
ICU Volume 10 - Issue 2 - Summer 2010 - Interview

Neurointensive Care Units in Germany

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Neurocritical care is an evolving subspecialty of neurology, anaesthesia, intensive care medicine, and neurosurgery that is still in the process of development. Its focus is the care for patients with neurological and neurosurgical problems requiring intensive monitoring or special techniques. Over the past 10 years the field has evolved from a niche specialty limited to the largest tertiary care teaching hospitals into a distinct medical specialty that links neurology, neurosurgery, interventional neuroradiology, and critical care medicine in the comprehensive management of complex and life-threatening neurological problems in some parts of the world.

Development of Neurocritical Care in Germany

Neurological intensive care in Germany was born in the early fifties during the last polio epidemics. First independent neurocritical care units (NICU) were established in the nineteen sixties in Giessen and Chemnitz. The German Neurological Society of Neurological Intensive Care and Emergency Medicine (DGNi) was founded on January 28 in 1984 (Kunze 2006).

The initiation of neurocritical care specialised units followed the German tradition. The historical growth and organisation of academic medical centres in Germany is quite different from many other countries. Many German university hospitals are built as separate buildings on a common campus or in different parts of town representing the notion of the different subspecialties to inhabit their own building. This concept includes the emergency services of which each department provides their own as opposed to one central emergency room and combined neuro-oriented critical care units.

Initially, the patients undergoing neurosurgical procedures were managed postoperatively in anaesthesia care units. Later the spectrum expanded to patients with traumatic brain injury, intracerebral and subarachnoid haemorrhage, and other conditions with increased intracranial pressure. Traditionally, these patients are managed under the care of anaesthesia and neurosurgery. In most hospitals, there are one or two anaesthesia-run critical care units for all postoperative including the neurosurgical patients.

Specialised units for management of patients with cerebrovascular diseases began to grow separately within neurology departments in the mid eighties, followed by combined or split stroke and neurocritical care units under the direction of neurologists with training in neurocritical care. This development enabled maturation of specialised therapies such as intravenous and intraarterial thrombolysis and haemicraniectomy, which are now standards of care. Most of these NICUs encompass 6-12 ventilated beds and an intermediate care section. First units were opened at the University of Hamburg, Giessen and Chemnitz, followed by other major centers such as University of Heidelberg (1986), Leipzig (1991), Munich Grosshadern, Hospital Frankfurt Nordwest, University of Wuerzburg, Charité University Medical Center, University of Dresden and Martin-Luther-University Halle-Wittenberg (1997). The German Society for Neuro intensive Care and Emergency Medicine merged with the Section of Neurocritical Care of the German Society for Neurosurgery in 2009 to represent the units under the leadership of neurology and neurosurgery, whereas the German Interdisciplinary Union of Intensive and Emergency Medicine (DIVI), the German Society for Anaesthesia and Intensive Care Medicine (DGAi) support neurointensive care for neurological and neurosurgical patients in multidisciplinary units. Recently, all societies combined forces and efforts to unify and improve the care in this emerging field. The University of Heidelberg and Martin-Luther-University Halle- Wittenberg may serve as an example for excellent relationships between the neurology and neurosurgery services and with a tendency to work as a team and combine neurocritical care in one unit to heighten the level of expertise.

Model of a Neurological Neurointensive Care Unit

The spectrum of diseases treated in a neurological NICU cover cerebrovascular emergencies, status epilepticus, brain tumors, intoxications, hypoxic brain injury, traumatic brain injury, infectious, autoimmune, metabolic and neuromuscular disorders requiring intensive care as well as

medical complications of neurological patients and disturbances of consciousness. Aside from cardiac and neurological state-of-the-art monitoring including:

- haemodynamics (PICCO and Flowtrac);
 - end-tidal CO₂;
 - continuous venous oxygen saturation (SvO₂);
 - temperature, intracranial pressure (ICP);
 - cerebral perfusion pressure (CPP);
 - near infrared spectroscopy, continuous electroencephalography (EEG);
 - somatosensory evoked potentials (SSEP);
 - brain stem auditory evoked potentials (BAER);
 - transcranial and carotid Doppler and Duplex;
 - computed tomography (CT);
 - magnetic resonance imaging (MRI) perfusion; and
- angiography studies, most NICUs have 24-hour access to diagnostic and interventional angiography in cooperation with neuroradiology services and to neurosurgical procedures, continuous renal replacement therapy and compassionate specialised care through certified neuro registered nurses with a staffing ratio of one nurse to two patients.

Expertise to perform transthoracic and transesophageal echocardiography, tracheostomies, multimodal monitoring including cerebral tissue partial oxygen pressure, jugular venous oxymetry, continuous cerebral blood flow, microdialysis, and brain temperature monitoring can be found in some NICUs. Specific therapies offered in the NICU include intravenous and intraarterial thrombolysis for acute ischaemic stroke, controlled surface and intravascular hypothermia and normothermia, decompressive haemicraniectomy, extraventricular drainage, craniotomy, burr holes, brain biopsy through the neurosurgical services.

In most places, neurology residents provide coverage for the NICU in 8-hour shifts during the week and 12-hour shifts during the weekend. Each resident spends half to one year in the NICU as part of their residency training with the opportunity to rotate through the operating room and other intensive care units for procedural training and experience in stabilisation of haemodynamics and renal replacement therapy. They are supervised by a board-certified neurologist or attending physician. All NICUs with neurology leadership are closed units.

The weekday starts with rounds at 7:00 am, which includes the sign-out from the night to the morning shift, hand over of the problem list and orders for each patient, and the neurological examination of all NICU patients. The vital signs, laboratory values, and medication list of every patient are reviewed and the NICU patients examined by a resident once per shift. Neuroimaging from the past 24 hours is reviewed with a neuroradiologist, decisions regarding interventions and difficult cases are discussed. The day team is responsible for arrangement of routine imaging, consultations, and performance of bedside procedures, transport of patients to routine imaging (CT, MRI, angiography) and procedures. The night shift is in charge of completion of documentation including discharge summaries, stroke registries, records of time patients spent on the ventilator, DRG coding, and ICU scores. The ventilators are managed by the resident and the nursing staff. The physiotherapy and speech therapy teams visit every patient six days of the week for active and passive training. Important teaching points from the intensive care point of view are from an organ-system-based approach and focus on outcome, code status, discharge planning, and more intense participation of the nursing staff, determination of diagnostic and therapeutic goals for each patient.

As most units were created and are run from the perspective of a neurologist who is interested in, but not formally trained in critical care, these patient related issues are often not part of the daily routine and thought process. A more detailed formal core curriculum and examination for subspecialty training in neurocritical care like the one that exists in the US, an initiative of the Neurocritical Care Society needs to be created.

The Role of Neurocritical Care Units Today and Tomorrow

Closed ICUs and the around-the-clock availability of intensivists are important because this model has been shown to reduce costs and improve outcomes. High intensity staffing (mandatory consultation of an intensivist or closed ICU) was associated with reduced mortality and length of stay (Pronovost 2002). Introduction of a neurocritical care team including coordination of care by a full-time neurointensivist, as well as inter-hospital transfer systems, the implementation of best-medical practices, and continuous staff education lead to a reduction of in-hospital mortality and length of stay without any change in readmission rates and long term mortality, decreased total cost, increase in proportion of patients who were discharged home (Suarez 2004; Mirski 2001; Diringer 2001; Varelas 2006). Neurointensivists recognise details in the neurological status, provide expertise in interactions of the brain with other organ systems, cerebral physiology, common metabolic derangements, prognostication of severe brain injury, end of life support and related legal and ethical issues. Additionally, neurointensivists offer competence in organ donation and multimodality monitoring and are interested in aggressive approaches ("time is brain") as well as innovative management strategies (Rincon 2007). Therefore, we need to improve structure, effectiveness, and quality of neurointensive care, expand the multidisciplinary, combined neuroscience team approach towards integration, centralisation, and education with a national and international focus on teamwork and research platforms. These are the aims of the Neurocritical Care Society (www.neurocriticalcare.org). Networking of specialists, national societies, developing a core curriculum for neurocritical care fellowships and management guidelines, planning and conducting multicentre trials are big steps towards these goals.

