke patients with regard to patient outcomes. These differences remained significant after adjustment for case mix (Figure 2a and 2b). In 3 centers, we observed better prognosis than for reference center in terms of death outcome, but only 1 of them had beneficial effect confirmed for poor outcome. Three centers had worse prognosis for death compared with reference center, including 1 center, which was also associated with higher risk for poor outcome.

Discussion

In the present study, we found that there are marked differences in patient characteristics, acute hospital care, and outcomes for stroke patients among centers participating in the Polish National Stroke Prevention and Treatment Registry.

Patient Characteristic and Risk Factor Distribution

The most common risk factor was hypertension, which was observed in 70% of all patients. Other studies have shown that the prevalence of hypertension in Polish ischemic stroke patients may be higher than in other European countries.12

In our study, only 82% of patients with hypertension declared to receive blood pressure–lowering agents before stroke, but we had no information on whether they were sufficiently treated. Also important is that there were 18% patients with a diagnosis of hypertension not receiving any blood pressure–lowering agents. They were either not convinced by their general practitioner about the importance of treatment, or drugs were not prescribed. Atrial fibrillation...
was diagnosed in 30% of all stroke patients, which is high compared with other studies. Oral anticoagulants before stroke were prescribed for only 10% of atrial fibrillation patients, whereas antiplatelets were underused for patients with history of MI or stroke.

Hyperlipidemia and coronary artery diseases were diagnosed in many patients, of whom only a few received statins before stroke. The reason for this could be insufficient diagnosis or high acquisition costs of statins in the study period. Although there are local differences in the number of treated patients, antiplatelets, oral anticoagulants, and statins are still under prescribed in Poland.

In-Hospital Care Delivery

The Polish National Stroke Prevention and Treatment Registry was focused on in-hospital care delivery, and we found that there are significant differences among institutions participating in the registry. First, there are differences in time from onset of stroke symptoms to admission. Although many of the patients (42%) were admitted within 6 hours, 35% of patients were admitted after 6 and before 24 hours from symptom onset. Improving organization of local emergency transport and awareness of stroke symptoms among the patients could potentially reduce the delay before admission. It is important because early hospitalization allows monitoring of vital functions and treating complications, which may improve outcome. The present data from the Polish National Stroke Prevention and Treatment Registry were collected before recombinant tissue plasminogen activator treatment was established in Poland. Recommended onset to door time is 1 hour maximum, which is also the average time from onset to admission in patients registered in the SITS Registry (Safe Implementation of Thrombolysis in Stroke-Monitoring Study). Unfortunately, we lack detail information about the distribution of patient admittance within initial 6 hours from stroke onset.

Neuroimaging on admission was done in 87% of patients (range among centers was 57% to 100%). These differences may be explained by the participation of both neurological departments with and without stroke units. Only stroke units have easy access to CT/MRI, and other departments would have to send the patient to other hospitals for scanning.

Fifty-one percent underwent carotid Doppler ultrasound during hospitalization, with great range among institutions from 4% to nearly all patients. The rate is low, but there is also a big gap in providing this basic stroke care delivery component. There were also centers performing cerebral spinal fluid examination in the majority of patients. The purpose of this examination was to distinguish between ischemic and hemorrhagic strokes in centers without the possibility to perform CT scan on admission. These results suggest that there is a marked difference in the procedures different departments can provide for stroke patients.

Comparing early treatment in different institutions, the usage of antiplatelets (aspirin) is 82%, but there are institutions in which only half of the ischemic stroke patients...
receive aspirin, although it is recommended for all patients after ischemic stroke.16

The high usage of antibiotics during hospitalization suggest a high complication rate or generous prescription of antibiotics. In the present study, data on infections were not collected, and we are unable to provide information that can clarify the reason for these results.

It has to be mentioned that in some centers, the neuroprotective drug piracetam was used in every stroke case, although its benefit was not proved in clinical trials (Piracetam in Acute Stroke Study I).17 Its continuous use is most surprising and may both indicate that resources are spent inappropriately and that stroke patients are exposed to adverse effects of a treatment for which there is no scientific support.18

Physiotherapy was performed in 81% of patients and speech therapy in 28% of patients, which is higher than reported from other hospital-based studies.19,20 Because we did not collect data on aphasia, we are unfortunately not able to indicate whether the current level of speech therapy is sufficient. Previous studies indicate that 1 of 3 stroke patients has aphasia.21 It is possible that centers with low reported speech therapy may not have provided proper rehabilitation to admitted patients, which should be examined further in future studies.

Stroke Outcomes

Average hospitalization lasted 2 weeks. The high number of deaths caused by complications should be stressed. Stroke complications (and specially infections) could be regarded as the indicator of general care quality.20 Improving general nursing care and reducing the number of complications would probably decrease the death rate in Polish stroke patients.7 Differences in death and poor outcome rates are significant among centers even after adjusting for case mix differences. Although two thirds of study patients were managed in stroke units, treatment based in stroke units was not associated with better outcomes (data not presented). Stroke units were in the early stage of organization during study time. We did not have information about quality of stroke units from participating centers; we had only the statement of the head of the department about having a stroke unit. Other studies showed significant discrepancies between centers in terms of stroke unit quality of care in Poland.21,22 Detailed guidelines for organization of stroke unit–based treatment were defined by the expert council of the National Stroke Prevention and Treatment Program after study data completion.10

There are several limitations of the present study. The National Stroke Prevention and Treatment Registry was the first registry of stroke patients, having collected data from different parts of Poland. Unfortunately, not all institutions that were taking care of stroke patients participated in the National Stroke Prevention and Treatment Registry. Mazowieckie province and Warsaw were over-represented in the registry, and there is still a shortage of information from several provinces in Poland. Nevertheless, the collected sample includes not only patients from academic hospitals but also from less specialized ones. Our analysis captures only in-hospital data; we do not have long-term stroke outcomes such as death and dependency in participating centers. Although we initially had data from 48 different institutions, 22 did not meet the criteria for adherence to the protocol and were excluded from the analyses. The study was made before recombinant tissue plasminogen activator treatment in Poland, so there is no current data on these patients.

Several factors can contribute to local differences in stroke care. Some of them can be effectively eliminated with standardization of stroke management in Poland. The widespread use of standard care (including patient education, effective stroke risk factor control, and quality stroke unit–based acute treatment) based on novel guidelines would result in clinical benefits and cost savings.

Despite limitations, this is the first study collecting cross-country information from neurological departments. The questionnaire, based on the WHO STEPS Stroke for hospital-based studies (step 1), was standardized to enable comparison of different neurological departments.

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Disclosures

None.

References


Acute Ischemic Stroke Care and Outcome in Centers Participating in the Polish National Stroke Prevention and Treatment Registry
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on behalf of the Polish National Stroke Prevention and Treatment Collaborative Group

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