Outcomes of Neurocritical Care
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Introduction
Medical outcomes research has gained significant prominence as healthcare providers work to determine the utility and efficacy of practice. Consequently, the outcome of neurocritical care is a topic of developing interest in the clinical neuroscience community. In fact, both outcomes research and neurocritical care are relatively new fields that are being defined and developed.

Neurocritical Care
Broadly defined, neurocritical care would include the rudimentary attempts at resuscitation and care throughout history or the care of patients after crude neurosurgical interventions, such as trephination in ancient times. Modern definitions would steer us toward the care of critically ill patients with primary or secondary neurologic problems. Much needs to be done to examine the outcomes of neurocritical care, and the following is a review of the pertinent concepts of both outcomes and neurocritical care research.

Outcomes Research
The outcomes that are used to measure neurologic disease have been crude and not well developed, in part due to the few therapeutic interventions available for neurologic disease. One of the oldest scales used in neuroscience research is the Barthel Index (Table 1) [1], which is a functional scale that was developed in 1965 to assess neuromuscular or musculoskeletal disorders. Besides mortality scales for severe or acute neurologic problems, the Glasgow Coma Scale (GCS) (Table 2) [2] and the Glasgow Outcome Scale (GOS) (Table 3) [3] were the only measures available for a long time. Both of these were designed for head trauma and are not necessarily applicable to other disease processes. To maintain reliability, the designers of the scales sacrificed accuracy and specificity and limited the scale to very gross measures.
As new therapies have been developed for neurologic disease, new outcomes scales have been developed to measure the efficacy of these therapies. In trauma, these have been primarily variations on the GCS, such as the Glasgow-Liege scale [4], the Innsbruck Coma Scale [5], and Reaction Level Scale [6], among others. None have surpassed the GCS in popularity, however.

In the field of stroke research, many new scales have been developed. This has led to the appearance of the Scandinavian Stroke Scale (SSS) [7], National Institutes of Health Stroke Scale (NIHSS) [8], Canadian Neurological Scale [9], European Stroke Scale [10], and numerous others. These scales all take different components of the standard neurologic exam and attempt to weight these in some fashion to obtain the most accuracy possible. The NIHSS is shown in Table 4 as an example. Not surprisingly, the scales are most frequently used in the countries in which they originated.

In general critical care, severity of illness scales have been developed and used to help allocate resources, which are especially scarce in critical care. The most popular scale used is the Acute Physiology, Age, Chronic Health Evaluation (APACHE) scale [11], which was developed in 1981 and has had two major revisions since then. The APACHE scale uses various physiologic data to measure illness and has been used to help prognosticate mortality (Table 5). There have been several other scales developed; unfortunately, the neurologic information incorporated in these scales is usually limited to the GCS.

As the field of physical medicine and rehabilitation developed, new scales were often developed by physiatrists to monitor patient progress in the rehabilitation setting. And as rehabilitation often starts in the intensive care units, these scales are sometimes used early in patient care. Probably the most widely used of these scales is the Functional Independence Measure (FIM) (Table 6) [12,13], which consists of 18 items and is used by over 100 rehabilitation institutions.

The state of the art in outcome research expands upon physical function and now tries to measure health status as well as quality of life. Many researchers now use these terms interchangeably. Though not specifically designed for neurologic diseases, these scales are important in the incorporation of nonphysical factors, such as emotional and social dimensions of health. One of the most widely used of these is the Short Form-36 Health Survey that came out of the Medical Outcomes Study [14]. More recently, there have been efforts at developing disease-specific quality of life scales, such as in stroke [15].

Finally, one outcome that is increasingly important, and yet equally difficult to measure, is cost. The surrogate for actual cost of care is charges, but often this number has little relation to the actual cost of care. In patient outcomes research, in addition to the direct costs of care, it is also important to include the indirect costs that the patients bears, such as loss of employment and time spent by other caregivers.

### Outcomes of Neurocritical Care

Unfortunately, because of the newness of neurocritical care and the many different outcome scales, there has been very little actual research in outcomes of neurocritical care. The research done in the neurocritical care patients focuses on the efficacy of new therapies and not the efficacy of the neurointensive care unit care that the patients encounter. However, there has been some research in other areas that may be relevant to neurocritical care, which can then be used as evidence of outcomes or models for future research.

The first examples would be research in procedure-oriented care. There are numerous examples of the association of improved outcome with high-patient volume...