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New Standards of Care

Telestroke 2.0: Innovative Approach to Optimise Timing and Automate Workflow

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Rapid stroke care that allows early detection and treatment is essential for optimal recovery and evolution of patients. For this reason, Catalonia has a telestroke network that connects regional hospitals with reference hospitals where emergency neurologists are located. Through telemedicine tools, they achieve a rapid response to possible cases of stroke occurring in the region.

Key Points

- Stroke is a treatable emergency. Clinical recovery depends largely on early identification and specialised treatment, that must be initiated within the first hours from symptom onset.
- A very close coordination between different levels of care, including prehospital and hospital levels, as well as a planification and support from administrative health systems, is crucial to achieve equitable and effective care for the population.
- Telestroke networks allow specialised care to be provided in remote locations, speeding up treatment.
- The efficacy and safety of thrombolytic treatment delivered via the telestroke connection has been shown to be similar to face-to-face care.

Introduction

Currently, stroke is the second most common cause of death in Europe and the world, and one of the leading causes of disability in adults (Allender et al. 2008; Feigin et al. 2014). According to recent statistics, approximately 1.1 million Europeans suffer a stroke each year (Béjot et al. 2016), and the incidence is estimated to increase by 34% by 2035 (Vivien 2021).

A stroke is a syndrome caused by a decrease in cerebral blood flow. This can be caused by the occlusion (partial or total) of a cerebral blood vessel caused by a blood thrombus, known as ischaemic stroke (Gutiérrez-Zúñiga et al.2019), or it can be caused by extravasation of blood to the cranial cavity as a result of the rupture of a cerebral blood vessel, the case being haemorrhagic stroke (Smith and Eskey 2011).

Diagnosis and Treatment

The diagnosis of stroke can be made clinically. The most characteristic symptoms are motor disturbances affecting facial, arm and leg (such as hemiparesis and hemiplegia), and speech disturbances (Gutiérrez-Zúñiga et al. 2019). However, these symptoms are usually present in both types of stroke, and it is imaging tests that can distinguish between cerebral ischaemia and cerebral haemorrhage.

Imaging tests (CT scans) are therefore of particular importance in the correct diagnosis of stroke, since the treatment of ischaemic stroke is different from that of haemorrhagic stroke. In the case of haemorrhagic stroke, the treatment consists of offering measures as strict control of blood pressure, giving drugs to reverse the anticoagulant effect in patients under anticoagulation treatment, and, in some cases, treating the lesion by evacuating the extravasated blood or

inserting ventricular drainages through surgical intervention (Fernández et al. 2018). However, in ischaemic strokes, treatment is based on restoring blood flow in the vessel that has been occluded through pharmacological treatment of fibrinolysis, or in cases of large vessel occlusion through mechanical thrombectomy (Henderson et al. 2018).

Challenges

After stroke stabilisation, it is very common for survivors to experience various types of sequelae, resulting in levels of disability that significantly alter their quality of life. The severity of the sequelae varies especially, in addition to the blood vessel affected, depending on the speed of detection and treatment. For example, in some cases, a 30-minute delay in treatment can mean a 20% increase in mortality (Vivien 2021). Evaluation of the patient by a neurologist within the first 6 hours from the onset of symptomatology is associated with a fivefold lower risk of poor outcome. In addition, some treatments can only be given hours after symptom onset, such as fibrinolysis, which must be administered within 4.5 hours after symptom onset, and mechanical thrombectomy, which can only be given within 24 hours after symptom onset and only in certain specialised healthcare centres, sometimes requiring a specialised diagnostic process using advances neuroimaging (Henderson et al. 2018). Therefore, early detection of acute stroke patients, a very close coordination between different levels of care, including prehospital and hospital levels, as well as a planification and support from administrative health systems, is crucial for the evolution and recovery of these patients.

The problem of delayed stroke detection is particularly exacerbated in cases of patients living in areas far from referral hospitals. In these cases, the problem lies in the fact that not all health centres have the necessary resources to allow evaluation by a neurologist specialised in stroke. Traditionally, when a patient with a high suspicion of stroke arrived at these centres, he or she was transferred to a specialised centre urgently, with the consequent loss of time in diagnosis and treatment that this entailed.

This is why the telestroke code was created, with the aim of providing a rapid response to possible cases of stroke occurring in areas far from referral hospitals. The referral hospitals have a specialist team of neurologists who are organised to provide support 24 hours/365 days a year through a centralised on-call service.

In this way, the telestroke system connects hospitals which have emergency neurology services with the rest of the health centres in the area. Thus, in the event of a possible case of stroke in a healthcare centre, the neurologist on duty can diagnose the patient remotely, and therefore the patient can benefit from effective and specialised treatment during the acute phase of the stroke.

Catalonia's Telestroke Network

The Telestroke network in Catalonia connects 16 regional hospitals with a remote stroke neurologist network from reference hospitals for the sharing of medical tests through telemedicine tools, with the aim of providing the best service to the whole territory.

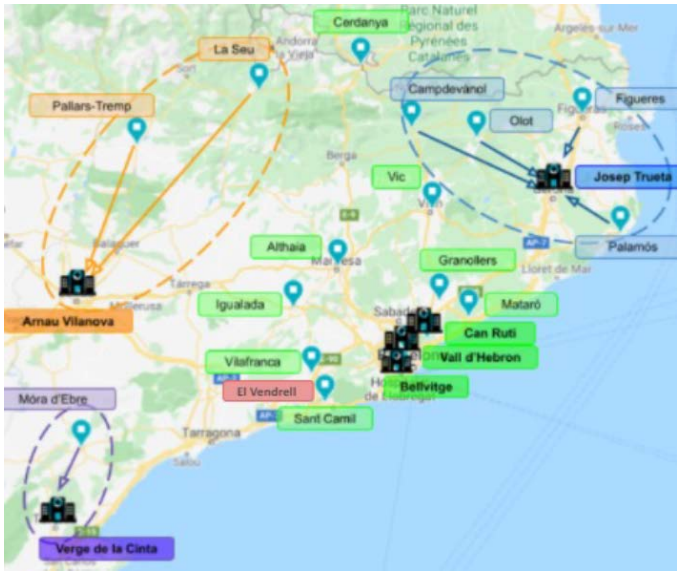


Figure 1. Catalonia telestroke network

The Telestroke system in Catalonia has an alarm system that immediately alerts the emergency neurologist. In this way, the neurologist connects to the web platform that allows him to visualise the patient's cranial CT scan as soon as it has been performed. The CT scan is further informed by a radiologist who issues a final report. In addition, the remote neurologist can establish a videoconference with the patient in real time to check his neurological status, which allows a better diagnosis to be made. Traditionally, the videoconferencing systems available in hospitals are not directly connected with the imaging visualisation platform and do

In some cases, a 30-minute delay in (post-stroke) treatment can mean a 20% increase in mortality

not allow connection between mobile devices or devices located outside the emergency room, requiring a dedicated room. However, recently, the telestroke network has undergone significant development and allows the emergency neurologist to make a video call to the regional centre via computer, cell phone or table, all integrated in the same platform, which allows the visualisation of the CT image and the patient in real time, thus facilitating the connection and agility in decision making without changing between applications or communication systems.

Thus, as soon as a case of suspected stroke occurs in the regional centres, the emergency neurologist service receives a notification by SMS, email and WhatsApp business (WABA) instantly to connect to the platform. This notification does not contain patient information, but allows the neurologist to connect to the platform immediately in order to treat the patient in real time, regardless of where the patient is located. As soon as the CT scan is performed on the patient at the health centre, it is shared via a cloud service with the on-call team of neurologists. Thus, the neurologist can access the image through any device and, thanks to the platform's online viewer, can visualise and interact with it, thus offering a better diagnosis.

Figure 3. Telestroke system operating circuit

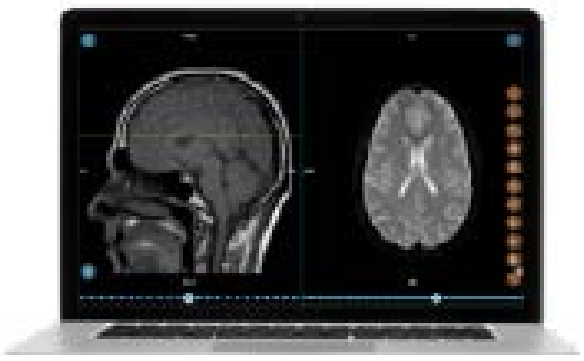


Figure 2. DICOM image viewer used in telestroke

This telestroke system in Catalonia has been supported by the Idonia.com platform since 2017. In 2020, Idonia enabled the sharing and storage of more than 2,500 CT scans of potential stroke cases in Catalonia, accessed by more than 150 different emergency neurologists. Idonia also centralises all communications, alerts and video communication.

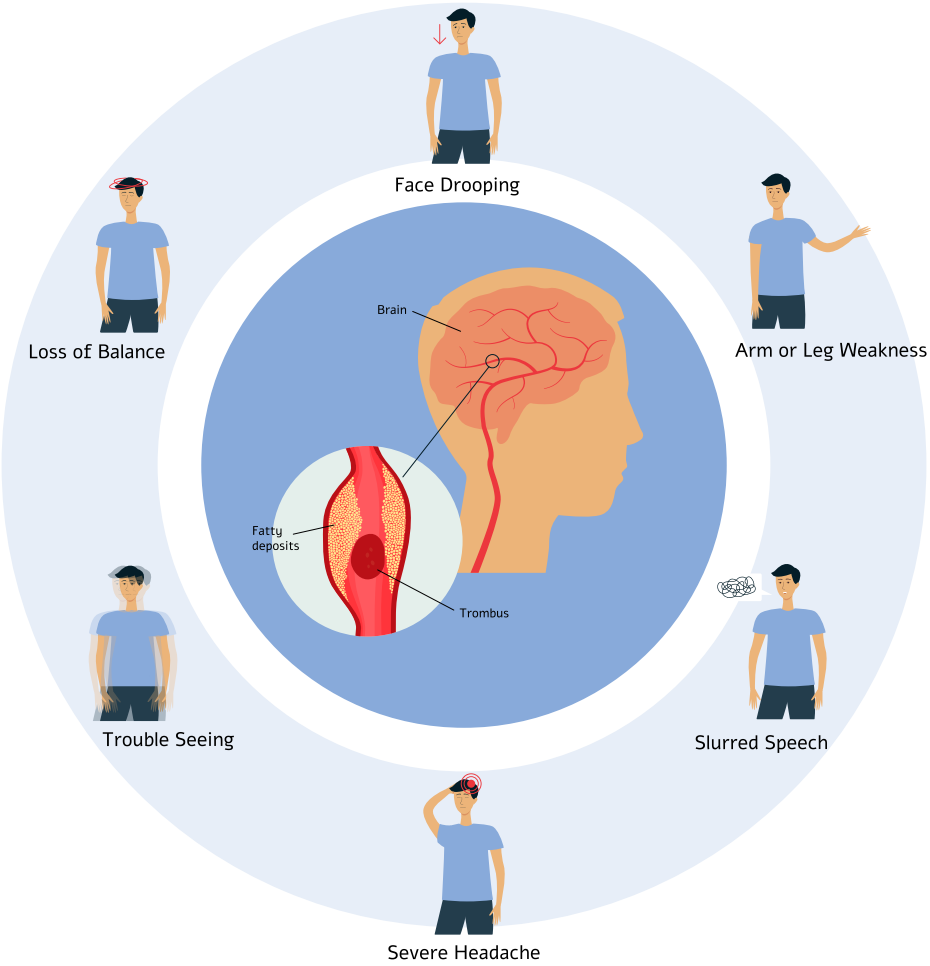
Evaluation of the patient by a neurologist within the first 6 hours from the onset of symptomatology is associated with a fivefold lower risk of poor outcome

Results

The regional telestroke centres serve as referral hospitals for acute stroke care for a population of 1.5 million inhabitants in Catalonia. The rest of the Catalan population (6 million) has a primary or tertiary referral centre with an on-site neurologist. Thanks to the deployment of the telestroke network, the population rate of thrombolytic treatment in remote areas could be equated to metropolitan areas covered by hospitals with on-site neurology teams (López-Cancio et al. 2018).

Activity in the telestroke centres in Catalonia is high, with 400 connections per year generated by patients with acute stroke, 26% of whom received treatment with intravenous thrombolysis. The close internal coordination in these hospitals and with the remote neurologist allows care and treatment to be provided very quickly, with a median of 33 minutes from the patient's arrival at the telestroke hospital and 125 minutes from the onset of stroke symptoms. The efficacy and safety of thrombolytic treatment delivered via the Telestroke connection has been shown to be similar to face-to-face care (Lopez-Cancio et al. 2018).

The assessment by the neurologist through the Telestroke system also makes it possible to optimise resources and patient transfers between hospitals, so that 40% of patients received remote specialised care that avoided the need for transfer to another centre of greater complexity, while the remaining 60% required a transfer to perform mechanical thrombectomy or admission to a more specialised unit.



Conclusions

The development of telemedicine technologies in stroke care is in continuous development and is undergoing a rapid transformation, which must be adapted to the needs of the system. In this sense, the Telestroke platform that allows high quality image visualisation in real time may be integrated with artificial intelligence algorithms that support image diagnosis, with the aim of identifying the best treatment for each patient and making decisions as quickly as possible and in an integrated way. The integration of videoconferencing to visualise the patient, not only from a fixed point in a hospital but also during their transfer between hospitals for example, from an ambulance with 5G connectivity, would allow better management of patient transfers and reception. Moreover, the platform will integrate all the necessary information and serve as an effective communication channel be tween users, including the collection (from different information systems) and transmission of structured clinical information and serve as a simultaneous alert system for all those involved in the care process.

Conflicts of Interest

None. ■

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