Neurocritical Care: A White Elephant or an Unavoidable Obligation?

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Though neurosciences have made great progress over the last 20 years, the optimal place to care for the critically-ill neurologic patients remain ill-defined. Some institutions have established specialized neurocritical care units (NCCUs), which provide comprehensive support for patients with life-threatening neurological illnesses by integrating the management of both the brain and the other organs simultaneously. Admission to these NCCUs has been claimed to decrease the mortality and improve the outcomes in the form of discharge dispositions.[1]

However, there is skepticism among the hospital administrators and some clinicians too that neurocritical care is expensive and resource-demanding with relatively poor outcomes. The cost effectiveness of these units remains debatable. A Finnish Intensive Care Consortium database showed that the cost per independent survivor in an NCCU was €58,497 for traumatic brain injury (TBI) and €96,369 for subarachnoid hemorrhage (SAH). Acute ischemic stroke (AIS; €104,374) and intracerebral hematoma (ICH; €1,78,071) are even more expensive.[2] An American study supports these statistics with the mean cost per survivor of intracranial hemorrhage at $1,18,813.[3]

Apart from the cost issue, the accessibility to an NCCU is a major issue. Access to the NCCU is limited even in the resource-rich western world.[4]

In spite of heavy costs and accessibility issues, several studies documented clinical benefits conferred by these dedicated NCCUs. Suarez et al reported that introduction of a neurocritical care team, including a full-time neurointensivist who coordinated care, was associated with significantly reduced in-hospital mortality and length of stay without change in readmission rates or long-term mortality.[5] Another recent report concluded that admission to the NCCU was a significant predictor of increased hospital discharge with an odds ratio (OR) of 2.3 and significantly lower ICU length of stay (LOS; 15 vs. 21.4 days) and lower ICU and hospital mortality rates (5.3% vs. 10.2% and 9.1% vs.19.5%, respectively; $p < 0.05$). NCCU patients had higher discharge Glasgow Coma Score (GCS) and underwent fewer tracheostomies.[6]

Neurological patients cared for in specialized neuro-ICUs underwent more invasive intracranial and hemodynamic monitoring, tracheostomy, and nutritional support, and received less intravenous (IV) sedation than patients in general ICUs. These differences in care may explain the observed disparities in outcome between neurocritical care and general ICU care.[7]

In individual diagnostic entities too, better results have been reported with NCCU care. In patients with status epilepticus, NCCU care resulted in fewer antiepileptic drugs and less vasopressor use.[8] Use of continuous video-electroencephalography (video EEG) as a part of the neonatal neuro-critical care program was associated with improved electrographic seizure detection, decreased phenobarbital burden, and antiseizure medication use at discharge.[9]

Management in dedicated NCCUs, compared with combined neuro/general units, led to improved quality of life, though at higher costs in TBI.[10] While overall outcomes were not significantly different between general ICUs and NCCUs, some metrics of care were significantly better in NCCUs. In a study comprising 2,487 patients of which 1,572 and 915 were admitted prior to and after NCCU establishment, respectively, the length of ICU stay and the number of days on ventilator were significantly lower in NCCU patients. Critical care unit mortality was significantly lower in NCCU patients. The mortality ratio (observed mortality/predicted mortality) was 0.34 and 48.1% patients showed good functional recovery (modified Rankin score, 0–2).[11] In a study aimed at validating risk prediction models for acute TBI and to use the best model to evaluate the optimum location and comparative costs of neurocritical care, the results suggested that management in a dedicated NCCU may be cost-effective compared with a combined neuro/general critical care unit. These results support the recommendation that all patients with severe TBI

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would benefit from transfer to an NCCU in a neurosciences center, regardless of the need for surgery.[12]

Outcomes of subarachnoid hemorrhage (SAH) have also been reported to be better when managed by a neurointensivist. In a study of 243 patients of whom 151 were managed by a neurointensivist, univariate analysis demonstrated significantly better outcomes for neurointensivist-managed group compared with general intensivist-managed intensive care unit group (good outcomes, 58.3 vs. 41.0%, respectively, $p = 0.01$). Though multivariate logistic regression was not significant for the difference, outcomes in SAH patients with Hunt and Kosnik grades I to II were better when managed by the neurointensivist.[13]

Stroke units are a subset of NCCUs, which have been documented to improve the outcomes of patients with intracranial hemorrhage (ICH) and ischemic stroke. Among 6,223 eligible patients with ischemic stroke admitted to regional stroke centers in Ontario, the 30-day risk-adjusted mortality was lower for stroke unit care across all stroke subtypes. In multivariate analysis, after controlling for age, gender, medical comorbidities, and stroke severity, there was a significant reduction in stroke mortality associated with stroke unit admission in all stroke subtypes. The results remained similar after a sensitivity analysis excluding patients receiving palliative care. This study provides "real-world" evidence that all ischemic stroke subtypes do benefit from a stroke unit admission regardless of the etiology.[14] The benefits of stroke care units reported in larger tertiary centers extend to smaller community hospitals with more limited resources. Establishing stroke care units in a community hospital not only increases the survival of stroke patients, but also the proportion of patients discharged home to live independently.[15]

Some limitations of NCCU admission in certain category of patients have been reported. In a study of 3,641 patients with CT evidence of TBI, patients with TBI and multiple injuries had lower mortality risk when admitted to a trauma ICU. This survival benefit increased with increasing injury severity. Isolated TBI patients had similar mortality risk when admitted to NCCU compared with those admitted to a trauma ICU.[16]

Of late, there is some evidence that it is the standardized management protocol rather than the NCCU that improves the clinical outcomes of TBI. In a study conducted in North American trauma centers, care in a dedicated NCCU did not improve risk-adjusted in-hospital survival. However, the presence of a standardized management protocol for severe TBI patients was associated with lower risk-adjusted in-hospital mortality.[17] Another study showed that mild TBI patients with a convexity SAH, small convexity contusion, small intraparenchymal hematoma (≤ 10 mL), and/or small subdural hematoma do not require admission to an ICU.[18]

In stroke management, combination of an organized acute stroke unit and a short-term ward is shown to reduce the mortality and complications of ischemic stroke as well as the length of stay when compared with the general medical ward. The results of this study assure that the combination of a stroke unit and a short-term ward is useful in developing countries, which have limited number of beds in their stroke units.[19] A shorter length of stay but no large differences in functional outcome, safety, or cost is seen among patients with minor intracerebral hematomas admitted to a dedicated stroke unit compared with those admitted to general ICUs.[20]

Thus, there is contradicting evidence regarding the need for NCCUs versus general ICUs. The best approach to resolve the conflict of whether to admit a patient to NICU or not is to use predictive models, of which there are not many at the moment. The authors of one study derived a clinical tool that defined a subset of pediatric patients with mild TBI at low risk for ICU-level care. The clinical decision rule (CDR) in this study consisted of five predictor variables: midline shift > 5 mm, intraventricular hemorrhage, non-isolated head injury, postresuscitation GCS score of < 15, and cisterns absent. The CDR correctly identified 37 of 40 patients requiring ICU-level care (sensitivity = 92.5%; 95% CI = 78.5–98.0) and 154 of 244 patients who did not require an ICU-level intervention.[21]

Futility of care is something to be remembered while admitting certain category of patients to the ICUs in general and NCCUs in particular. Some studies have brought forth this issue. These studies looked at patients with poor outcome in NICU. In one study the authors prospectively identified patients who were admitted to the NCCU with partial loss of brainstem reflexes persisting for > 24 hours due to an intrinsic lesion of the brain (trauma, stroke, hemorrhage, etc.). Of the total 102 patients, 72 died after a mean of 16 days and 23 remained comatose, locked-in, or in a vegetative state. Four were conscious and followed commands, while three were minimally conscious, episodically obeying simple commands.[22] More such predictive models should be developed to utilize the neurocritical care resources more usefully.

In conclusion, while there is no doubt about the benefits of NCCUs, limitations and futility in certain category of patients have to be kept in mind while admitting the patients to this facility. More reliable data should be generated through multicenter trials regarding the nature of patients who benefit from admission to the NCCU. Only when we use such prudence, then only we can convince the administrators about the investment that goes into the facility of neurocritical care which is perceived as a white elephant.

Conflict of Interest

None declared.

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