Intensive Care Unit Management of Patients with Stroke

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Opinion statement
Patients admitted with the diagnosis of “stroke” have a variety of different disorders that require specific treatment approaches in the critical care unit. Early thrombolysis for ischemic stroke and improvements in surgical and neurointerventional techniques for the treatment of aneurysms and arteriovenous malformations in patients with subarachnoid hemorrhage have been milestones in the past decade, but the evolution of general management principles in critical care and the dedication of neurointensivists are equally important for improved outcomes. Strategies, which have been developed in other areas of intensive care medicine (eg, in patients with septic shock, acute respiratory distress syndrome, or trauma), need to be adopted and modified for the stroke patient. Prevention of iatrogenic complications and nosocomial infections is of utmost importance and requires sufficient numbers of trained personnel and high-quality equipment. Although the focus of attention in stroke patients is “brain resuscitation,” comorbidities often limit the diagnostic and therapeutic options, and overall cardiopulmonary and metabolic functions need to be optimized in order to prevent secondary injury and allow the brain to recover. As part of a holistic approach to the rehabilitation process, psychologic and spiritual support for the patient must start early on in the intensive care unit, and family members should be involved in the patient’s care and provided with special support as well.

Introduction

This review focuses primarily on the management of adults with stroke who require intensive care and describes the general principles of intensive care unit management, as well as specific considerations regarding the underlying etiology.

The organization of critical care services differs between countries and even within the United States. In general, closed units with 24-hour intensivist coverage seem to be associated with better outcomes [1,2, Class II].

Several points serve to summarize the key issues: 1) life-threatening deterioration occurs most often within the first 48 hours after onset of symptoms in patients with middle cerebral artery (MCA) stroke [3, Class II]; 2) patients should be closely monitored, including continuous electrocardiogram, pulse oximetry, frequent noninvasive blood pressure (BP) measurements, and at least hourly neurologic checks in the first 24 to 48 hours after the insult; and 3) stroke patients should be admitted to a high-dependency intensive care unit with full life support capacities if their level of consciousness is severely reduced or rapidly declining, if they require ventilatory support or control of hypertension with continuous infusions or hemodynamic augmentation, or if they have severe comorbidities such as obstructive sleep apnea syndrome, oxygen-dependent chronic obstructive pulmonary disease (COPD), acute coronary syndrome, uncontrolled diabetes, or end-stage renal disease.

The following treatment recommendations focus on the latter group of patients who require high dependency care and are intended to show a practical approach in how to achieve the treatment goals of the American Stroke Association and European Stroke Initiative Guidelines [4,
Class I–III, Tables 1 to 3 provide a quick reference summary. Comprehensive recommendations for primary and secondary prophylaxis can be found in the 2006 Guidelines for Prevention of Stroke in Patients with Stroke or Transient Ischemic Attacks by the American Heart Association/American Stroke Association [5••, Class I–III]. They are only included in this review when they need to be initiated in the critical care setting.

### Treatment

#### Monitoring and diagnostic procedures

- Basic monitoring of stroke patients consists of continuous electrocardiogram, pulse oximetry, and noninvasive BP monitoring for at least 24 hours (Table 1).
- A brief examination of the neurologic status should be documented at least every hour in the first 24 to 48 hours. The interval may then be prolonged based on the clinical course.
- Invasive BP monitoring is often indicated if the patient is admitted to a high-dependency intensive care unit. In ventilated patients, the analysis of systolic pressure variation from the arterial line tracing allows a dynamic assessment of volume status, and different monitoring devices allow continuous cardiac output monitoring based on pulse contour analysis [6, Class III].

#### Table 1. Synopsis of diagnostic and monitoring recommendations for IPH, SAH, and IS

<table>
<thead>
<tr>
<th></th>
<th>IPH</th>
<th>SAH</th>
<th>IS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic monitoring</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>(ECG, NIBP, pulse-oximetry)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Formal clinical neuromonitoring</td>
<td>Every 60 minutes</td>
<td>Every 60 minutes</td>
<td>Yes (cave: immediately after thrombolysis)</td>
</tr>
<tr>
<td>A-line</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>CVC</td>
<td>As needed</td>
<td>As needed</td>
<td>As needed</td>
</tr>
<tr>
<td>PAC/LidCO/PICCO</td>
<td>As needed</td>
<td>As needed</td>
<td>As needed</td>
</tr>
<tr>
<td>ICP monitoring</td>
<td>Consider ventriculostomy</td>
<td>Ventricleostomy for hydrocephalus</td>
<td>As needed</td>
</tr>
<tr>
<td>Invasive brain tissue oxygenation and/or microdialysis monitoring, NIRS</td>
<td>Consider as part of multimodal monitoring</td>
<td>Consider as part of multimodal monitoring</td>
<td>Consider as part of multimodal monitoring</td>
</tr>
<tr>
<td>Continuous EEG</td>
<td>As needed</td>
<td>As needed</td>
<td>As needed</td>
</tr>
<tr>
<td>12-lead ECG on admission</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Echocardiography</td>
<td>As needed</td>
<td>As needed</td>
<td>TEE</td>
</tr>
<tr>
<td>TCD</td>
<td>As needed</td>
<td>Daily</td>
<td>As needed</td>
</tr>
<tr>
<td>Troponin</td>
<td>As needed</td>
<td>Yes</td>
<td>As needed</td>
</tr>
<tr>
<td>BNP</td>
<td>As needed</td>
<td>As needed</td>
<td>As needed</td>
</tr>
<tr>
<td>CRP/procalcitonin</td>
<td>As needed</td>
<td>As needed</td>
<td>As needed</td>
</tr>
<tr>
<td>MRSA and/or VRE screening</td>
<td>As needed</td>
<td>As needed</td>
<td>As needed</td>
</tr>
<tr>
<td>Chest radiograph</td>
<td>As needed</td>
<td>As needed</td>
<td>As needed</td>
</tr>
<tr>
<td>CT</td>
<td>Performed and read within 45 minutes after hospital admission</td>
<td>Yes</td>
<td>As needed</td>
</tr>
<tr>
<td>CT angiogram/angiogram/magnetic resonance angiogram</td>
<td>As needed</td>
<td>As needed</td>
<td>Consider early MRI to determine penumbra</td>
</tr>
<tr>
<td>MRI</td>
<td>As needed</td>
<td>As needed</td>
<td></td>
</tr>
</tbody>
</table>

BNP—brain natriuretic peptide; CRP—C-reactive protein; CVC—central venous catheter; ECG—electrocardiogram; EEG—electroencephalogram; ICP—intracranial pressure; IPH—intraparenchymal hemorrhage; IS—ischemic stroke; MRSA—methicillin-resistant *Staphylococcus aureus*; NIBP—noninvasive blood pressure; NIRS—near-infrared spectroscopy; PAC—pulmonary artery catheter; SAH—subarachnoid hemorrhage; TCD—transcranial Doppler; TEE—transesophageal echocardiography; VRE—vancomycin-resistant *Enterococcus*. 