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Importance of the telemedicine network for neurosurgery in Slovenia

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Abstract

The number of invasive procedures in medicine is increasing, as is the employment of new technological achievements. In the era of information-communication technology, one such achievement is also the telemedicine network. In Slovenia, it is known as the Telekap (TeleStroke) network, which was primarily designed for fast and efficient management of stroke patients. In the neurosurgical community, the system is frequently used also for conveying vital information regarding subarachnoid haemorrhage and trauma. Especially in neurosurgical emergencies, this communication system offers thorough information about the extent and location of bleeding and facilitates the preoperative planning of neurosurgical interventions. From our experience so far, the system should be expanded to other neuro-centres as well to all neurosurgery departments in order to facilitate patient management, their acute hospital care, and inter-speciality collaboration.

Key words: Telemedicine; Neurosurgery; Neurosurgical planning; Neuroimaging; Slovenia

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Core tip: The telemedicine network in Slovenia is known as the Telekap (TeleStroke) network, which was primarily designed for fast and efficient management of stroke. In the neurosurgical community, the system is frequently used for conveying information regarding subarachnoid haemorrhage and trauma. It offers thorough information about the extent and location of the pathology and facilitates the neurosurgical intervention.

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INTRODUCTION

The number of invasive procedures and the use of new technological achievements in medicine are increasing. Telemedical connections are one of such important acquisitions in the era of information-communication technology (ICT)^[1,2]. Telemedicine is defined as the use of medical data, mostly in emergencies, which emergency services are sharing between themselves by using electronic communication and with the purpose to improve healthcare, health and educational services in outpatient and emergency situations^[1,3]. Hospital and outpatient neurology is one of the emerging subspecialties in neurology that was developed to improve access to neurological care in areas without specialised neurology centres^[3-6]. Telemedical network system is not used only by neurological professions, and it is also very useful for neurosurgery.

IMPLEMENTATION OF THE TELEKAP SYSTEM IN NEUROSURGERY

In Slovenia, the telemedicine network is called Telekap (TeleStroke) and it has been used since 2015. All hospitals in the country are connected in this network, which provides continuous access to the data and connections with consulting specialists in the tertiary centre. The main idea during establishing this system was that telemedicine may provide care for all neuropathology patients in the country with quick and easy accessibility. This telemedicine network was initially designed for fast and efficient treatment of patients with a stroke. The Telekap system enables clinical and radiological assessment of location and scope of stroke, tumour, hydrocephalus, or head and spine injuries, and fast decision-making about further diagnostic procedures. It also provides triage for patients and thus enables a suitable therapy. When the patient is admitted to a peripheral hospital, the images are forwarded directly to the telemedicine centre, where neurosurgeons may plan the optimal treatment strategy. According to the conveyed images, the resuscitation and surgical team may be properly prepared for the operation during the transport of the patient. Additionally, the postoperative accommodation and care of such a patient may be forecast and organised. Increased prevalence and mortality due to stroke is partially the consequence of slow treatment due to large distances to specialised neurology centres^[7]. The time of treatment is therefore extremely important, and it affects the outcome of the treatment. The patient suffering from stroke must not only be transferred to an appropriate centre as soon as possible, and data about the disease that provide fast and expert assessment, planning, and correct action during admittance are also important. However, this is possible only if the data is promptly available. Similarity also applies for neurosurgical pathology where fast action is needed^[8,9].

The Telekap system is being used in neurology principally in relation to haemorrhagic and ischemic strokes as it provides fast informing and transfer of data from remote hospitals to centres that are specialised in stroke treatment^[5,9]. However, the telemedicine system is useful not only for informing and preparation for stroke treatment but also for other types of pathology. Beside neurology, the Telekap system is extremely valuable for neurosurgeons. They are using it frequently for acquiring significant information, mostly in relation to subarachnoid haemorrhage, tumours, and head injuries, being most frequent indications^[10].

In Slovenia there are two referral tertiary neurosurgical centres for the 1.8 million population. Due to the specifics of neurosurgical pathology, the paucity of neurosurgery experts in peripheral emergency departments, and the lacking availability of a range of effective treatments there, the patients with corresponding pathology and in need of emergency treatment are transferred for the specialist management to the either centre always when possible. On some occasions, the worsening clinical condition would direct immediate action and preclude the transport. In these sceneries, the Telekap is particularly valuable. Numerous factors have all contributed to optimal conditions for Telekap implementation in Slovenia, including the opportunity to improve access and quality of care, narrow window of time frame and treatment efficacy, the resources required for ground and helicopter

medical transportation, and the expansions and improvements of the medical care dedicated ICT. As a result, the Telekap is being used extensively in the national health care and its use is still rising.

On some occasions, the surgeons in local hospitals are capable of exerting immediate neurosurgical treatment for the patients who need urgent action and where transport would deteriorate the worsening condition due to the time required for reaching neurosurgical department^[11-13]. These are in the most cases the trauma settings with intracranial pressure (ICP) monitor placement and operations where evacuation of acute blood is needed from the brain in order to prevent a high rise of ICP and brain herniation. In such cases, only immediate surgical decompression can save the patient^[14-16]. Mostly these emergency procedures in Slovenia are connected with acute subdural, epidural, and rare superficial intracerebral hematomas and decompressive craniectomies as well as when there are difficulties encountered with the subsequent postemergency neurosurgical care.

This communication system is especially important in neurosurgery cases as it provides complete information on the extent and location of haemorrhage, and it simplifies pre-operative planning of a neurosurgical procedure. Information that is available from images on the computer system and is important for the neurosurgeon includes the type and precise location of the intracranial pathological process (injury, bleeding, ischemia, tumour, and hydrocephalus), the extent of affected brain tissue due to oedema or adjoining ischemia, and combined injuries or pathological processes which may also affect extracranial parts, such as cranial and facial bones, as well as scalp and facial soft tissues^[17,18]. Data on the optical nerve channel, eyeballs, pyramid bones, or sinuses are also extremely important, especially in the acute setting, such as head and face injuries. This information is crucial for planning surgical treatment where interdisciplinary operation is necessary, especially in patients with combined injuries. In such difficult medical emergencies, the help of maxillofacial surgeons, ophthalmologists, or otorhinolaryngologists is always welcome and leads to increased treatment quality and faster patient care^[17-19].

The Telekap has been designed to provide any patient with symptoms and signs consistent with acute neurosurgical pathology with a quick expert clinical evaluation, a review of diagnostic findings, a diagnosis, decision making, emergency treatment recommendations, and postoperative advice. It is the most reasonable to perform the Telekap consultation in collaboration with the treating physicians and nurses, as they are the ones that know the patient's condition in detail.

When the patient is accepted to a general hospital, the system submits images directly to the telemedicine centre. According to the information, neurosurgeons can optimally plan the treatment, which depends on the type of pathology. Additionally, the reanimation and surgical team can suitably prepare for the surgical procedure during the transport of the patient. It is also possible to plan and organise postoperative management of such patients, often needing intensive care and prolonged hospitalisation^[18-22].

Time is an important factor in brain injury, which may affect the final treatment outcome. The delays in providing adequate resuscitation and definitive care in a timely fashion and appropriate management are often detrimental for patients with brain injury^[19]. Thus, the telemedicine network is indispensable for neurosurgeons for the treatment of patients with urgent surgical situations, especially for those who were transferred from remote centres where time plays an important role^[22]. The Telekap can be used regardless of the hospital location, emergency department versus other unit, time of day, and proximity to the nearest neurosurgical centre. According to previous extremely positive experience, we propose that such a system should be expanded to other centres with neurological patients, and also to all neurosurgery departments in the country in order to facilitate preparation for procedures for such patients, their acute hospital treatment, and interdisciplinary collaboration. The process is still ongoing and we are expecting further expansion, modifications, and improvements of the system in the following years.

Decision making is a central function of a telestroke network. In hospitals without neurosurgical experience and neurocritical care units, the surgeon on call may perform the initial intervention. In such typical neurosurgical setting taking part in the Telekap service, medical consultations are delivered to local hospitals from specialists in the referral centre who are located at distant sites and they have unusually no connection with the patients and their treatments in the local hospitals. The referral centre is frequently an academic medical centre and provides the neurosurgical Telekap services to distant sites within its geographic region. The most numerous emergencies are those related to the high ICP for various reasons. It is essentially to release this high ICP in order to assure the best possible recovery for the patient. With the Telekap network, the operating surgeon in a distant hospital may sometime be guided with the audio-video support of a neurosurgeon. Later on, when

the decompression is achieved, the ICP rescued, and the patient stable, a transport into the tertiary centre may be organised in order to completely accomplish the surgical procedure. In case the patient requires a higher level of care following the Telestroke evaluation, a transfer to the corresponding neurosurgical center is facilitated. When the transfer is indicated, the referral center typically receives the patient from the local hospital and can provide continuity of care, having already observed the patient virtually. Alternatively, the neurosurgeon may be transferred to the local hospital. In our clinical practice, the latter is a frequent event, where the neurosurgeon may take over the operation in the local hospital in case of difficulties and advises during the immediate postoperative care.

OUR EXPERIENCE WITH THE TELEKAP

In the period of using the Telekap system in University Medical Centre Ljubljana, we surgically treated patients at the neurosurgery department for various pathologies. Those included cerebral vascular diseases (aneurysms, arteriovenous malformations, ischemic and haemorrhagic strokes), injuries (contusions, epidural and subdural haematomas, cranial and facial fractures, and soft tissue injuries), brain oedema of various aetiologies, and primary and secondary brain tumours where oedema or bleeding occurred and the neurological status of patients deteriorated due to a sudden increase of ICP. The larger share of patients included those with ischemic and haemorrhagic strokes where surgical intervention was required by inserting a sensor for measuring ICP, external ventricular drainage, evacuation of brain haemorrhage, or decompressive craniectomy for lowering refractory increased ICP.

Worldwide, the value of telemedicine has been confirmed clinically and scientifically. In 2009, the American Heart and American Stroke Association reported about the evidence of telemedicine significance in the stroke schemes of care and made recommendations for telestroke implementation^[19,23]. The 2009 policy statement included guidelines with the recommendations that were based on class I evidence^[23]. Key recommendations emphasized the value of telestroke system to support the assessment of acute stroke severity, the equivalence to that of a bedside evaluation, the review of imaging results by remotely located stroke specialists, and urgent decisions about further treatment^[24-26]. In our experience, such evidence may directly mirror the neurosurgical practice. The Telekap proved to be an invaluable tool in the management and care of patients, as perceived by the treating surgeons and consulting neurosurgeons in the two Slovenian referral centres. As communicated in the current stroke guidelines, telestroke remains a standard care in hospitals that cannot provide an acute stroke team^[24,27]. In recent years since implementation of the Telekap in the emergency neurology services, we have successfully broadened its applications also into neurosurgical practice. We may therefore state that in Slovenia the Telekap system has developed in the last three years into a standard and indispensable tool for communication, connection, and flow of medical information between the hospitals that cannot provide a neurosurgical team and the referral centres. It now remains a standard element of the treatment strategy for neurosurgical patients from distant locations.

The monitoring of the image transmission from primary diagnostic centre (*i.e.*, emergency or radiology centre in the local hospital) as well as the flow and quality of video, audio, and Internet connectivity should be a part of technology workflow. In order to perform the consultation, surgical and postoperative guidance soundly and to achieve good treatment results, a flawless operation of all systems involved and a good technical support are mandatory^[28,29].

Considering the positive experience, we believe that it would be necessary to expand the use of Telekap also to other medical specialties in order to facilitate the flow of important medical and treatment related information. Especially, emergency medical services among the hospitals in the country may be connected, including prehospital units, interventional specialties, and traumatology, as well as paediatric units and internal medicine emergency services, in order to improve and speed up the management of urgent conditions and to improve treatment outcomes.

CONCLUSION

Progress in the treatment of intracranial pathology included the development and expansion of computer systems, networks, and applications for fast and simple informing and data transfer from the location of primary diagnostics to specialised centres. Beside technical support, which includes information communication

technology, a close cooperation of various experts is also important for the efficient operation of the entire treatment mechanism. Such a multidisciplinary team includes, in addition to neurologists and neuroradiologists, also interventional radiologists, intensive care specialists, anaesthesiologists, and neurosurgeons. It would be useful to provide such an information network, which would be intended for other specialists in medicine as well, to all hospitals and diagnostic centres in Slovenia in order to significantly improve the speed and quality of healthcare and thus improve the treatment efficacy for patients even more.

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