

Improved Treatment of Cerebral Stroke Patients in Small Hospitals? Reporting from a Telestroke Service in North Norway

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Abstract - In 2010, Norwegian Centre of Integrated Care and Telemedicine (NST), in collaboration with Northern Norway Regional Health Authority (Helse Nord RHF), initiated a project to establish and explore a telestroke service for diagnosing and treatment of cerebral stroke patients. The first step was to set up a video-conference system between the three hospitals that constitute The Nordland Hospital (in Norwegian: Nordlandssykehuset, NLSH). This service connects the neurological department at NLSH Bodø with the two small rural hospitals; NLSH Lofoten and NLSH Vesterålen. The telestroke service was made available between NLSH Lofoten and NLSH Bodø from September 2010. At NLSH Vesterålen, the telestroke equipment was made available, but the usage was postponed due to reorganization of the local cerebral stroke care. The second step of our study was to explore the significance of the context when establishing a telestroke service in North Norway. This article is based on telestroke log data, semi-structured interviews, and focus group discussions with involved health personnel. We report from the implementation of the service, and the preliminary experience from the first year of use.

Keywords-cerebrale stroke, rural hospitals, video conference consultation, telestroke

I. INTRODUCTION

The volcano ash incident in Iceland in April 2010, gave a reminder of how vulnerable the health services in Norway are without air transport. In May 2010, Northern Norway Regional Health Authority (Helse Nord RHF), decided to establish a telemedicine service for diagnosis and treatment of cerebral stroke patients in The Nordland Hospital (from now on we will use the Norwegian name, Nordlandssykehuset, NLSH), connecting the two rural hospitals; NLSH Lofoten and NLSH Vesterålen, to the Neurology and Radiology departments at NLSH Bodø. The

two rural hospitals receive approximately two patients with stroke symptoms every week; NLSH Lofoten (1.6) and NLSH Vesterålen (1.25). NLSH Bodø receives an average of one stroke patient every two days. As the numbers are small, a fully specialized stroke unit is difficult to maintain with stroke specialists physically present (day and night, seven days of the week) at the small hospitals in Lofoten and Vesterålen.

A “VAKe” -compatible video-conference system [1] was installed in June 2010. After completion of common procedures and on-site training, the telestroke service was operational from September 2010. It was utilized immediately between Lofoten and Bodø, but the use was postponed in NLSH Vesterålen waiting for the employment of a specialized stroke nurse and the refurbishment of the intensive care unit.

Telestroke implies that the stroke specialist examines the patient in cooperation with the physicians and nurses at the local site, through video- and sound communication systems. Radiology images are transmitted using the RIS/PACS system [2]. When a patient with stroke symptoms is expected to one of the two local hospitals, the procedures are as follows: In Bodø, the stroke specialist is notified by phone, and moves quickly to a dedicated room for telestroke conferences. At the relevant local hospital the involved staff is gathered at the intensive care unit, waiting for the patient to arrive. The “VAKe” video-conference system is also prepared.

This article addresses treatment of cerebral stroke patients. We report from the implementation of a telestroke service in North Norway, and the preliminary experience from the first year of use.

II. BACKGROUND

Cerebral stroke is the third most frequent cause of death in Norway, and the most common cause of severe disability in adults. The annual incidence is about three per thousand inhabitants, where 85-90% is due to ischemic stroke. The average cost of one stroke incident is approx. NOK 600,000, adding up to a total annual cost of NOK 7.8 billion. Timely treatment and rehabilitation can reduce disability after stroke, improve quality of life and reduce costs [3, 4]. Hospitalization in a specialized stroke unit leads to a 10 % absolute reduction in mortality in the acute phase [3]. The prognosis for patients with ischemic stroke is further improved by thrombolytic treatment in the acute phase. The challenge is the narrow time window: Thrombolytic treatment should be given as soon as possible, and not later than 4.5 hours after the first symptoms. The national numbers on thrombolytic treatment indicates that only 5.9 % of all stroke patients in Norway receive such treatment (the numbers for NLSH is 2.7%), whereas 20 % is expected to benefit from thrombolytic treatment [4]. The low rate could be due to geographical conditions with long travel distances, lack of awareness in the population, but also limited experience with the treatment in local hospitals may play a role [5].

It is crucial to decide the diagnosis and indication for thrombolytic therapy as soon as possible after the patient with suspected stroke reaches the emergency unit. If the local hospital is without specialists with adequate experience and competence in the field, telemedicine can guide and support the clinician remotely [6-10].

Organization in telestroke networks includes [6, 7]:

1. Specialized stroke units in all hospital.
2. Comprehensive and continuous education and training of the entire staff in the units,
3. Stroke specialists available 24/7 on videoconference combined with teleradiology,
4. Centralized organization of patient transfers. This is in consistence with The Norwegian Directorate of Health's national guidelines for treatment and rehabilitation of stroke [4].

Telestroke consultations may be useful to assess whether patients need more advanced specialist neurological or neurosurgical emergency treatment, by supporting quick triaging and transfer to the appropriate unit. Although the decision to give thrombolytic treatment is seen as the end-point of the telestroke consultation, this is just the beginning of care for the patient [5]. Post-thrombolytic care requires intensive cardiovascular and neurological monitoring, neurosurgical backup, and decision whether to keep the patient or to "drip-and-ship". Tele-consultation may also be useful for follow-up after the acute phase [5].

There is limited experience with telestroke in Norway. Many hospitals use teleradiology image transfer combined with phone advice to support local hospitals for stroke patients. A telestroke service established between Haukeland

University Hospital and local hospitals in Voss and in Førde reports an increase in thrombolytic treatment [11].

There is substantial scientific evidence of the medical impacts of telestroke [12]. A meta-analysis shows that a telestroke network, where the experienced stroke specialists perform an evaluation and examination of the patient through a video-conferencing system, and considers the indication for initiation of thrombolytic treatment, is comparable with face-to-face consultations [10]. There is also evidence that video-conferencing counseling is more effective than telephone counseling in the acute treatment of stroke. Several studies of telestroke solutions including video, versus solutions without video, show that video conferencing may [13, 14]:

1. Reduce the number of wrong diagnoses.
7.1 % vs 17.6 %, $p < 0.05$
2. Reduces death rate.
1.3 % vs 6.8 %, $p < 0.05$
3. Reduces needs for nursing homes.
2.6 % vs 5.4 %, $p = 0.58$

In this project we aim to implement and organize a telestroke service, and explore whether the same benefits that are reported internationally, are possible to obtain in a North Norwegian context.

III. MATERIALS AND METHODS

In this section, we present the research settings, the materials and the methods used.

A. Research settings

The research was conducted at three hospitals within Northern Norway Regional Health Authority, more precisely Nordlandssykehuset, NLSH, in Nordland County. NLSH serves a geographical area of 131,000 inhabitants, and consists of three local hospitals, Bodø, Lofoten and Vesterålen. NLSH Bodø is the largest hospital in the county and act as the central hospital of NLSH [15]. NLSH Lofoten and NLSH Vesterålen are two rural hospitals, situated in a geographical area known for its wild and beautiful nature, long distances, dispersed settlement and extreme rough weather conditions. The weather conditions often make it difficult or even impossible to use air transport for severe ill patients. Other types of transport take between five to ten hours to reach Bodø. NLSH Vesterålen, covers a geographical area of approximately 30,000 inhabitants, and employs about 400 people. The hospital has a full surgical and medical emergency unit and a maternity ward. A new hospital is under construction in Vesterålen. NLSH Lofoten is placed on the island Vestvågøy, in the middle of Lofoten, and serves approximately 24,000 inhabitants.

The telestroke service was implemented and has been operative since September 2010. When a potential stroke patient arrives at one of the two rural hospitals, the standard procedure is to conduct a Computed tomography (CT) scan and collect the necessary blood samples. At NLSH

Vesterålen, the patient is then transferred to the intensive care unit, where a telestroke conferencing is prepared for a potential collaboration with stroke specialists in Bodø. At NLSH Lofoten, the patient is transferred to the emergency room for telestroke conferences and given thrombolytic treatment if relevant.

To ensure that the technology is operational and works flawlessly, as well as maintain the users' expertise, NST has recommended that each hospital test the telestroke solution regularly, and preferably once a week. The staff agreed on being abundant in using the system in the initial phase in accordance with this.

B. Materials

To implement a telestroke service it is necessary to obtain video-conferencing equipment, at least one for each site. In this project, we decided to supply each of the hospitals with the same type of equipment, which reduces possible sources of error. Only minor local adjustments were made due to room configuration. The video conferencing equipment consists of a Tandberg Quick set C60 and a Sony full HD (1080p) television, mounted on a mobile rack (see Fig. 1). The Tandberg Quick set C60 has the possibility to connect medical equipment like: Electrocardiography (ECG) together with two full HD (1080p) cameras. The system is also made ready for multipart conferences for communication between more than two locations. The total cost of each unit ready for use is approximately NOK 200,000.



Figure 1. Telestroke equipment

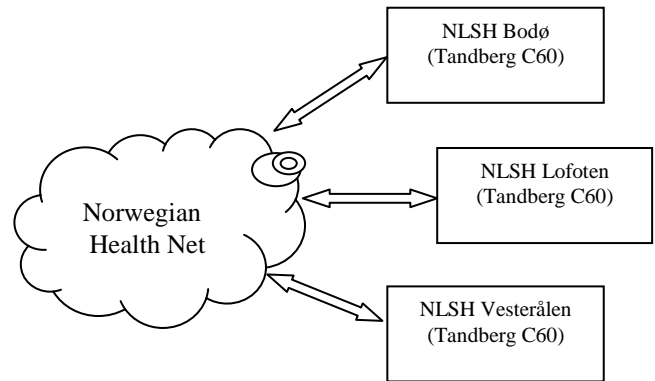


Figure 2. NLSH Telestroke service

At NLSH Bodø, the telestroke system is installed in a dedicated room connected to the neurology department. This room has also a computer equipped with two 24 inch displays; one display devoted to the electronic patient record, and one to the CT images.

At NLSH Lofoten and Vesterålen, the telestroke equipment (Fig. 1.) is mobile. When not in operation, it is stored in the intensive care clinic. However, when the local hospital is notified about a possible cerebral stroke patient, the equipment is brought from storage and moved into position. The video conference unit is then prepared for a telestroke session. The 3 telestroke units are connected through the Norwegian Health Net [16], which is a dedicated secured network for health information between hospitals and different health care institutions, see Fig. 2. All institutions require authorization before connection to ensure data protection and security [17]. This solution is approved by the Norwegian Data inspectorate and Privacy Protection Committee [16].

C. Methods

We have used a qualitative, multi-method research approach to gather relevant data on the telestroke service in North Norway, in this case Nordlandssykehuset. Quantitative methods with control-groups have been considered, but found not ethical since the telestroke equipment is already installed in the hospitals. We have also considered including more hospitals as control-groups, but found difficult within the framework of the project. The methods used are:

- Analyzing telestroke log data
- Video conference and phone interviews with involved health personnel
- Focus group discussions

This approach does not only capture research data, it also ensures that the telestroke system is working according to the plan, and reveals potential need for follow-up actions like training and revision of procedures.

1) Analyzing telestroke log data

Exploring telestroke log data is an adequate approach to gather an understanding of the usage of the telestroke service. Telestroke log data indicates the frequency and length of the telestroke sessions between the hospitals. Log data is sufficient to observe which hospital that has been connected, and which hospital that are more reluctant with telestroke collaboration. This data includes the year, season, time and length of the video and sound communication between the collaborating hospitals. Analyzing log data is an adequate approach to map out the actual telestroke collaboration. It is also a useful approach to visualize the numbers and the length of the training sessions, and how often the different hospitals are testing the equipment. Analyzing log data also captures potential changes in the organization of stroke treatment over time.

2) Semi-structured interviews

Semi-structured interviews with involved health personnel are a constructive approach for gathering the users' satisfaction and experiences with the telestroke system. Health personnel can share their knowledge from specific cases where the telestroke service has been used. For instance, information about medical results like; time from onset of symptoms to thrombolytic treatment or proportion of thrombolytic treatment. The method is also sufficient to gather information about health personnel experiences with the technology and the online collaboration between the hospitals. Semi-structured interviews can reveal potential differences between users, for instance between the remote neurological experts and the onsite local hospital staff. The approach is also useful to detect technological obstacles or organization challenges with the telestroke service. We have conducted the interviews by phone and video-conferencing systems.

3) Focus group discussions

Focus group discussions with participants from all three hospitals are an adequate approach to get in contact with the everyday practice of cerebral stroke treatment. Similarities, differences and the dynamic character of the local practices are often revealed in group discussions [18]. Focus group discussions between health personnel from different institutions are also suitable to expose contextual and organizational aspect of the telestroke service.

D. Ethical considerations

The study has been approved by the North Norwegian Regional Medical Ethics committee (REK).

IV. RESULTS

The telestroke service has so far been used for treatment of a few cerebral stroke patients at NLSH Lofoten, but until now, none from NLSH Vesterålen. After approximately one year of service, the frequency of telestroke conferences has been considerable lower than expected. However, the few conferences that have been carried out were reported as constructive and valuable. The conference quality has been characterized as excellent: The video quality was good

enough to detect pupil contraction and eye movements like nystagmus (a rapid, involuntary, oscillatory motion of the eyeball). Despite the high video and sound quality, health personnel at both the rural hospitals have expressed concerns about the low frequency of use, which might be a threat to the long term success of the telestroke service. Low frequency of use can result in ambiguity and hesitation on how to operate the telestroke equipment, and thereby result in even fewer telestroke consultations. Even though NST recommended that the hospitals tested the telestroke system regularly, preferably once a week to maintain the users' expertise, the log data shows that the recommendations has not been followed. This has not been done regularly, and far from once a week.

It also needs to be emphasized that the involved staff at NLSH Vesterålen, in general, were perceived as more reluctant to adopt the new service than the involved staff at NLSH Lofoten.

Health personnel also reported that the telestroke system could be useful for other clinical consultations. This could be other acute neurological sufferings, but also in none acute situations with uncertain diagnoses or treatment. At NLSH Lofoten some of the local staff also suggested to use the telestroke system for collaborations with other departments, for instance, dermatologists at NLSH Bodø.

The two rural hospitals have developed different telestroke procedures. At NLSH Vesterålen the second-call physician is always consulted first, if there are any doubts about whether thrombolytic treatment is adequate or not. If the local team still is uncertain about the best treatment, the telestroke service should be used. This differs from NLSH Lofoten where the procedure is to always seek guidance from neurologist at NLSH Bodø, if thrombolytic treatment is considered. The telestroke service replaces the phone as a collaboration tool at this hospital. None of the three involved hospitals indicated any delays in thrombolytic treatment when using the telestroke service compared to ordinary phone conferences.

As already mentioned the telestroke service has only been used for treatment of a few cerebral stroke patients at NLSH Lofoten. Here we report from three cases where the telestroke service has been used for patients hospitalized with cerebral stroke symptoms. As we will show, all three cases had different outcomes.

1) The first patients arrived at the rural hospital with a diagnosis of possible cerebral stroke. After using the telestroke service, this diagnose was dismissed and changed. No thrombolytic treatment was given, and the patient was discharged from the rural hospital two days later.

2) The second patient who arrived with cerebral stroke symptoms was a person with a heart transplant. After using the telestroke service, this patient was diagnosed with a possible severe rejection of the transplant. The patient was transferred by air ambulance directly to national expertise in Norway, located in Oslo. No thrombolytic treatment was given.

3) The third patient who arrived with a possible cerebral stroke diagnosis had a former diagnose of cerebral stroke. The patient had successfully received thrombolytic treatment

one and a half year earlier. After using the telestroke service, the patient received thrombolytic treatment successfully.

V. DISCUSSION

The results presented here indicate anecdotally how a telestroke service might be useful in rural hospitals for diagnosing and treating patients with suspected cerebral stroke. The collaboration was described as constructive and valuable by the involved health personnel. Despite successful implementation and positive feedback from the few telestroke conferences that has been conducted, the frequency of telestroke conferences has been considerable lower than expected. This interesting paradox needs further investigation.

The preliminary results from NLSH Lofoten question the estimated number of potential stroke patient in the Lofoten region. This number might be too high. The next step in our study will include data from patient records to reveal both actual numbers of stroke patients last year, and the patients that arrived with a suspected stroke diagnosis. This data will then be compared with the numbers from the telestroke log data.

The results also question the frequency of thrombolytic treatment in Lofoten. In general only 2% of all Norwegian stroke patients receive thrombolytic treatment, whereas 20 % is expected to benefit from such treatment (Helsedirektoratet, 2010). The low rate could be due to geographical, environment or organizational conditions. Hazard weather conditions, long travel distances and lack of stroke awareness in the population, might be of importance for how quickly patients arrive at the hospital. The established practice of shipping patients to the central expertise, rather than giving local treatment, might also affected on the frequency of use.

The preliminary results from NLSH Vesterålen point in direction of organizational or technological challenges. A new hospital is under construction, and the staff is naturally eager to move into a new building. New procedures and training might be put on hold until the new facilities can be used.

It also needs to be highlighted that the involved staff at NLSH Vesterålen, in general, seems more reluctant to adopt the new service than the involved staff at NLSH Lofoten. NLSH Vesterålen is a bigger hospital than NLSH Lofoten, which means that they have more staff and local expertise present than NLSH Lofoten. The physicians at Vesterålen expressed, for instance, concern about the level of expertise at NLSH Bodø after office hours. The stroke unit at NLSH Bodø is organized with a stroke specialist present at the hospital during office hours. After hours, a stroke specialist might not be present at the hospital, but be the second physician on-call, possibly located outside the hospital. This is off course a legitimate concern, and something that needs further exploration in the next step of our research.

The next step of our study will therefore focus on the local context for the telestroke service. Few or none studies are found on the significance of the context when implementing a telestroke service. This is unfortunate since

the geographical, contextual and organizational environment is known to be significant to other telemedicine services in the region [19, 20]. A telestroke service in North Norway is expected to face other challenges than those reported internationally: In NLSH as in North Norway in general, the number of cases is low, clinicians have high turnover, technical support is not available 24/7 and severe weather conditions and long distances might add to the transport time.

There is long experience with telemedicine in Northern Norway [21-23]. Unfortunately, in Norway as well as internationally, there is also a long track record of telemedicine services terminating after the pilot project is over [24-26]. Therefore it is important to follow the telestroke service by studying the local context and the organizational requirements as well as the clinical outcome of the service. The organization of the health service (work-flow, technical support, maintenance of staff, etc) are important factors to ensure a functional and sustainable telemedicine service.

Another interesting aspect is the expressed concern about the low frequency of use. Low frequency of use may be a threat to the long term success of the telestroke service. This concern came from both the rural hospitals' staff. Compared to the telestroke log data, this concern is particularly interesting, since the log data shows that the recommended testing of the telestroke solution has not been followed. Running tests to maintain users' expertise, in an already stressful work day, may not be prioritized and is easily skipped. On the other hand, not following NST's recommendation may be one of the reasons for the low frequency of use.

VI. CONCLUSION AND FUTURE WORK

The preliminary results indicate that it is possible to implement and organize a telestroke service in rural hospitals in North Norway. So far the usage has been limited to a few cases, but in all these cases, the involved personnel reported beneficial results for the patient, successful online cooperation, and excellent video and sound quality. However, the sparse frequency of use in a North Norwegian context raises important questions. To our knowledge there are few or none studies focusing on the significance of the context when establishing a telestroke service. This will be the next step for our research.

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