ASSESSMENT of the value of Stroke Intensive Care Units has been mainly related to reports dealing with mortality from stroke in patients cared for in such units — an easily definable end point. The reports in the literature vary from that of Kennedy et al., which concludes that "special intensive care units devoted only to the acute phase care of the stroke patient, even with specially trained nurses, are not productive in terms of a reduction in stroke deaths," to that of Taylor, who reported mortality was lowered from 49% to 13%.

Drake et al. reported that "hospitals with neurovascular care units showed a 50% reduction in secondary complications; hospitals without neurovascular care units showed no reduction." Associated with this decreased complication rate was a decrease in mortality for non-hemorrhagic strokes.

Experience in a combined (cardiac and cerebrovascular disease) unit was described by Cooper et al., but is difficult to interpret. The mortality rate for patients with subarachnoid hemorrhage in the unit was 40%; before the unit was formed, 6/6 patients died. The authors mention that the accuracy of diagnosis of subarachnoid hemorrhage and intracerebral hemorrhage was uncertain. When patients with each were grouped, there was no difference in the mortality in the control population and in the intensive care unit population. The authors reported several non-objective advantages of the unit; 1) efficiency of patient care was improved, 2) awakening of the interest of the medical, nursing and paramedical profession to the problem of acute stroke was noted and 3) the unit provided a focal area for education concerning stroke.

Pitner and Cornelius wrote, "the conclusion seems inescapable that stroke ICUs are not productive in reducing mortality in the acute stroke patient, at least in a general hospital setting." In this report 81 patients admitted to a 4-bed stroke intensive care unit were compared with 81 control cases. "No significant differences in overall mortality (33% versus 27%) or in mortality by diagnostic category were found."

Norris and Hachinski studied 199 patients with stroke admitted to an intensive stroke care unit during the first year. The results were not compared to similar experience in the regular hospital setting. The mortality rate was 8% for patients with acute (admitted within 48 hours of onset) brain infarction. Apparently there was a "sharp decline in complications commonly seen in stroke patients, especially deep venous thrombosis, pneumonia, pressure sores and urinary tract infection." The authors carefully describe the problems encountered in determining whether the "results achieved in an intensive stroke care unit are better, the same or worse than when similar patients are treated in a general or community hospital setting."

Carpenter and Reed abstracted medical records of 1,117 patients with stroke from 4 community hospitals and one university hospital. A number of differences in treatment and outcome are described but these cannot be related to the presence or absence of stroke intensive care units, as this subject is not mentioned. Haerer and Woosley reported an 11% mortality in patients with acute anterior circulation infarcts in a university hospital stroke unit; no information is provided about similar patients not in the stroke unit. Jones and Millikan also reported 11% mortality in patients with an acute carotid system cerebral infarction but no comparison is made between patients in or not in a stroke intensive care unit.

Examining only mortality-morbidity data provides no general agreement about the usefulness of stroke intensive care units. However, details of stroke pathophysiology and medical center responsibilities for the acute phases of the nation's third commonest killer should be inspected before concluding that such units are not helpful.

Objectives of an Intensive Care Unit

Patient care, teaching (including demonstration) and research are the traditional core functions of medical centers. Before analyzing the interrelationship between each of these and stroke intensive care units, a primary question should be answered. What is the cause of death in acute stroke? A more precise question is: what is the cause of death in acute cerebral infarction which is the most common of all types of stroke? Following cerebral infarction, how many patients die from: a) infarcts destroying brain stem function, b) edema with brain stem compression, c)
pneumonia, d) myocardial infarction and/or heart failure, e) pulmonary embolus or f) other? Strangely, almost nothing has been written about this. Kennedy et al. reported that 104/513 patients died during day 0–9 “overwhelmingly due to the stroke itself.” However, 66/104 had subarachnoid hemorrhage or intracerebral hemorrhage; only 38/104 had cerebral infarction. The distribution of the mechanism of death is not given. During the 10–30th day 45/410 patients died; 16/45 had subarachnoid or intracerebral hemorrhage. Causes of death included pneumonia, respiratory insufficiency, sudden death, pulmonary embolism, myocardial infarction and “undetermined.” Oxbury et al. mentioned that autopsy was performed on 14/15 patients dying of acute stroke; this was from a total series of 93 patients. Four of 14 had intracerebral hemorrhage. Six of 10 had cerebral edema with midbrain distortions. These patients died on days 1, 2, 3, 4, and 15 after the onset. The remaining 4 patients died on days 3, 9, 10 and 11 and the mechanism of death was less certain.

Ng and Nimmannitya reviewed 353 consecutive supratentorial cerebral infarctions (postmortem examination) at Philadelphia General Hospital. Forty-five (13%) showed severe acute brain swelling with transtentorial herniation. Death occurred within 7 days in 34/45.

One hundred fifteen patients with acute stroke, (infarction) found at autopsy, were reviewed by Brown and Glassenberg. Thirty-three (29%) died in the first 7 days, but the number of patients with transtentorial herniation was not given. Pneumonia and pulmonary emboli were more frequently the cause of death in patients living longer than 7 days.

Bounds studied the records of all autopsied cases at Mayo Clinic from January 1966 through September 1975. There were 100 patients with acute infarction in the distribution of the internal carotid artery. Table 1 illustrates the mean survival time for patients with various causes of death.

Thus, about 60% of the deaths occur in the first week; brain herniation, cardiac abnormalities and pulmonary embolus being the usual mechanism of death. Forty percent of deaths occurred during the second and third weeks and pneumonia, septicemia, etc. were the most common mechanisms.

If the early deaths are to be prevented some type of excellent intensive care facility or program appears more likely to be effective than routine hospital care. In the initial hours after admission, following cerebral infarction, rapid changes often occur in the patient’s neurological examination. The changes can be quickly assessed and recorded by trained personnel in a stroke intensive care unit (SICU); but might go undetected on a regular hospital service.

<table>
<thead>
<tr>
<th>Cause of death</th>
<th>Mean survival</th>
<th>Number of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herniation</td>
<td>3.7 days</td>
<td>32</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>13.7 days</td>
<td>29</td>
</tr>
<tr>
<td>Cardiac</td>
<td>6.9 days</td>
<td>17</td>
</tr>
<tr>
<td>Pulmonary embolus</td>
<td>5.2 days</td>
<td>12</td>
</tr>
<tr>
<td>Other (septicemia, etc.)</td>
<td>11.8 days</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 2 contains items related to patient care. It is apparent that some of these items are relatively easy — others are relatively complex; i.e., if the blood pressure is to be precisely lowered by administering sodium nitroprusside the patient must be in intensive care and the personnel should have special experience with the use of this drug. Airway protection and respiratory support may require minute-to-minute action. Several needs may develop simultaneously, such as aspiration, change in blood pressure or convulsions. Such problems of patient care constitute ample

**Table 2 Patient Care**

1. Respiratory protection and support
2. Heart - Blood pressure recording data and treating
3. Monitoring
   a. Neurological status
   b. Cardiac function
   c. Pulmonary function
   d. Intracranial pressure
   e. Other
4. Metabolic balance (systemic) (in appropriate ADH)
   a. Fluids
   b. Electrolytes
   c. Nutrients
5. Bowel and bladder
6. Anti-infection
7. Skin protection
8. Psychological support
9. Anticonvulsant
10. Special treatment modalities
    a. Blood pressure control
    b. Anticoagulant
    c. Antiplatelet agglutinating
    d. Antiedema (brain)
       1. Glycerol
       2. Mannitol
       3. Steroids
       4. Other
    e. Fibrinolytic
    f. Other
11. Metabolic inhibition
    a. Barbiturates
    b. Other

*The gross specimens of brain, intracranial arteries, extracranial carotid arteries and microscopic sections of vessels and brain were re-examined.*
need for an intensive care unit for stroke patients.

A second objective is the teaching-demonstration function of such a unit. Kennedy et al.¹ and Pitner and Cornelius⁶ make no mention of this in their appraisal of stroke intensive care. Others⁴, ⁵ write that such units "have awakened the interest of the medical, nursing and paramedical professions to the problem of acute stroke." The impact of an SICU on interest in cerebrovascular disease in an individual hospital cannot be assessed. I have noticed a complete change in medical personnel reaction to stroke in the last 25 years. Part of this has been stimulated by collecting patients with stroke in a special hospital area, a stroke unit. Patients with stroke, with their many focal neurological deficits, constitute an important experience of individuals learning neurology, a point which should be considered when building a neurology-neurosurgical teaching service.

The third function is research. The SICU provides an extraordinarily helpful base for conducting clinical investigation. Having acute stroke patients in a special area of the hospital with personnel trained to detect and record observations of the neurological status of patients can produce appropriate data concerning natural history and the effect of treatment being studied. There is, in addition, the much needed phenomena — "drawing attention to stroke."

Conclusions

1. Mortality-morbidity data from acute stroke may not be significantly improved in a stroke intensive care unit compared to mortality-morbidity data of acute stroke cared for in other intensive care areas in a hospital. However, patients with acute stroke must have expert intensive care, which is generally better in disease and disability oriented units.

2. Teaching-demonstration and research in stroke is greatly facilitated by a stroke intensive care unit.

On balance, a stroke intensive care unit is an important adjunct in a major medical center hospital.

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References

13. Bounds JV Jr: 100 cases of recent internal carotid artery distribution infarctions — a thesis. Submitted to the faculty of the graduate school of the University of Minnesota, December 1976
Stroke intensive care units: objectives and results.
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