Clinical Efficiency Tools Improve Stroke Management in a Rural Southern Health System

Samuel D. Newell, Jr, MD; Janet Englert, RN; Anita Box-Taylor, RN; Kenneth M. Davis, MD, MPH; Karen E. Koch, PharmD

Background and Purpose—Ischemic stroke is a high-volume and financially draining diagnosis at this rural health system. The purpose of this clinical practice analysis was to identify resource utilization and clinical process inefficiencies and to promote clinically efficient, evidence-based improvements.

Methods—A retrospective analysis of medical record and financial databases of 356 patients with ischemic stroke was performed. The medical record data were adjusted for severity, and outliers were eliminated. The resources utilized by each physician were determined. Comparative graphs were prepared, presented, and discussed. The physicians implemented two types of changes: (1) alteration of resource utilization and consultation patterns and (2) support of clinical process improvement. In 1997, a follow-up analysis of 399 patients was performed.

Results—The initial comparison of internists’ to neurologists’ patient populations found the following: patient age (75 versus 65 years), patient severity ratings (2.8 versus 2.5), length of stay (10.7 versus 8.8 days), costs ($7360 versus $6862), mortality rates (12.5% versus 8.9%), and aspiration pneumonia rate (8.5% versus 3.8%). A comparison of the 1995 analysis to the 1997 analysis revealed the following per patient resource utilization decreases (all \(P<0.05\)): chemistry laboratory, 2.65 to 1.95 studies; intravenous fluids, 2.85 to 1.85 L; oxygen use, 6.06 to 2.75 U; and nifedipine use, 1.62 to 0.33 capsules. The clinical process improvements resulted in the following overall outcomes (all \(P<0.05\) except mortality): length of stay (7.2 days), nonadjusted costs ($6246), mortality (6.5%), and rates of pneumonia (2.7%).

Conclusions—Objective analysis of resource utilization resulted in physicians changing their individual management of stroke and collectively supporting clinical process changes that improved clinical and financial outcomes. (Stroke. 1998;29:1092-1098.)

Key Words: cost and cost analysis ■ quality of health care ■ stroke management

Mississippi is in the middle of the “Stroke Belt,” a section of the southeast United States with the highest stroke-related death rates in the United States. In 1994, the Mississippi Foundation for Medical Care, a PRO, used six basic predetermined criteria and reviewed 427 patients at four facilities. The review of this comparative database became a springboard for each facility to discuss and improve stroke management.

Our facility was in the PRO’s initial survey. In concert with the qualitative care indicators that the PRO was measuring, our facility’s internal evaluation found that stroke (DRG 014), specifically ischemic stroke, was its most financially draining diagnosis (loss of more than one million dollars in 1993). Stroke is a large-volume diagnosis at our facility, with an average of 400 cases per year. The volume, along with the financial loss, provided significant motivation for improving stroke management. Several factors, however, predicted that making improvements would be challenging, namely, (1) a wide variation in current stroke management; (2) a sense of complacency regarding the stroke population (ie, the myth that “not much could be done”); and (3) the requirement of multidisciplinary management.

Stroke units, protocols, care guides, team care, and case management have helped other facilities to improve their management of stroke. These clinical management tools are usually more effective when the medical staff has participated in their development and supports their use. This article describes the use of clinical efficiency tools to determine each physician’s resource utilization and clinical outcomes as well as the resulting stroke management changes that the medical staff personally implemented and collectively supported.

Subjects and Methods

Background

Our 647-bed facility is the tertiary-care referral center of an integrated rural healthcare system that serves more than 600,000 people in a 22-county region in northern Mississippi, Alabama, and Tennessee. In addition to our facility, our health system consists of four community hospitals, 32 family medicine clinics, 3 nursing homes, 5 internal medicine clinics, and a home healthcare agency.
Selected Abbreviations and Acronyms

COPD = chronic obstructive pulmonary disease  
CPA = clinical practice analysis  
DRG = diagnosis related group  
FY = fiscal year  
ICD-9 = *International Classification of Diseases, Ninth Revision*  
LOS = length of stay  
PRO = physician review organization  
RCM = rehabilitation case manager  
SCM = stroke case manager  
SITF = Stroke Initiative Task Force

that provides an average of 500 000 visits per year. The details of system integration are important because stroke management starts with its prevention in the primary care settings and often ends in nursing homes or with assisted home living.

At the time of the initial PRO evaluation, our facility had four neurologists on staff and a neurological nursing unit, but no stroke case manager and no dedicated stroke unit. Our facility also had two physiatrists on staff and an inpatient acute rehabilitation unit.

The majority (88%) of our patients experienced ischemic stroke, which therefore became the focus of the CPA. Patients with hemorrhagic strokes or transient ischemic attacks were not included in this analysis. Since the patient population was identified by ICD-9 codes (173 were ischemic stroke patients). The PRO tabulated the information and presented our results as a subgroup of the statewide findings to a group of neurologists, internists, clinical managers, and administrators. In response to the stroke expert’s presentation, the Stroke Initiative Task Force (SITF), a multidisciplinary group, was formed to evaluate and improve stroke care.

Clinical Practice Analysis of Stroke

The SITF’s first step was to request a CPA of stroke. CPAs use severity-adjusted and resource utilization data to provide detailed reviews of medical and surgical diagnoses. The CPA was managed by a clinical efficiency provider, an experienced nurse with training in health information and clinical and financial database management. The SITF worked with the clinical efficiency provider to determine the parameters of the CPA.

The goal of this CPA was to improve the clinical efficiency (ie, good outcomes with optimal resource utilization), and therefore it went beyond the PRO study parameters, which were rooted solely in improving outcomes. To achieve clinical efficiency, the CPA also examined internal processes such as the timing of consultations and patients’ discharge placement.

The majority (88%) of our patients experienced ischemic stroke, which therefore became the focus of the CPA. Patients with hemorrhagic strokes or transient ischemic attacks were not included in this analysis. Since the patient population was identified by ICD-9 codes for ischemia, patients who underwent carotid endarterectomy procedures were excluded from this study population because the procedure places them in a surgical DRG. The CPA process used proprietary severity-adjusting software (3 M-APR DRG) to determine each stroke patient’s severity on a scale of 1 to 4, with 4 being the worst. The patients’ severity level was based on their coded comorbidities, complications, risk of mortality, age, sex, and discharge status. To determine each physician’s patient population’s average severity level, the clinical efficiency provider defined the patient population (time frame, financial status for inpatients, facility, DRG 014, and ICD-9 codes for ischemia); identified each physician’s ischemic stroke patients; and finally used the medical record database to produce an average severity index for each physician’s stroke patients in the defined population. Patients whose cost of care or LOS was more than twice the population average were identified as outliers. They were noted in the CPA but were excluded from the comparative database.

The resource utilization of each physician managing ischemic stroke was then examined. The clinical efficiency provider used an internally developed financial database, cost-information decision support (CIDS), which is housed in Oracle and is electronically accessed through Powersoft’s Infomaker, a query and reporting tool. This information was combined with the severity-adjusted data to provide a database of more than 100 elements. The clinical efficiency provider and one of the neurologists reviewed the initial findings, then selected the elements that would be analyzed and presented. The criteria for their selection included evidence-based diagnostic and treatment recommendations as well as observed internal variations in resource utilization. Two CPAs were performed: one for the neurologists and one for the internists, which was compared with the neurologists’ CPA.

The clinical efficiency provider prepared graphs that compared each physician’s ischemic stroke management with that of his or her colleagues as well as with internal and external benchmarks. Bar graphs and scattergrams depicted each physician’s patient population’s severity, LOS, overall costs, and resource utilization. The physicians were each identified by a letter.

CPR Presentation and Improvement Plans

At the beginning of the CPA presentation, each physician was given an envelope with his or her identifying letter inside. This enabled the physicians to privately view and compare their resource and outcome information. The clinical efficiency provider described each graph and encouraged questions and discussion.

The neurologists’ CPA was presented in January 1996. Although their outcomes were generally good, they agreed that they could reduce the incidence of aspiration pneumonia and improve several inefficiencies in their overall management (ie, lag time in orders, rehabilitation evaluations, and discharge placement). The neurologists developed a process improvement plan that included hiring a stroke case manager, enhancing the stroke care team, creating a stroke unit, and developing a stroke care guide. The internists’ CPA was presented in November 1996, and these physicians were encouraged to take advantage of the process improvements that the neurologists had implemented.

Data Analysis

The impact of these improvements was tracked by both economic and clinical outcomes: cost of care, LOS, mortality, and complication rate, specifically aspiration pneumonia. Although outcome data are available since the initial PRO review (1993 data), statistical analysis was performed only on the initial CPA data (1995) and data from the most recent year (1997). The Student’s t test was applied to the parametric data (cost, LOS), whereas the χ² test was applied to the nonparametric data (mortality, aspiration pneumonia) and to the resource utilization data in which we compared proportions. A value of P≤0.05 was selected as significant, and correlative statistics were performed with the use of electronic software, Sigma Stat (SPSS).

Results

The 1995 baseline CPA found that the neurologists had both a shorter LOS (8.8 versus 10.7 days) and a lower cost ($6862 versus $7360) than the internists managing ischemic stroke. The internists’ patients were older (75 versus 65 years) and had more comorbidities, which accounted for the slightly higher severity ranking (2.8 versus 2.5) (Figure 1). These rankings, however, were considered close enough to perform a valid practice management comparison. The racial composition of these populations was comparable: 24% of the 1995 patients were African American, as were 26% of the 1997 population. The percentages of patients who were outliers were also similar: 8.3% of internist’ patients and 8.1% of
neurologists’ patients in 1995, and 6.6% of internists’ patients and 5.2% of neurologists’ patients in 1997.

The CPA analyzed the physicians’ utilization of over 20 resources and reviewed three common patient comorbidities (diabetes, congestive heart failure, and COPD). The analyses of internists’ use of oxygen and patients with COPD are provided as examples of the individualized data analysis (Figures 2 and 3).

The key outcome parameters for the internists and the neurologists during FY 1995 through 1997 are depicted in Table 2. Statistical significance was achieved in the following key parameters: overall decrease in LOS (9.9 to 7.2 days; \( P = 0.049 \)); overall decrease in aspiration pneumonia (6.4% to 2.7%; \( P = 0.03 \)); and overall decrease in nonadjusted costs ($7111 to $6246; \( P = 0.001 \)) (note that the 1997 costs were not adjusted for inflation). The overall decrease in mortality (11.1% to 6.5%) approached statistical significance (\( P = 0.063 \)).

The collective use of individual resources for the internists and the neurologists during FY 1995 and 1997 is depicted in Table 3. Changes in resource utilization were measured as an average of what each physician group used per patient. The following changes from 1995 to 1997 achieved statistical significance: increase in MR angiography usage (0.22 to 0.41 studies per patient; \( P = 0.001 \)); decrease in basic electrolyte chemistry laboratory tests, “Chem 7” orders (1.94 to 1.43 serum concentrations per patient; \( P = 0.001 \)); decrease in expanded electrolyte and enzyme chemistry laboratory tests, “Chem 12” and “Chem 18” orders (0.71 to 0.52 serum concentrations per patient; \( P = 0.011 \)); decrease in prothrombin time orders (2.92 to 2.27 prothrombin time orders per patient; \( P = 0.004 \)); decrease in liters of intravenous solutions (2.85 to 1.85 L per patient; \( P = 0.001 \)); decrease in increments of oxygen usage, (6.06 to 2.75 increments per patient; \( P = 0.001 \)) (note that oxygen is billed for, and therefore measured, in 12-hour increments); and decrease in nifedipine usage (1.62 to 0.33 capsules per patient; \( P = 0.001 \)).

The only resource of potentially considerable impact that was not compared between the two time periods was tissue plasminogen activator. During FY 1997, two patients received tissue plasminogen activator, and they are included in the 1997 patient data. This usage could not be compared with usage in 1995, and it was too low to evaluate its potential impact on overall costs or mortality.

It is difficult to quantify process data from the financial database. One process parameter, however, was determined: the mean number of days from patient admission to the consultation of the stroke team. In 1995 the internists consulted the stroke team on day 3 of the patients’ admission. This consultation pattern changed to day 1 in 1997.

**Discussion**

The significant improvements in ischemic stroke management started from an external chart review of clinical out-
comes and were completed by an internal database analysis of clinical efficiency. The SITF responded to the two pharmacotherapy-related PRO issues by producing a pharmacy newsletter on the dangers of sublingual nifedipine and posting laminated signs that reminded physicians to order subcutaneous heparin for immobilized and/or stroke patients. These passive actions did not ensure positive changes, and therefore the SITF turned to the CPA process to actively engage the medical staff in the improvement process.

Clinical efficiency tools were used for three purposes: (1) to objectively determine the baseline practice and outcomes; (2) to create a forum for reviewing evidence-based literature, resource utilization, and clinical processes; and (3) to measure the outcome of the practice changes. The CPA relies on medical record coding and a financial database. Although these databases have limitations, the CPA identified inconsistent and excessive resource utilization. The physicians became engaged in resource utilization because it was individualized. For example, oxygen use was reviewed, and one physician (physician F) was using an average of 21.9 U of oxygen therapy per patient. However, when the comorbidities were analyzed, none of physician F’s patients had a pulmonary comorbidity (Figures 2 and 3). Note that overall use of oxygen decreased by 55% (Table 3).

The CPA could not address clinical processes or appropriateness of care, but it provided the stimulus for the medical staff to pursue these issues and make the necessary changes. For example, the internists were unaware that a rehabilitation evaluation should be ordered during the acute phase management. With this realization, the paradigm shifted, and they fully endorsed an automatic evaluation on day 3. During their CPA presentation, the neurologists discussed several general “coordination of care” problems. They recommended the hiring of an SCM to identify and solve specific process problems. The SCM coordinated the efforts that resulted in the significant decrease in overall LOS (9.9 to 7.2 days; \(P=0.049\)).

The SCM worked with the SITF to efficiently move patients through the evaluation and management processes. The first efficiency step was an obvious one: identify the etiology of the stroke as early as possible (within 24 to 48 hours) and plan the patient’s course of care within 48 to 72 hours. The neurologists expedited the diagnostic process by creating a standard list of diagnostic tests and defining when and why they are performed. CT scan of the head within 24 hours was one of the criteria of the PRO, and it is now routinely performed on admission (Tables 1 and 3).

Early diagnosis enables the neurologist to determine and implement the patient’s course of therapy. For example, if the patient had a correctable condition such as an internal carotid artery stenosis, then carotid endarterectomy could be considered. Early recognition of atrial fibrillation also stimulates specific treatment. In contrast, if the patient has a hopeless condition, such as a massive intracranial hemorrhage, then it may be more appropriate to implement social work and pastoral care consultations while exploring patient placement options. The majority of patients do not fit into either of these categories and benefit from early assessments of their rehabilitative abilities.

The second efficiency step improved patient care management processes through a proactive stroke team. Although a stroke team had been in place since 1988, the new emphasis on efficiency changed the composition of the team and its dynamics (ie, from passive to active). The SCM, an RCM, a social worker, and a psychological associate were added to the team, which already consisted of a neurologist, nurse, occupational therapist, speech therapist, physical therapist, pharmacist, dietician, and discharge planner. The stroke team meets weekly and is coordinated by the SCM.

Instead of waiting for individual consultations, the team members now automatically review patients as soon as a stroke team consultation is ordered. The occupational therapist, speech therapist, and physical therapist are required to complete their evaluations within 24 hours and will remove themselves from a case if they cannot offer the patient any benefits. The RCM reviews the therapists’ consultations and discusses the potential rehabilitation options with the patient’s family. This social worker also reviews the patient’s insurance coverage and coordinates this information for the rehabilitation physician, who determines the patient’s rehabilitation course (ie, acute, subacute, or outpatient). For example, if the patient’s family plans to care for him or her at home, the RCM provides them with a realistic picture of how to meet the patient’s needs. In this way the family can evaluate their ability to care for the patient, and, if necessary, nursing home placement plans can be made accordingly. Once the rehabilitation physician orders the patient’s course, the RCM then arranges specific bed location and other rehabilitation services for the patient.

The SCM optimizes the physicians’ rounds by making all the laboratory and study results available for their timely evaluation and ensuring that the physicians’ decisions and actions are carried out. If a patient care issue is not addressed during rounds, the SCM and other team members highlight

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**Figure 2.** Internists’ use of oxygen for 1995 (x axis, internists; y axis, average number of units per case).

**Figure 3.** Internists’ COPD comorbidity for 1995 (x axis, internists; y axis, percentage of patients with COPD).
the patient’s specific needs on a standard list of day 2 or day 4 patient care reminders and place it on the patient’s chart. These reminder lists were approved by the stroke team as a means for the nonphysicians to prompt the physicians about the patients’ nutrition, medication, activity level, and intravenous access status.

During the weekly team meetings, the stroke team discusses each patient’s progress and continues to make process improvements. For example, the stroke team identified “harmless” sips of water as a source of aspiration pneumonia and educated everyone with patient contact about them (Table 2). The stroke team incorporated all of these improvements into a clinical care guide. The care guide defines the first 24 hours of patient evaluation, after which the patient progresses through 48-hour “phases” that depend on the patient’s capabilities. A “decision time” is noted after the 24- to 72-hour phase and again at 5 days, and the goal is to discharge patients within the 7- to 9-day phase.

The stroke team’s lead neurologist presented the ischemic stroke care guide to the internists. This evidence-based stroke management review complemented the previously presented CPA and provided solutions to identified clinical and efficiency problems. The internists individually changed their resource utilization and collectively incorporated the stroke team process improvements into their practice. The ischemic stroke care guide was implemented in May 1997.

### Table 2. Comparison of Financial and Clinical Outcomes for FY 1995 and FY 1997

<table>
<thead>
<tr>
<th></th>
<th>1995 Data</th>
<th>1997 Data</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Internal Medicine</td>
<td>Neurologists</td>
<td>Total</td>
</tr>
<tr>
<td>No. of patients</td>
<td>200</td>
<td>156</td>
<td>356</td>
</tr>
<tr>
<td>Average cost, $</td>
<td>7402</td>
<td>6739</td>
<td>7111§</td>
</tr>
<tr>
<td>Average LOS, d</td>
<td>10.8†</td>
<td>8.7†‡</td>
<td>9.9§</td>
</tr>
<tr>
<td>Mortality</td>
<td>25 (12.5)</td>
<td>14 (8.9)</td>
<td>39 (11.0)</td>
</tr>
<tr>
<td>Aspiration pneumonia</td>
<td>17 (8.5)</td>
<td>6 (3.8)</td>
<td>23 (6.4§)</td>
</tr>
</tbody>
</table>

Values for mortality and aspiration pneumonia are number of patients (%).
*P<0.05, 1995 internists’ data vs 1997 internists’ data.
†P<0.05, neurologists’ data vs internists’ data during the same year.
‡P<0.05, 1995 neurologists’ data vs 1997 neurologists’ data.
§P<0.05, 1995 total data vs 1997 total data.

### Table 3. Comparison of Resource Utilization for FY 1995 and FY 1997

<table>
<thead>
<tr>
<th></th>
<th>1995 Data</th>
<th>1997 Data</th>
<th>P</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Internal Medicine</td>
<td>Neurologists</td>
<td>Usage per Patient</td>
</tr>
<tr>
<td>No. of patients</td>
<td>200</td>
<td>156</td>
<td>201</td>
</tr>
<tr>
<td>CT head</td>
<td>214</td>
<td>162</td>
<td>1.06</td>
</tr>
<tr>
<td>MRI head</td>
<td>100</td>
<td>114</td>
<td>0.60</td>
</tr>
<tr>
<td>MR angiography</td>
<td>28</td>
<td>52</td>
<td>0.22</td>
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<tr>
<td>Carotid angiography</td>
<td>10</td>
<td>30</td>
<td>0.11</td>
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<tr>
<td>ECGs</td>
<td>213</td>
<td>151</td>
<td>1.02</td>
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<tr>
<td>Arterial blood gases</td>
<td>89</td>
<td>102</td>
<td>0.54</td>
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<tr>
<td>Partial thromboplastin times</td>
<td>614</td>
<td>701</td>
<td>3.69</td>
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<tr>
<td>Prothrombin times</td>
<td>553</td>
<td>487</td>
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<tr>
<td>Chem 7†</td>
<td>426</td>
<td>264</td>
<td>1.94</td>
</tr>
<tr>
<td>Chem 12/18‡</td>
<td>131</td>
<td>123</td>
<td>0.71</td>
</tr>
<tr>
<td>Complete blood count</td>
<td>319</td>
<td>238</td>
<td>1.56</td>
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<tr>
<td>Oxygen units</td>
<td>1588</td>
<td>571</td>
<td>6.06</td>
</tr>
<tr>
<td>IV fluids (1000 mL)</td>
<td>530</td>
<td>486</td>
<td>2.85</td>
</tr>
<tr>
<td>Warfarin doses</td>
<td>456</td>
<td>381</td>
<td>2.35</td>
</tr>
<tr>
<td>Nifedipine doses</td>
<td>276</td>
<td>301</td>
<td>1.62</td>
</tr>
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</table>

*IV indicates intravenous.
*Probability values were obtained by comparing total usage per patient for 1995 with total usage per patient for 1997.
†Basic electrolyte chemistry laboratory test.
‡Expanded electrolyte and enzyme chemistry tests.
The SITF’s initial improvement plan included implementing a stroke unit. The CPA and resulting improvements were the basis of the unit’s proposal. An eight-bed stroke unit utilizing telemetry and dedicated nursing staff was incorporated into the neurological nursing unit in November 1997.

With the stroke management improvements in place at the tertiary care referral center, the stroke team’s lead neurologist presented stroke prevention and management guidelines to the health system’s primary care providers and community hospitals. During this time the health system implemented blood pressure screening at its 37 primary care clinics. Although the impact of the stroke team’s efficiencies and resource utilization changes was easily measured, it will be difficult to measure the long-term impact of system-wide blood pressure screening and a neurologist’s stroke prevention and stabilization tutorial. The assumption that better screening and prevention will result in fewer patients experiencing stroke is supported by the prediction of Pharaoh and Sanderson18 of a 17% reduction in stroke deaths after the implementation of a health promotion program.

Improving patient assessment and placement processes resulted in a statistically significant decreased LOS (9.9 to 7.2 days; \( P=0.049 \)). One of the concerns about showing a 4-day decrease in acute care LOS is that it may actually reflect a transfer of costs to another provider and not a true decrease in the patient’s total healthcare cost. The true impact of the shortened LOS can be assessed by the patients’ discharge status, specifically the percentage of patients who are discharged to their homes. During FY 1995, 52% of all stroke patients were discharged to their homes, whereas in FY 1997, 56% of stroke patients went directly to their homes. Since the number of patients discharged to home did not decrease, it would appear that the 4-day decrease in acute care LOS is a true decrease in overall healthcare expense. The discharge status of patients to nursing homes (7.4% in 1995 and 6.4% in 1997) and rehabilitation facilities (23.6% in 1995 and 23.7% in 1997) also remained constant.

The lasting process improvements can be attributed to the efforts of the SCM and the stroke team. The CPA process, however, is responsible for measuring outcomes and resource utilization and most importantly for stimulating the desire to make improvements. By providing detailed, line-item review of clinical practice, the CPA allowed the physicians to see how they were performing relative to each other and encouraged them to question their management. Alberts et al19 also found that educating physicians on the utilization and charges for their patients.

The management of stroke is complex and requires multidisciplinary involvement. CPA is a clinical efficiency tool that examines each step of stroke care management and creates a forum for multidisciplinary involvement. Healthcare facilities can use CPA to improve the efficiency of their acute care management and develop stroke units.

**Acknowledgments**

We would like to acknowledge Dorie Crouch for managing the databases and the stroke team members for their dedication to their patients.

**References**


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