Modern stroke management requires specialized stroke care and advanced stroke expertise. In order to achieve these requirements in non urban areas two specialized stroke centers and 12 general hospitals founded a telemedicine network (TEMPSiS) in Eastern Bavaria. The telemedical system consists of a digital network including a 2-way video conference and CT/MRI-image transfer using a high-speed-data transmission up to 2 Mb/s. Each network hospital established specialized stroke wards where qualified teams treat acute stroke patients. The medical staff of the community-based hospitals completed a training program in state-of-the-art stroke treatment. Physicians in the local hospitals are able to contact the stroke centers 24 hours per day. Indications for telemedical support were predefined.

More than 4,000 stroke patients per year are treated in the network hospitals (4,179 patients in 2003). Between Feb. 1st 2003 and Sept. 23rd 2004, 3,888 teleconsultations were performed, including 1,935 videoconferences. One hundred and fifty-four patients received systemic thrombolysis. In 544 cases (14%) teleconsultations yielded non-vascular diagnoses.

Four hundred and twenty patients were transferred to stroke centers to receive extended diagnostic or therapeutic procedures, e.g. for malignant brain infarcts or basilar artery thrombosis. Critical issues remain audio quality and transport times. User and patient’s satisfaction are very good concerning quality of consultation. Telemedicine combined with specialized stroke wards offers advanced stroke care in community hospitals. The telemedic approach provides rapid diagnostic and therapeutic support and is well accepted by all participants.

Since 1995, the World Health Organisation (WHO) proclaims that “all patients with acute stroke should have access to care in specialized stroke units or from stroke teams”. However, this specialized treatment is expensive and therefore not available everywhere. In Bavaria, expertise in acute stroke treatment is – more or less – concentrated in academic stroke centers of big cities – whereas a majority of stroke patients is treated in local general hospitals. Only about half of the population of Bavaria has the chance to be transferred to one of the 18 existing stroke units within the critical time window of 30 to 40 minutes. Therefore, there is a general underuse of therapeutic options in acute stroke treatment like systemic thrombolysis. In order to improve the unbalanced situation with different levels of stroke care in rural and urban areas a stroke network was established (figure).

**DESCRIPTION OF THE TELEMEDICINE FOR STROKE (TELESTROKE) PROGRAM**

Two specialized stroke centers in this area – the Departments of Neurology Städtisches Krankenhaus München-Harlaching and University of Regensburg – consult 12 community hospitals in Eastern Bavaria. The 12 participating hospitals had to fulfill a number of structural requirements:

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• 24 hours availability of CT, or MR-imaging, Doppler-sonography and emergency laboratory diagnoses.
• Establishing of a stroke care ward with 10-15 beds where all acute stroke patients of the hospital are treated. Monitoring of neurological status and vital parameters as well as early mobilisation of the stroke patients.
• Continuous treatment by physiotherapists, occupational therapists and speech therapists.
• Presence of a neurologist during the week and on call for emergencies during the weekend.

The medical staff of each hospital was augmented moderately with two nurses, one speech therapist and one physiotherapist as well as an additional half-time physician. The hospitals created stroke teams which completed a specific training program:
• The training program is based on Standardized Optimized Procedures for diagnosis and treatment of stroke syndromes.
• Video training and certification in NIH-SS evaluation.
• Bobath training.
• Courses in transcranial Doppler-sonography.
• Courses in swallowing disorders and dysphagia treatment.

A continuous stroke education program including ward rounds in the local hospitals with one of the stroke experts every 3-4 months, newsletters and workshops is running in order to achieve further improvement of stroke care in the participating hospitals.

Each of the 14 participating hospitals was equipped with a high-speed video conferencing system including a multiplex-ISDN transmission system (up to 30 ISDN lines) and a branch office router. This system allows data transfer rates up to 2 megabytes/second. The telemedicine workstation consists of a Windows 2000-based videoconference system (VICON® VIGO Professional) with a large size monitor (22”) and a remote control video camera (SONY® Camera EviD100P). The DICOM interface of the local CT-scanners and MRI-scanners (if existent) are connected to the workstation and assessment of images is carried out using an Efilm® workstation. Each workstation is situated in a special room, close to the emergency facilities of the regional hospitals, in order to facilitate rapid patient evaluation. The two stroke centers provide a 24-hours service with 5 full-time stroke experts for telestroke consultation. Contact is taken via a central telephone line; video connection is then established within 5 minutes. This service is provided by the 2 centers in a weekly-by-week rotation. Each teleconsultation is accomplished with a written report via electronic transmission.

The following indications for teleconsultations were predefined:
• possible indication for systemic thrombolysis;
• intracerebral hemorrhage;
• impaired consciousness;
• progressive stroke;
• brain stem symptoms;
• severe strokes with NIH-SS (National Institute of Health Stroke Scale) >10;
• each uncertainty concerning stroke etiology and treatment.

RESULTS

In 2003, 4,179 stroke patients were treated in the network hospitals. Between Feb. 1st 2003 and Sept. 23rd 2004 a total of 3,888 teleconsultations were performed with a mean duration of 15 minutes. The proportions of indications for telemedec support are listed in table I. One hundred and fifty-four (~2.5%) patients received systemic thrombolysis with 12 symptomatic intracerebral hemorrhages. In 544 patients (14.0%), teleconsultations yielded non-vascular diagnoses and the vast majority of them (>85%) was confirmed in the discharge letters.

Four hundred and twenty (~5%) patients were transferred to stroke centers to receive extended diagnostic or therapeutic procedures. User satisfaction was assessed by the attending doctors of the local hospitals in 92% (n=208) of all teleconsultations (n=226) conducted between March 23rd and April 25th 2004. In a 5-point scale (1=excellent, 5=bad), quality of video imaging (1.4) and relevance of contributions (1.4) were rated as very good, audio quality as good (2.3). Ninety-two patients were able to respond to the survey. They reported high satisfaction with the overall quality of the teleconsultations (1.2) and valued the cooperation between the hospitals (1.2).

Table I. Proportions of teleconsultations.

<table>
<thead>
<tr>
<th>Indications</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>First presentation of patients</td>
<td>3,654</td>
<td>90.4</td>
</tr>
<tr>
<td>Additional presentation</td>
<td>373</td>
<td>9.6</td>
</tr>
<tr>
<td>Possible indication for systemic thrombolysis</td>
<td>820</td>
<td>21.1</td>
</tr>
<tr>
<td>Intracranial hemorrhage</td>
<td>691</td>
<td>17.8</td>
</tr>
<tr>
<td>Impaired consciousness</td>
<td>397</td>
<td>10.2</td>
</tr>
<tr>
<td>Progressive stroke</td>
<td>256</td>
<td>6.6</td>
</tr>
<tr>
<td>Brain stem symptoms</td>
<td>596</td>
<td>12.0</td>
</tr>
<tr>
<td>Severe strokes with NIH-SS &gt;10</td>
<td>588</td>
<td>15.1</td>
</tr>
<tr>
<td>Uncertainty concerning stroke etiology and treatment</td>
<td>1,079</td>
<td>27.8</td>
</tr>
<tr>
<td>Non-stroke diagnoses, determined in teleconsultations</td>
<td>544</td>
<td>14.0</td>
</tr>
</tbody>
</table>

CONCLUSIONS

Analyzing the preliminary results of the project, the most important keys for this telestroke network are as follows:
• Combination with the Stroke Unit concept: only specialized units can respond appropriately to the heterogeneous challenges of stroke care. Routine is needed for a frequent utilization of the telemedicine equipment.
• Intensive training of all staff members in the cooperating hospitals is essential. If possible, these sessions should take place in the regional clinics: the participants need to “speak a common language”. Therefore, neurological examinations like NIH-SS or “neurostatus” need to be trained.
• Standardized procedures: teleconsultation should not skip the responsibility from the local partners. They need to have a strong base for their own decisions.
• Strong personal relationships: telemedicine cannot replace familiarity of a local team but a mutual trust is essential. Therefore, continuous visits, hospitalizations, educational activities and just joining time together is important.

• User-friendliness and service quality: to reduce the barriers of using the telemedic equipment, the utilization has to be simple ("only to press one button") and the service has to be generous.

The telestroke service, the educational program and the establishment of the local stroke wards require financial reimbursement. In TEMPiS, the major part of the costs are already compensated by the reduction of length of in-hospital stay.

Despite of the promising preliminary results, it remains to be proven whether this concept provides a similar treatment quality as compared to the existing stroke unit concept.

This is a pilot project which started on Feb. 1st 2003 and will be evaluated until Dec. 31st 2005. Funding support for this project is provided by the Bavarian health insurance companies, the Bavarian Ministry of Social Security, the German Stroke Foundation and all participating hospitals.