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Brain monitoring in hospitals needs to be strengthened

PERSPECTIVES

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Careful brain monitoring saves lives and is beneficial to patients' health. Nevertheless, Norway lacks guidelines for brain monitoring in hospitals.

The extent of brain monitoring in seriously ill patients varies considerably. There is therefore a need to establish a national standard for brain monitoring and to work systematically to enhance competence in this area.

Brain monitoring is a generic term for the close medical follow-up of hospital patients with serious neurological pathology. Every year, more than 20 000 people in Norway develop an acute illness or sustain an injury that requires brain monitoring (1). Brain monitoring is necessary at all ages and involves all levels of specialist health care as well as a number of medical and clinical specialist areas. The field of brain monitoring has undergone substantial change in recent years (2). New treatment methods for strokes, for example, highlight the need for more advanced monitoring of the brain in Norwegian hospitals (2). Developments in intensive care, neuromonitoring, neurosonology, radiology and clinical neurophysiology have also led to improvements in brain monitoring.

What is brain monitoring?

Brain monitoring is defined as clinical neurological, neurophysiological, neuroradiological, ultrasound-based and invasive monitoring of a patient's nervous system. The purpose of brain monitoring is to detect altered or pathological neurological function as quickly as possible so that the correct treatment can be administered before irreversible damage occurs. Monitoring can take place either continuously or intermittently (Table 1). Vital organ functions are monitored in parallel, because neurological function is dependent on adequate respiration and circulation. Monitoring should be continuous in unstable patients. In children, the central nervous system is still developing, and is therefore particularly vulnerable. Interpreting neuroradiological and neurophysiological examinations thus requires specialist knowledge of brain function at different ages. The benefit of various monitoring tools for choosing treatment and prognosis depends on the underlying pathology.

Table 1

Types of brain monitoring

Type of monitoring	Description
Clinical monitoring	Assessment of neurological functions: pupillary reactions, swallowing function, respiratory muscles, autonomic functions, etc. Monitoring of physiological parameters: pulse, heart rate, blood pressure, temperature, respiration rate, oxygen saturation, blood sample testing of acid-base status, glucose and electrolytes, fluid balance. Validated clinical scoring tools, e.g.: Glasgow Coma Scale, FOUR (Full Outline of UnResponsiveness) score, National Institute of Health Stroke Scale (NIHSS).
Neurophysiological monitoring	Continuous or repeated EEG, evoked response testing (somatosensory evoked responses and auditory evoked responses).
Radiological examinations and ultrasound	CT caput, CT angiography, CT perfusion, MR caput, MR angiography, MR perfusion and relevant protocols, neurosonological examinations (haemodynamics, collateral flow, perfusion, microembolus, autoregulation/vasoreactivity, vasospasms, stenoses).
Invasive monitoring methods	Intracranial pressure and oxygen measurement, cerebral perfusion examinations.

Different treatment levels

Brain monitoring takes place at different levels within the hospital – intensive care unit, intermediate unit or ward – depending on the patient's underlying condition. Basic brain monitoring encompasses clinical neurological examinations, use of relevant scoring tools and monitoring of vital parameters (3) (Table 1). Advanced brain monitoring entails neurophysiological examinations, neurosonology, neuroradiology and invasive monitoring of the brain. Continuous or repeated neurophysiological and ultrasound-based methods, together with clinical assessment, provide valuable real-time information on brain circulation and function (4).

However, there are no standardised national guidelines or formal training requirements in relation to brain monitoring. Competence, availability and skills vary between the hospitals, and greater use of electroencephalography (EEG) and neurosonology in particular in the intermediate and intensive care units would be beneficial. This is supported by data from the Norwegian Intensive Care Registry's annual report from 2019, which shows that only 0.5 % of intensive care patients were continuously monitored by EEG during their stay (5).

Which patient groups need brain monitoring?

The largest patient groups include those with acute stroke, head trauma, spinal trauma and multi-trauma, and severe epilepsy. Other relevant conditions, which in total constitute a large number, include various causes of impaired consciousness, such as poisoning, cardiac arrest, near-drowning, severe metabolic disorders, infections and inflammatory conditions, neuromuscular diseases and surgery that requires perioperative monitoring of the nervous system. Many patients with acute neurological pathology have heart disease or respiratory problems that affect brain function and require closer monitoring.

Brain monitoring of intensive care patients

Norwegian hospitals deal with nearly 20 000 intensive care patients every year (5). The brain is affected in up to 70 % of intensive care patients (6) as a result of primary brain pathology or as part of other organ pathology or failure. The majority of neuro-intensive care patients are neurosurgical patients. However, the proportion of neurological intensive care patients among the intensive care population is growing.

Systematic and repeated clinical neurological examinations using validated scoring tools are pivotal to the monitoring of all neuro-intensive care patients. Most neuro-intensive care patients have impaired consciousness due to sedation or brain pathology, which necessitates advanced neuromonitoring, such as intracranial pressure measurement and neurosonological examination. The European Society of Intensive Care Medicine recommends the monitoring of sedation depth with processed EEG for all sedated patients (7). Continuous multichannel EEG is used in epilepsy, but is also relevant for other conditions, such as intracranial haemorrhage, infection and head injury. Evoked responses and EEG are important prognostic tools in anoxic brain injury. Transcranial ultrasound is used for various stroke issues and for increased intracranial pressure, as well as death diagnostics. Neurosonological measurement of the optic nerve sheath diameter is probably the best non-invasive method for detecting increased intracranial pressure (8).

> ***«Despite the fact that the brain is the target organ for anaesthesia, there is no standard for brain monitoring in anaesthetised patients»***

Recognition that brain function is affected and may be reduced following a sedative overdose has led to an increase in the monitoring of sedation depth. Sedation should be as light as possible, partly to increase the value of clinical neurological examinations. Patients with neurological or neurosurgical pathology need sedation and attenuation of autonomic activation during critical periods where there is a risk of cerebral oedema and ischaemia, but prolonged and deep sedation increases the risk of delirium, reduced cognitive function and loss of muscle mass (9). Some patients develop critical illness polyneuropathy (CIP) and critical illness myopathy (CIM). Neurophysiological examinations such as EEG, electromyography and neurography are used to detect severe cerebral injury or CIP and CIM. Mobile CT equipment would make it possible to perform CT, CT angiography and CT perfusion at the intensive care unit without having to transport the patient to the radiology department. This could make a significant contribution to advanced brain monitoring.

Brain monitoring under anaesthesia during surgical procedures

Despite the fact that the brain is the target organ for anaesthesia, there is no standard for brain monitoring in anaesthetised patients. Clinical assessment of the depth of sedation can be supplemented with EEG-based monitoring. Processed EEG, as a bispectral index (BIS) or EEG spectral analysis, can be used to measure the depth of sedation where a general anaesthetic is used (10). Monitoring neurological function during major procedures reduces the risk of injury. Perioperative continuous measurement of evoked responses in motor and sensory pathways is one example of such neuromonitoring. Surgical procedures involving the heart, aortic arch and large precerebral and cerebral arteries are high-risk in terms of neurological complications. Cerebral oximetry to monitor the oxygen supply to the brain and neurosonological measurement of cerebral circulation can detect and occasionally prevent damage to the brain during such procedures (11).

Brain monitoring of stroke patients

Stroke patients in particular are indicated to be in the largest group of acute brain pathology patients for whom optimal monitoring helps to limit brain damage (12). It has long been known that, following a stroke, careful monitoring and regulating of vital parameters are important for the patient's subsequent functioning (13). Stroke patients should therefore be monitored by specially trained professionals in a stroke unit (14). Closer monitoring of consciousness, neurological symptoms and vital functions is essential for preventing unnecessary neuronal loss, loss of function and major sequelae in at least one in four acute stroke patients (15). Such patients should be monitored in special monitoring wards with continuous follow-up (16). In the critical monitoring phase, it is also valuable to assess cerebral blood flow with transcranial ultrasound (17). With intracranial haemorrhage, including subarachnoid haemorrhage, the blood supply to the brain is critically affected and consequential injury is common (18). Transcranial ultrasound, CT brain angiography and cerebral perfusion examinations should be available in order to detect or follow the development of vascular spasms in cerebral blood vessels. Measuring intracranial pressure, tissue oxygenation and temperature is vital in such patients.

Although several university hospitals and some of the other large hospitals have introduced brain monitoring in an intermediate unit within their stroke units, the service provision for stroke patients is still subject to large geographical inequalities (19). Standardised monitoring of patients with acute stroke is needed to bring monitoring in line with internationally established quality criteria (20).

Need for national guidelines

Brain monitoring is multidisciplinary. Collaboration across specialties is a prerequisite for the effective treatment of acute, severe brain pathology. The competence in neuro-intensive care at many hospitals, including the university hospitals, varies from person to person. Formalised, multidisciplinary neuro-intensive teams would increase the quality of the service and make it more robust. National guidelines and standards for brain monitoring are needed to ensure a systematic approach and equality in service provision between the hospitals. There is also a need to establish brain monitoring in stroke units at all Norwegian hospitals that is in accordance with international quality criteria for staffing and competence (20).

EEG monitoring is a key tool for monitoring brain function. Round-the-clock availability of neurophysiological expertise is needed. Many hospitals still do not have staff with sufficient neurophysiological expertise (21). Developing telemedicine solutions between hospitals and regions can improve the care provided.

Should be covered more in professional training

We believe that brain monitoring and neuro-intensive medicine should be covered to a greater extent in doctors' and nurses' basic education and in relevant specialist education. National postgraduate courses in neuro-intensive medicine should be established or participation in programmes in other parts of Scandinavia should be facilitated. Doctors and nurses treating serious brain pathology should have undergone training, including certification in validated clinical scoring tools, and have sound theoretical and practical knowledge of brain monitoring and various treatments. This area is not sufficiently covered in current bachelor programmes and specialist education.

Major advances in a number of disciplines mean that we are able to treat many patients with very serious diseases and injuries in both the nervous system and other organs. It is well documented that brain monitoring in hospitals saves neurological function and can be critical to survival and prognosis. However, at

Norwegian hospitals, monitoring of the brain and nervous system during the most critical phases is not in line with either the demand for such care or medical advances.

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