Significant Reductions in Length of Stay After Carotid Endarterectomy Can Be Safely Accomplished Without Modifying Either Anesthetic Technique or Postoperative ICU Monitoring

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Background and Purpose—We sought to determine whether postoperative length of stay (LOS) and resource utilization could be safely reduced without changing our uniform protocol of performing carotid endarterectomy (CEA) under general anesthesia with postoperative intensive care unit monitoring.

Methods—We retrospectively reviewed the hospital records of 421 consecutive CEA operations performed during a 3-year period of transition in discharge policy to determine LOS, complications, and resource utilization. We divided operated patients into 3 cohorts: cohort I patients were operated on before a stay reduction policy was instituted (1995, n = 171); cohort II patients were operated on after the institution of a single-day-stay policy for selected patients (January to August 1996, n = 95); and cohort III patients were operated on after the institution of a universal single-day-stay policy (September 1996 to December 1997, n = 155).

Results—While significant in-hospital complications leading to increased LOS remained essentially unchanged over time (cohort I: 4.0%; II: 6.3%; III: 3.9%; P = NS), the mean postoperative LOS decreased from 2.6 ± 0.3 days in cohort I to 1.6 ± 0.1 days in cohort III (P < 0.0001). The median postoperative LOS also decreased from 2 days to 1 day from cohort I to III, with 70% of patients discharged after 1 day in cohort III compared with only 32% for cohort I (P < 0.0001). In addition, the total number of laboratory studies ordered decreased from 8.0 ± 0.8 per patient in cohort I to 6.4 ± 0.5 in cohort III (P < 0.01).

Conclusions—A uniform policy of discharge home from the intensive care unit on postoperative day 1 following CEA under general anesthesia can reduce LOS and decrease resource utilization without compromising care. (Stroke. 1999;30:2341-2346.)

Key Words: carotid endarterectomy ■ costs and cost analysis ■ hospitalization ■ quality of health care

Carotid endarterectomy (CEA) is the most commonly performed vascular procedure in the United States, with almost 100,000 procedures performed in the United States annually.1-3 Because its efficacy in preventing stroke has now been convincingly established, procedural rates are likely to increase even further. As a result, there will undoubtedly be great pressure from third-party providers to decrease cost while keeping complication rates low. This pressure will certainly be increased by the development of alternative treatments for carotid disease, such as transluminal angioplasty and stenting procedures.

Although many studies have examined the effect of new management paradigms (using either local anesthesia, or nonintensive care monitoring) on cost and length of stay (LOS), we sought to determine whether it is possible to significantly decrease the LOS and associated resource utilization of CEA with a surgeon- and patient-motivated LOS program without changing the perioperative and operative protocol that historically had yielded a low complication rate.

Subjects and Methods

Study Period
We reviewed the records of 421 consecutive CEA operations performed by 2 neurosurgeons (RAS and DOQ) in 379 patients. All patients were operated on between January 1995 and December 1997. Computerized hospital records, including demographic profile, laboratory studies, radiological studies, and operative and discharge summaries, were reviewed to determine the total length of hospital stay, the postoperative LOS, the occurrence of in-hospital complications (death, stroke, myocardial infarction, pulmonary embolus, wound infection, wound hematoma, nerve injury, or need for
reoperation), and the postoperative utilization of laboratory (complete blood count [CBC], electrolytes, arterial blood gas, total) and radiographic studies (chest X-ray). Office records were used to determine posthospitalization complications and these were supplemented with computerized hospital records when readmission was necessary.

The patients were then divided into 3 cohorts. Cohort I (n=171) consisted of patients who were operated on during 1995, before the institution of any policy concerning LOS. Cohort II (n=95) contained patients operated on between January and August 1996, inclusive. During this period, there was a policy of intending to discharge patients deemed by their cardiologist to be at low risk for perioperative myocardial ischemia on the first postoperative day. Cohort III (n=155) consisted of patients who were operated on between September 1996 and December 1997, inclusive. During this period, we instituted a universal single-day-stay policy. Each operation was placed into the cohort during which it was performed.

Patient Profile

The mean age of the patients was 70.2±0.4 years (cohort I: 70.1±0.6; II: 70.0±0.8; III: 70.5±0.7), range 37 to 87 years. Two hundred sixteen patients (51%) were men (I: 48%; II: 48%; III: 57%, P=NS) and 205 (49%) were women. Information about indications for surgery was available for 401 patients. Seventy-five patients (I: 21%; II: 20%; III: 15%; P=NS) had suffered a previous ipsilateral stroke. One hundred twenty-three patients (I: 28%; II: 31%; III: 33%, P=NS) presented with ipsilateral transient ischemic attacks or ipsilateral amaurosis fugax. Dizziness was not counted as a transient ischemic attack unless another symptom clearly referable to the anterior circulation was noted (numbness, weakness, amaurosis fugax). All symptomatic patients exhibited >70% stenosis. Two hundred three patients (I: 50%; II: 50%; III: 49%, P=NS) were asymptomatic and were operated on for a critical stenosis >60%. Patients who underwent simultaneous CEA and coronary artery bypass procedures were excluded.

Of the 364 patients (86%) for whom risk factor data were available, 231 (I: 58%; II: 63%; III: 70%, P<0.05 for I versus III) of the patients had hypertension, 115 (I: 21%; II: 23%; III: 54%, P<0.001 for I versus III) had hypercholesterolemia, and 73 (I: 17%; II: 25%; III: 22%; P=NS) had diabetes mellitus. Because angiography was performed only in a small minority of cases (see perioperative management), information that would have allowed differentiation of patients in Sundt grade I from grade II (angiographic risk factors) was not available. As the reported risk of grades I and II are both less than 2%, we combined them into one group for analysis. Of the 419 (99%) operations for whom we were able to retrospectively assign a Sundt grade, 162 (I: 38%; II: 38%; III: 40%, P=NS) were classified as either grade I or II, 245 (I: 59%; II: 57%; III: 59%, P=NS) were grade III, and 12 (I: 4%; II: 4%; III: 1%, P=NS) were grade IV. We may have included some patients in the lowest-risk group (grade I or II) who should have been included in grade III based on their degree of hypertension (>180/110 mm Hg), because information regarding actual degree of hypertension was not available in the records we reviewed. Finally, there was an even distribution of asymptomatic cases in each cohort (I: 50%; II: 50%; III: 49%; P=NS). In summary, there were no differences in the cohorts with respect to risk factors except that cohort III patients tended more often to be hypertensive and hypercholesterolemic.

Perioperative Management

Patients were evaluated preoperatively with duplex Doppler and MR angiography in the vast majority of cases, as outlined and validated in our previous report by Lustgarten et al.5,6 During the study period, 5 patients underwent angiographic workup: 2 in cohort I, 1 in cohort II, and 2 in cohort III. In asymptomatic patients these studies were performed on an outpatient basis, whereas symptomatic patients often underwent some in-hospital evaluation. At no time between January 1995 and December 1997 did our policy of radiographic evaluation change.

All symptomatic patients underwent surgery without stopping their heparin infusions, but no patient was otherwise premedicated. General anesthesia was induced primarily with fentanyl, midazolam, and succinylcholine and maintained with isoflurane as tolerated. Standard monitors were applied, including an arterial catheter for measuring blood pressure continuously. All patients (including those receiving heparin infusions) received a 5000-U heparin bolus before carotid cross-clamp. In addition, continuous EEG monitoring was performed on all patients (Neurotrac II). Shunting was performed only for a significant EEG change, which was defined as ≥50% decrease in amplitude in the alpha or beta frequencies and a similar increase in the delta or theta frequencies, or complete loss of all cerebral electrical activity.7 The carotid arteriotomy was closed primarily with simple 6–0 prolene except in reoperations (n=1) or in patients who had received radiation to the neck (n=2). In these cases a vein patch was used. Postoperatively, patients were taken directly to the neurosurgical intensive care unit (ICU) where hemodynamic and neurologic status was closely monitored. Arterial blood pressures were transduced and the ECG monitored. All patients stayed in the ICU overnight.

Patients in cohort III were discharged home on postoperative day 1 if they had been hemodynamically stable (off of intravenous blood pressure medicines) and neurologically stable overnight and were able to ambulate and void. If not, a decision was made, based on the above parameters, as to whether the patient required continued ICU monitoring or could safely be transferred to the surgical floor. Cohort II patients were similarly managed if their cardiologist felt they were at low risk for perioperative myocardial ischemia based on preoperative evaluation. Otherwise, they were kept at least an extra day to check their 24-hour cardiac enzyme levels. All cohort I patients were treated with a routine postoperative day on the surgical floor.

Throughout the course of the study, an occasional patient expressed the desire to stay for social reasons (ie, no transportation home) or subjective tiredness. No such request was denied. Although it was difficult to determine which cohort II patients were kept for this reason, as a routine cardiac workup was often ordered, only 10 patients (6%) in cohort III were kept a second day for this reason.

Statistical Analysis

The data were collected with use of a computer database (Excel 5.0, Microsoft Corporation, 1995). Statistical analysis was performed with Instat software (Version 2.01, GraphPad Software, 1993). All values are expressed as mean±SEM. Statistical significance of differences between cohorts, defined as P<0.05, was determined with a 2-tailed Mann-Whitney test or Welch approximate t test.

Results

Complications

The overall complication rate by cohort is given in Tables 1 and 2. There was no obvious association between the rate of complications and LOS, and there was no statistical difference in the rate of major complications (death, myocardial infarction, or stroke) between cohorts. Two perioperative deaths (0.48%), both from ipsilateral hemispheric ischemic strokes, occurred during the study, 1 in cohort I and 1 in cohort III. Both patients had a known contralateral carotid occlusion. Two myocardial infarctions (0.48%) occurred. One involved asymptomatic ECG changes that subsequently resolved before discharge. The other patient was also found to have asymptomatic ECG changes. An echocardiogram showed basilar inferior middle septal/inferior apical hypokinesis with a moderately decreased ejection fraction. A diagnosis of a non-Q wave myocardial infarction was made, and the patient was discharged home in stable medical and neurological condition.

Thirteen strokes (3.1%) occurred [cohort I: 7 (4.1%); II: 3 (3.2%); III: 3 (2.0%)], including the 2 that resulted in death. All strokes were ipsilateral; 3 had a hemorrhagic component.
determined radiologically. Differences in the stroke rate between cohorts were not statistically significant. The characteristics of the strokes are presented in Table 3.

Seven patients (1.7%) underwent reoperation, 3 for acute exploration of the endarterectomized vessel for contralateral hemiparesis or hemiplegia with angiographic findings indicative of thrombus or a hemodynamically significant intimal flap, 2 for acute evacuation of a neck hematoma, and 2 for delayed drainage of wound infections. One wound infection was drained 2 weeks postoperatively. The other required 2 reoperations for complete drainage 11 and 18 days postoperatively.

Nerve injury occurred in 13 patients (3.1%). Nine were mild injuries of the marginal mandibular nerve, and 2 were injuries to the hypoglossal nerve that caused mild swallowing difficulty and tongue deviation. The final 2 cases were mild hoarseness caused either by endotracheal tube trauma or retraction injury to the superior or recurrent laryngeal nerve. In all cases the nerve injury was evident immediately and resolved by 6 weeks postoperatively. All complications were manifest by 24 hours with the exception of the wound infections, which were diagnosed 10 days and 2 weeks postoperatively, and 3 of the strokes that occurred 3, 7, and 24 days postoperatively.

**Length of Stay**

After surgery, the mean time to discharge for all patients was 2.1 ± 0.2 days. The mean postoperative LOS for patients in cohort I was 2.6 ± 0.3 days, for cohort II 2.3 ± 0.4 days, and for cohort III 1.6 ± 0.1 days. The decreases in postoperative LOS from cohort I to cohort II was not significant (P = 0.3), whereas the decrease in LOS from cohort I to cohort III (P < 0.0001) and cohort II to cohort III (P = 0.0001) were very statistically significant. The mean total LOS for the entire study population was 2.9 ± 0.2 days; for cohorts I, II, and III

**TABLE 1. All Complications by Cohort**

<table>
<thead>
<tr>
<th>Complications</th>
<th>Cohort I, n (%)</th>
<th>Cohort II, n (%)</th>
<th>Cohort III, n (%)</th>
<th>Total, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>1 (0.6)</td>
<td>0</td>
<td>1 (0.7)</td>
<td>2 (0.5)</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>0</td>
<td>2 (2.1)</td>
<td>0</td>
<td>2 (0.5)</td>
</tr>
<tr>
<td>CN deficit</td>
<td>9 (5.3)</td>
<td>2 (2.1)</td>
<td>2 (1.3)</td>
<td>13 (3.1)</td>
</tr>
<tr>
<td>Reoperation</td>
<td>2 (1.2)</td>
<td>2 (2.1)</td>
<td>3 (1.9)</td>
<td>7 (1.7)</td>
</tr>
<tr>
<td>Hematoma*</td>
<td>4 (2.3)</td>
<td>9 (9.5)†</td>
<td>3 (1.9)</td>
<td>16 (3.8)</td>
</tr>
<tr>
<td>Stroke</td>
<td>5 (2.9)</td>
<td>2 (2.1)</td>
<td>3 (1.9)</td>
<td>10 (2.4)</td>
</tr>
<tr>
<td>Subtotal</td>
<td>21 (12.3)</td>
<td>17 (17.9)</td>
<td>12 (7.7)</td>
<td>50 (11.9)</td>
</tr>
<tr>
<td>Per patient</td>
<td>18 (10.6)</td>
<td>15 (15.8)‡</td>
<td>8 (5.1)</td>
<td>41 (9.8)</td>
</tr>
</tbody>
</table>

**Early outpatient (within 1 month of discharge)**

<table>
<thead>
<tr>
<th>Complication</th>
<th>Cohort I, n (%)</th>
<th>Cohort II, n (%)</th>
<th>Cohort III, n (%)</th>
<th>Total, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke</td>
<td>2 (1.2)</td>
<td>1 (1.0)</td>
<td>0</td>
<td>3 (0.7)</td>
</tr>
<tr>
<td>Infection§</td>
<td>0</td>
<td>2 (2.1)</td>
<td>0</td>
<td>2 (0.5)</td>
</tr>
<tr>
<td>Subtotal</td>
<td>2 (1.2)</td>
<td>3 (3.2)</td>
<td>0</td>
<td>5 (1.2)</td>
</tr>
</tbody>
</table>

**All**

<table>
<thead>
<tr>
<th>Complication</th>
<th>Cohort I, n (%)</th>
<th>Cohort II, n (%)</th>
<th>Cohort III, n (%)</th>
<th>Total, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>1 (0.6)</td>
<td>0</td>
<td>1 (0.7)</td>
<td>2 (0.5)</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>0</td>
<td>2 (2.1)</td>
<td>0</td>
<td>2 (0.5)</td>
</tr>
<tr>
<td>Stroke</td>
<td>7 (4.1)</td>
<td>3 (3.2)</td>
<td>3 (1.9)</td>
<td>13 (3.1)</td>
</tr>
<tr>
<td>Cranial nerve deficit</td>
<td>9 (5.3)</td>
<td>2 (2.1)</td>
<td>2 (1.3)</td>
<td>13 (3.1)</td>
</tr>
<tr>
<td>Reoperation</td>
<td>2 (1.2)</td>
<td>2 (2.1)</td>
<td>3 (1.9)</td>
<td>7 (1.7)</td>
</tr>
<tr>
<td>Infection</td>
<td>0</td>
<td>2 (2.1)</td>
<td>0</td>
<td>2 (0.5)</td>
</tr>
<tr>
<td>Hematoma</td>
<td>4 (2.3)</td>
<td>9 (9.5)†</td>
<td>3 (1.9)</td>
<td>16 (3.8)</td>
</tr>
<tr>
<td>Subtotal</td>
<td>23 (13.5)</td>
<td>20 (21)</td>
<td>12 (7.7)</td>
<td>55 (14.1)</td>
</tr>
<tr>
<td>Per patient</td>
<td>20 (11.8)</td>
<td>18 (19)</td>
<td>8 (5.1)</td>
<td>46 (11)</td>
</tr>
</tbody>
</table>

*N=NS for all comparisons, using the Fisher exact test for 2-tailed contingency tables.

**TABLE 2. Significant Early Complications Leading to Increased Length of Stay**

<table>
<thead>
<tr>
<th>Complication</th>
<th>Cohort I, n (%)</th>
<th>Cohort II, n (%)</th>
<th>Cohort III, n (%)</th>
<th>Total, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myocardial infarction</td>
<td>0</td>
<td>2 (2.1)</td>
<td>0</td>
<td>2 (0.5)</td>
</tr>
<tr>
<td>Reoperation</td>
<td>2 (1.2)</td>
<td>2 (2.1)</td>
<td>3 (1.9)</td>
<td>7 (1.7)</td>
</tr>
<tr>
<td>Stroke</td>
<td>5 (2.9)</td>
<td>2 (2.1)</td>
<td>3 (1.9)</td>
<td>10 (2.4)</td>
</tr>
<tr>
<td>Total</td>
<td>7 (4.0)</td>
<td>6 (6.3)</td>
<td>6 (3.9)</td>
<td>19 (4.5)</td>
</tr>
</tbody>
</table>

*P = NS for all comparisons, using the Fisher exact test for 2-tailed contingency tables.
mean totals were 3.4±0.4, 2.8±0.4, and 2.3±0.2 days, respectively. The differences between cohort I and cohort III (P<0.0001) and cohorts II and III (P<0.0001) showed strong statistical significance. The median total LOS was 2 days for cohorts I and II and 1 day for cohort III.

In cohort I, 54 patients (32%) were discharged on postoperative day 1. In contrast, 39 patients (41%) in cohort II and 108 patients (70%) in cohort III were discharged on the first postoperative day. Ninety-two percent of patients in cohort III were discharged by postoperative day 2.

### Radiographic Resource Utilization

A total of 94 postoperative chest radiographs (22%) were taken during the study. By cohort, the values were as follows: I, 50 (29%); II, 12 (13%); and III, 32 (21%). To determine whether there were a few patients undergoing many radiographic studies or these were spread evenly through the study group, we determined the number of patients who had at least 1 chest radiograph after surgery, compared with 11 (12%) in cohort II and 21 (14%) in cohort III.

### Laboratory Study Utilization

A trend of decreasing utilization of standard laboratory tests was noted during the study. Decreases in the mean number of CBCs from cohort I to cohort II (P=0.07) and cohort II to cohort III (P=0.07) were not statistically significant. However, the difference in mean CBCs ordered in cohorts I and III was highly statistically significant (P<0.0001). Although there was not a statistically significant decrease in mean number of electrolyte studies ordered in cohorts I (2.3±0.2) and II (1.8±0.2) (P=0.07) or between cohorts II and III (1.7±0.2) (P=0.2), the difference between cohorts I and III was statistically significant (P<0.0008). By contrast, the mean number of arterial blood gas measurements obtained per patient remained steady [cohort I (1.5±0.1) versus cohort III (1.4±0.1), P=0.2], which suggests that operating room and ICU services were uniform throughout the study period, despite the change in the use of floor-based services. Finally, the total number of laboratory studies ordered decreased from a mean of 8.0±0.8 per patient in cohort I to 6.4±0.5 in cohort III. This was statistically significant (P=0.009). The median number of laboratory studies decreased throughout the study as well (cohort I, 6; II, 5; and III, 4).

### Discussion

With the number of carotid endarterectomies performed annually now exceeding 100 000 and the recent development of alternative methods of extracranial revascularization aimed at stroke prevention, there exists an increasing need to examine the methods by which procedural costs might be contained. To date, most groups concerned with endarterectomy have focused on reducing cost by decreasing ICU utilization, or in some cases by substituting local for general anesthesia. Unfortunately, while initially attractive, these strategies may unwittingly deny patients access to certain time-honored cerebroprotective pharmacological maneuvers as well as critical postoperative physiological monitoring, which has been shown to be useful in managing rare complications such as arrhythmias secondary to myocardial infarction and the hyperperfusion syndrome. Moreover, these sacrifices have not as yet been shown to necessarily reduce cost, aside from an unclear association with reducing the length of hospital stay.

Thus, in an effort to determine whether we could safely reduce cost solely by reducing LOS without eliminating ICU observation or switching anesthetic paradigms, we gradually adopted a paradigm of early discharge to home after a 12- to 18-hour observation period in the neurological ICU. During this transition, we continued to keep certain patients “in-house” for an additional 24 hours to monitor cardiac enzymes in the event that preoperative cardiological evaluation had determined them to be at increased risk for perioperative ischemia. After 8 months of this transitional management paradigm, we realized that no “high-risk” patient’s management was affected by the additional 24-hour stay, thereby...

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**TABLE 3. Characteristics of Strokes by Cohort**

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Side of CEA</th>
<th>Time to Symptoms</th>
<th>Radiological Findings</th>
<th>Outcome</th>
<th>GOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>L</td>
<td>30 min</td>
<td>Large L MCA ischemic infarct</td>
<td>R hemiplegia, aphasia</td>
<td>4</td>
</tr>
<tr>
<td>I</td>
<td>R</td>
<td>Immediate</td>
<td>R hemispheric ischemic infarct</td>
<td>Death</td>
<td>5</td>
</tr>
<tr>
<td>I</td>
<td>R</td>
<td>3 d</td>
<td>5-mm R putamen hemorrhagic infarct</td>
<td>Increased L arm leg weakness</td>
<td>2</td>
</tr>
<tr>
<td>I</td>
<td>R</td>
<td>Immediate</td>
<td>R basal ganglia ischemic infarct</td>
<td>L arm greater than leg weakness</td>
<td>2</td>
</tr>
<tr>
<td>I</td>
<td>R</td>
<td>1 w</td>
<td>L superior frontal gyrus hemorrhage</td>
<td>Decreased cognition</td>
<td>2</td>
</tr>
<tr>
<td>I</td>
<td>Reop L</td>
<td>Immediate</td>
<td>L hemispheric ischemic infarct</td>
<td>Aphasia, hemiparesis</td>
<td>3</td>
</tr>
<tr>
<td>II</td>
<td>L</td>
<td>Immediate</td>
<td>L watershed deep and subcortical ischemic infarct</td>
<td>R hemineglect, dense right hemiplegia</td>
<td>3</td>
</tr>
<tr>
<td>II</td>
<td>L</td>
<td>No imaging obtained</td>
<td>L posterior temporal/occipital ischemic infarct</td>
<td>Slight R arm weakness, normal speech</td>
<td>2</td>
</tr>
<tr>
<td>II</td>
<td>L</td>
<td>24 d</td>
<td>L posterior-frontal subacute ischemic infarct</td>
<td>Slight R arm weakness, aphasia at preoperative baseline</td>
<td>3</td>
</tr>
<tr>
<td>III</td>
<td>L</td>
<td>1 h</td>
<td>L MCA ischemic infarct, acute L parietal and frontal hemorrhage</td>
<td>Word-finding difficulty</td>
<td>2</td>
</tr>
<tr>
<td>III</td>
<td>R</td>
<td>6–8 h</td>
<td>R hemispheric ischemic infarct</td>
<td>Death</td>
<td>5</td>
</tr>
<tr>
<td>III</td>
<td>L</td>
<td>Immediate</td>
<td>L posterior frontal and parietal ischemic infarcts</td>
<td>Slurred speech, ambulating, weak R arm</td>
<td>3</td>
</tr>
</tbody>
</table>

GOS indicates Glasgow Outcome Scale score; Reop, reoperation; and MCA, middle cerebral artery.
emboldening us to discharge patients directly from the ICU unless there was compelling evidence of perioperative myocardial/cerebral ischemia or the development of some periprocedural complication (eg, pneumonia, urinary tract infection, or wound hematoma). Once we had fully transitioned to the new policy, we treated an additional 155 cases and retrospectively reviewed our experience to determine whether there was any increase in the number of periprocedural complications or untoward outcomes and whether this policy had any indirect effect on ancillary radiographic/laboratory resource utilization.

In short, we were able to reduce LOS by 40%, increasing the number of next-day discharges from 32% to 70%. Coincident with this decrease in stay, we witnessed a statistically significant reduction (20%) in the use of routine laboratory studies, with the average patient undergoing one third fewer tests. These reductions were achieved while patient age, as well as the severity of medical and neurological illnesses, remained essentially unchanged. Similarly, surgeon experience, which has been an issue in previous cost-saving studies, did not increase dramatically, as each surgeon had performed in excess of 75 endarterectomies per year by the same technique for 7 years prior to the study period and institutional volume had not changed in nearly 15 years. Furthermore, these reductions in LOS and resource utilization did not appear to be the result of reductions in the number of periprocedural complications, nor did efforts to reduce LOS result in any increase in either in-hospital or posthospital complications. In fact, the in-house stroke rate remained between 2% and 3% for each cohort, and no patient’s stroke would have been avoided or managed more effectively by any increase in LOS. As the only myocardial infarctions and wound infections occurred in cohort II, this clustering clearly did not affect the safe reductions witnessed in cohort III in comparison with cohort I. Finally, although there does appear to be a reduced incidence of nerve injuries over time, no patient suffering a nerve injury required prolonged stay, with tongue deviation and hoarseness without swallowing difficulty being the sole symptoms.

When compared with prior efforts at reducing LOS without eliminating either ICU stay or general anesthesia, these results compare favorably, with Dardik et al achieving 2.8 days and Friedman and Tortolani 1.13 days. In fact, the best LOSs recorded with recovery room alone and local anesthesia still run 1.56 days. Thus, while several groups continue to question the need for routine ICU monitoring, arguing that if the blood pressure is stable in the first few postoperative hours it is likely to remain stable thereafter, we continue to witness what others have shown, namely, that severe hypertension affects as many as 40%, requires pressors in 75%, and usually lasts 12 to 24 hours. Severe hypertension may also occur, and although less frequent, it is less predictable, and requires a more experienced staff to manage it safely. For these reasons the prolonged use of the recovery room to determine which patients need ICU care or the use of intermediate care units for routine postoperative monitoring have proved less attractive options. Instead, we tend to agree with Kaufmann et al that “the issue is not which critical care area one chooses for early postoperative care after carotid surgery, as the true resource cost structure of a particular hospital may favor one acute care area over another; rather, the issue is the efficiency with which problems such as blood pressure control are addressed, so that the patient is ready for discharge the day after surgery”.

Recently, percutaneous transluminal angioplasty with stenting of the carotid artery has been offered as an alternative treatment for both asymptomatic and symptomatic lesions. Among the proposed advantages of endovascular treatment of carotid stenosis is the possibility of reduced hospital stays, ostensibly because of the less invasive nature of the procedure. With the need to monitor the groin for sheath related complications, it is hard to see how future randomized studies will show any benefit whatsoever, especially with nonrandomized, retrospective studies already showing no benefit. Nonetheless, we await this data anxiously.

Conclusion

With the efficacy of CEA established, attention has now shifted to maintaining a low complication rate while decreasing costs. At our institution, we have achieved a low complication rate by performing the operation under general anesthesia and monitoring patients in the ICU routinely. This study demonstrates that a decrease in LOS and resource utilization is possible by the institution of a next-day discharge policy without increasing complications or limiting care.

Acknowledgments

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References

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